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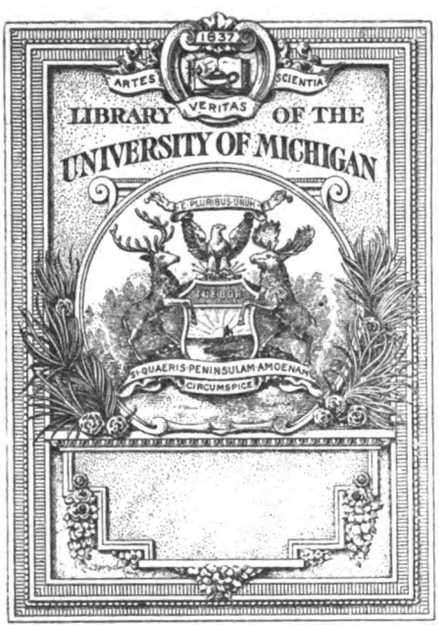

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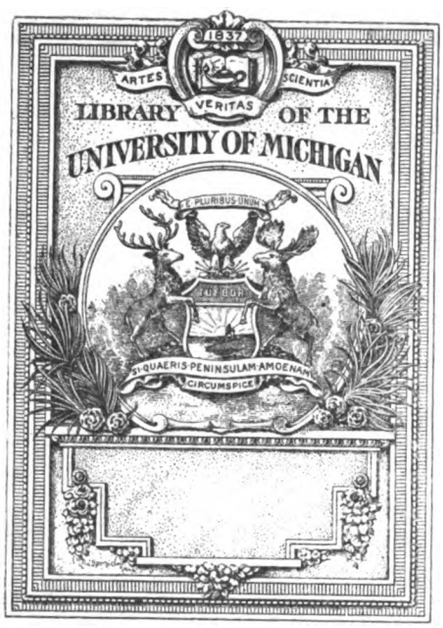

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INDEX TO VOL. XXX. (New Series.)

NOTE.—General Articles, Correspondence, and Companies' Meetings are indicated by heavier type (thus, 290) than the Notes and Business Notes, references to which are shown by light type (thus, 290).

A.

Accidents, 31, 32, 67, 101, 210, 247, 320, 352, 356, 357, 390, 394, 428, 462, 498, 500, 536, 541, 567, 570, 572, 643, 676, 715, 716, 749, 750, 752, 784, 788, 824, 892

Accumulators, etc.:
Combine for, 607, 642
Durability Tests of Storage Batteries, 544
Gaulard and Gibbs Patents, 131
Light-Weight Storage Batteries, 74, 904
Non-Active Metal for, A, 903
Silver for Electromobile Batteries, 473
Standard Cells, 326
Telephone Batteries, 146
for Traction, 74, 181, 473, 865, 904
Use of, 37

Addresses, New, or Change of, see "Removals"
Agencies, 66, 464, 715, 752, 860
Air-Pump Design, Some Notes on, C. L. Browne, 692, 733; also Supplement, Dec. 12
Airships, 325
Alcohol, Lighting by, 253
Alloys, Potential of, 903
All-Station Express, An, 398
Alternate-Current Curves, An Instrument for the Determination of, E. Goldschmidt, 117
Alternating Constant-Current Circuits, 363
Alternators, see DYNAMOS, ETC.
Aluminium, 483, 652, 710, 746
American University Power and Lighting Plant, F. C. Perkins, Supplement, Nov. 14
Appointments, 248, 253, 289, 320, 390, 464, 497, 500, 505, 567, 603, 671, 752, 753, 757, 758, 784, 787, 829
Appointments Vacant, 26, 60, 98, 125, 171, 208, 276, 317, 350, 377, 420, 461, 491, 530, 601, 632, 705, 741, 783, 819, 853, 887, 913
Arbitration at Devonport, 3
Arc Lamps, British Thomson-Houston Twin-Carbon, 275
Arc Lamps, Enclosed *v.* Open, 74
Arc Lamps, Tests of, 732
Arc Works, Chelmsford, 150
Arnold Single-Phase Railway System, 220
"Assistance," The, 357
Astor Turbine, The, 866
Atmosphere, The Electric Nitrification of the, W. H. Browne, Supplement, Dec. 12
Atmospheric Nitrogen, 328
Attractive Force and Magnetic Induction, 758
Automobiles, 2, 110, 139, 253, 281, 320, 321, 354, 462, 470, 473, 568, 644, 712, 714, 748, 749, 790, 822, 856, 857, 924
Awards, 38, 212, 218, 397, 505, 677, 722, 752, 824, 859

B.

Balance-Sheets and Reports of Electricity Works:
Aberdeen Report, etc., 563, 600
Barking Accounts, 96
Birkenhead Accounts, 349
Birmingham Tramways, 556
Bolton Tramways (E. Ll. Morgan), 493, 593
Brighton Accounts, 168
Bristol Accounts, 237
Bury Accounts, 23
Bury St. Edmunds Accounts, 95
Cardiff Accounts, 672
Chelmsford Company, 171
Cheltenham Accounts, 845
Chester Accounts, 129
Croydon Accounts, 238
Ealing Accounts, 23
East Ham Accounts, 565
Eccles Accounts, 97
Edinburgh Accounts, 633
Fareham Accounts, 744
Glasgow Telephones, etc., 238, 312
Gloucester Accounts, 96
Govan Accounts, 881
Greenock Accounts, 565
Grimsby Accounts, 206
Hammersmith Accounts, 600
Keighley Accounts, 671
Lancaster Accounts, 96
Leyton Accounts, 701
Luton Accounts, 206
Manchester Accounts, etc., 313, 743
Nottingham Accounts, 238
Oldham Accounts, 130
Portsmouth Accounts, 672
St. Helens Accounts, 490, 701
St. Pancras Accounts, 205
Salford Accounts, 129
Sheffield Accounts, 23
Southampton Accounts, 128
Stepney Accounts, 96
Stirling Accounts, Supplement, Dec. 12
Sunderland Accounts, 60
West Bromwich Accounts, 312
West Ham Accounts, 167
Wolverhampton Accounts, 130
Worcester Accounts, 278
York Accounts, 827

Balloons, Navigable, 831
Banti, Prof. A., The Castelli Coherer and the Royal Italian Navy Coherer, 55
Barnard, A. S., High-Tension Continuous-Current Systems, 14
Batteries, see ACCUMULATORS
Battersea Science Lectures, 685
Baum, F. G., Surges in Transmission Circuits, 188
Bellias and Morcom's Works, 510
Bismuth, 41
Bigge, D. S., The Application of Electric Power in the Iron and Steel Industries, 667, 700, 728
Bismuth-Polonium, Radioactive, 325
Booth, N. H., Smokeless Combustion of Bituminous Fuels, 552
Bradley, J. W., Street Lamp Testing, 732
Brazil, An Opening in, 589
Break, Break, Break (Poetry), 773
Brighton Exhibition, 573
Bristol Tramways Electrical Installation, J. C. Robinson, 155
British Thomson-Houston Company's Rugby Works, 582
Bromine, 901
Browne, C. L., Some Notes on Air-Pump Design, 692, 733; also Supplement, Dec. 12
Browne, W. H., The Electric Nitrification of the Atmosphere, Supplement, Dec 12

C.

Cable Laying at Dartmouth, 296
Cable Laying, Underground, A. T. Stewart, 152
Calcium Carbide, etc., 95, 326, 642
Cape Town Exhibition, 105
Carbides, Metallic, 326
Carbon Electrodes, Baking of, 290
Carbon Spectrum, The, 794
Cardiff Automatic Pumps, 626
Carnarvonshire Power Scheme, The, 91
Carpentier's Torsion Permeameter, 145
Castelli Coherer and the Royal Italian Navy Coherer, Prof. Banti, 55
Catalogues, 68, 104, 173, 174, 285, 312, 319, 356, 420, 529, 633, 753, 773, 857, 896; see also "Trade Notices"
Cathode Depolarisation, etc., 181, 184
Cauvery Power Transmission, 109, 184, 618
Central-Station Heating, 758
Cerium Silicide, 577
Chelmsford Lectures, 521, 522
Chloric Acid, Electromotive Behaviour of, 760
Clark, G. A., Some Notes on Electric Wiring, 343
Cleckheaton Electricity Works, 762
Clinker, R. C., Heating of Transformers, 906
Colonial Conference, The, 218
Colour Photography, 218
Commutation, A Contribution to the Theory of, A. Rothert, 694, 726, 769

Companies' Meetings, Reports, etc.:
Allgemeine Elektricitaets-Gesellschaft, 718
Anglo-American Telegraph, 136, 171, 207, 499
Anglo-Argentine Tramways, 462, 533
Armstrong-Orling Wireless Telegraph, 183, 213
Aron Meter, 919
Automatic Telephone, 888
Baker-street and Waterloo Railway, 208, 243
Barcelona Tramways, 170, 210, 681
Bastian Meter, 888, 920
Belfast Tramways, 243
Birmingham, etc., Tramways, 208
Blackpool Electric Tramways (South), 710
Blackpool and Fleetwood Tramroad, 208
Brighton and Rottingdean Seashore Electric Tramroad, 132
British Aluminium, 710, 746
British Columbia Electric Railway, 387, 491
British Electric Traction, 164, 920
British Electric Transformer Manufacturing, 170
British Insulated Wire, 429, 607
British Thomson-Houston, 602, 710
British Westinghouse, 818, 889
Brockie-Pell Arc Lamp, 639, 673
Calcutta Electric Supply, 63, 132, 465
Callender Cable, etc., 62, 212, 642
Cape Electric Tramways, 176, 639, 710, 712, 893
Cavehill, etc., Tramways, 350
Central London Railway, 139, 170, 207
Charing Cross and Strand Electricity, 31, 213, 283, 825
Chelmsford Electric Lighting, 98, 171
Chilian Electric Tramway, etc., 530
Chili Telephone, 63, 132
Chloride Electrical Storage, 387, 459
City of London Electric Light, 32, 170
City and South London Railway, 98, 132, 169
City and Surrey Railway, 245, 379, 534
Clyde Valley Electrical Power, 725, 754
Commercial Cable, 823
County of London and Brush Provincial, etc., 173
Coventry Electrical Engineering, etc., 920
Crompton and Co., 103, 133, 169
Cuba Submarine Telegraph, 602
Daimler Motor, 746
Dick, Kerr, and Co., 460, 491
Direct Spanish Telegraph, 464
Direct United States Cable, 103, 133, 169, 535
Direct West India Cable, 424
Dublin and Lucan Railway, 134
Dublin United Tramways, 134, 169
Eastern Extension, etc., Telegraph, 64, 103, 464, 709, 745, 895
Eastern Telegraph, 67, 103, 131
East London Railway, 132
Edison and Swan, 896, 920
Edmundson's Electricity, 27, 61, 602
Electric and General Investment, 61, 861
Electric Lamp Regenerating, 460
Electric Lighting Boards, 32, 285
Electric Railway, etc., 425
Electrical, 67
Electrical Construction, 62, 98
Electrical Power, 62
Electrical Power Storage, 96
Electricity Supply Company for Spain, 676
Electrolytic Alkali, 602, 746

Companies' Meetings, etc. (*continued*):
Folkestone Electricity Supply, 464
Galloways, 925
General Electric, 133, 207, 248
Glasgow Subway, 425
Globe Telegraph and Trust, 169, 606
Great Northern and City, 171
Harrington Electric Light, 27
Harrow Electric Light, 640
Henley, W. T., and Co., 285
Hove Electric Light, 389
Imperial Tramways, 281
India Rubber, etc., 752, 854, 889
Indo-European Telegraph, 567
Isle of Thanet Tramways, etc., 854, 890
Johnson-Lundell Electric Traction, 921
Kalgoorlie Electric Power, etc., 27
Lanca. Electric Power, 317
Liverpool Overhead Railway, 139, 170, 243, 283
London Electric Supply Corporation, 285
London and Greenwich Tramways, 354
London United Tramways, 281
Marconi Telegraph, 818, 854
Maxim Electrical, etc., 208
Mersey Railway, 317, 350
Metropolitan District Railway, 169, 176, 242, 888
Metropolitan Electric Supply, 173
Metropolitan Railway, 139, 207
Meyra Electric, 27
Monte Video Telephone, 602, 673
Motor Traction, 858
National Telephone, 104, 133, 208
Nernst Electric Light, 818, 854
North-Eastern Railway, 243
North Metropolitan Tramways, 208, 243
Oriental Telephone, 607
Paisley Tramways, 207
Perth Tramways, 243
Power Gas, 782, 855
Provincial Tramways, 857
Rand Central Electric Works, 62
Reno Electric Stairways, 534
Rothesay Tramways, 208
St. James's and Pall Mall, 103, 136, 571
Schuckert Electric, 174
Sensitised Paper, 350
Share Market, 136, 173
Siemens Electric Appliances, 643
South Lanca. Traction, etc., 890
South London Electric Supply 136, 607
South Wales Electrical Supply, 285, 607, 824, 897
Stock Exchange Settlements, etc., 31, 68, 104, 137, 175, 213, 284, 319, 356, 428, 464, 493, 536, 572, 607, 642, 676, 716, 752, 785, 824, 896, 925
Sykes Signal, 673
Taff Vale Railway, 243
Telegraph Construction, etc., 98
Telegraph Manufacturing, 33
Tin Electro-Smelting, 639, 675
Tynemouth Tramways, 350
Typewriting Telegraph, 173, 825
United River Plate Telephone, 212
Waterloo and City Railway, 170, 176
West African Telegraph, 62
Western Telegraph, 602, 639, 823
West India and Panama Telegraph, 745
Westminster Electric Supply, 136, 173
Willans and Robinson, 460
York Tramways, 387

Companies, New, 17, 67, 99, 102, 130, 208, 313, 356, 377, 420, 464, 491, 530, 564, 640, 674, 710, 746, 782, 819, 835, 921
Companies' Receipts, see each Issue
Companies' Shares, New Issues of, 140, 174, 282, 714
Companies' Stock and Share List, see each Issue
Condensers, Duration of Charge and Deformation of, 650
Conductivity of Solvents, etc., 723
Conversion of Single-Phase into Multi-Phase Stations, S. Hutchins, 85
Copper, 37, 688
Cordite, 217
Cork Industrial Conference, 650
Coronation Bazaar, 61
Coronation Illuminations, 31, 33, 38, 61, 104, 135, 245

Correspondence:
Arc Lighters, 915
Bolton Tramways, Depreciation of, 523, 559, 595, 631
Braking of Tramcars, 703, 739
Bristol Telephones, 271
City and Surrey Electric Railway, 379
Electricity from Refuse, 775
Ewing's Hysteresis Tester, 235
Fire Damage, 451
Institution, The, 55
Isle of Man Trams, 307
Motor, 704, 739, 811, 883
Municipal Matters, 739
Nernst Lamp, The, 307
Peat Beds, 91
Portable Lamps, 704
Professional Etiquette, 595
Questions and Answers, 595
Steam Turbines, 343, 379
Taunton Engineer's Case, 847
Tenders Accepted, 451
Tramcar Letter Boxes, 595
Tramways, 19, 55, 307, 523, 559, 595, 631, 703, 739
Tunbridge Wells Telephones, 776, 811, 883
University College, London, 703
Wanted, Identification, 19
Water Power in Ireland, etc., 451, 739
Wireless Telegraphy, 307

Crystal Palace Engineering Exhibition, 573
Cyanides, 181, 507

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D

Dalton, W., Some Engineering Hints on a Tramway System, 875
Dartmouth, Cable Laying in, 296
Davies, F. W., Leaves from a Testing Engineer's Notebook, 518, 554, 591, 624
Davies, F. W., Sparkless Commutation: How to obtain it, 235
Day, A. A., The Correct Type of Engine for Large Generating Stations, 48
Denham, J., Some Notes on Electrical Engineering Practice in Europe and America, 194
Depreciation, 472, 486, 493, 523, 569, 595, 631
Dewar, Prof., British Association Address, 416
Dick, F. J., Water Power in Ireland, 409, 451
Dinners, etc., 37, 53, 139, 164, 356, 676, 704, 717, 749, 868, 885
Distribution at 500 Volts, Supplement, July 18
Dusseldorf Exhibition, 78, 294, 587

Dynamos, Motors, etc.:
Alternate-Current, Compounding, 73, 903
at Bellias and Morcom's Works, 510
British Thomson-Houston, 582
Continuous-Current, Design of, H. A. Mavor, Supplement, Nov. 14
Design, The Specific Utilisation of Materials in, Prof. Thompson, 407
Differentially Compounded Motor, W. R. Kelsey, 837
Double-Current Generators and their Application, E. T. Ruthven-Murray, 10, 68
at Electricity Works, see under name of town in ELECTRIC LIGHTING
Flood-Proof, 181
Heyland Induction Motor, 38
High-Potential Direct-Current, 74
Induction Motors, New Method of Starting, 615
Lahmeyer, 311
on Liverpool Overhead Railway Trains, 402
Motors for Elevators, 255
Motors for Machine Tools, 904
Niagara Falls Plant, 75, 110, 194
Parsons Turbo-Alternator at Neptune Bank Station, 186
Polyphase Motors, Notes on, 771, 803, 839, 877
Printing Office Motors, 825
for Pumps at Cardiff, etc., 626, 688, 798
Questions and Answers on, 87, 734, 848, 915
Scott and Mountain, 186
Tramway Motors, Mr. Field's Paper on, 222, 301
for Yarmouth Trams, 264
25,000-Volt Direct-Current, 759
500-Volt of E.C.C., Supplement, July 18
800-kw., Tests of, 150

E.

Earthing, Notes re, H. F. Proctor, 92
E.L.B. System, 32, 285

Electrical:
Apparatus, Some Novelties in, M. B. Field, 406
Automobiles, see "Automobiles"
Bascule Bridge, 579
Boats, 140, 291, 433, 469, 571, 757, 793
Car Driving, 198, 231
Coal Cutters, 866
Coaling Apparatus for Ships at Sea, 686
Conduction in Gases, 577
Conductivity of Air, 147
Conductivity of Aluminium Alloys, etc., E. Wilson, 483
Cranes, 33, 356, 392
Current, Induction of Sleep by, 723
Development in America, 867
Drills, 197
Drying Oven, 469
Engineering Practice in Europe and America, J. Denham, 194
Engineering, Some Limits in Heavy, J. Swinburne, 841, 915
Engineering, Teaching of, 5, 327
Fire Alarms, 581, 861
Fire Pump, 902
Furnace, 505
Glass Smelting, 399
Haulage on Canals, 292, 505, 752
Heating, 607, 793
Insulating Porcelain, 796
Laboratories in America, 652
Legislation, 2, 219
Lifts, 255, 358
Lighting Returns—Company v. Municipal, 551, 740
Loans, Repayment of, 40
Locomotive for Mine Haulage, 77
Manufacture of Peat Fuel, 579
Nitrification of the Atmosphere, 328; also Supplement, Dec. 12
Omnibuses, 292
Organs, 676, 823
Patents in Germany, 37
Plant for Rhodesia, 186
Postal Service, 392, 397, 505, 541, 577, 712, 749
Power and Irrigation Schemes, 256
Power in New York, 506
Preparation of Colloidal Mercury, 254
Pumping Plants, 626, 688, 798, 902
Radiators, 607
Railmaking, 833
Resistance of Metallic Sulphides, 435
Resistance of Steel, 181
Response in the Skin, 253
Ropeway, 255
Saw Bench, 420
School in Paris, 721
Shock, 289
Signalling, 39, 140, 219, 254, 741, 829, 858
Spark, Decomposition of Water Vapour by, 721
Standards Committee's Report, 523
v. Steam Power, 435
Steering Gear, 793, 805
Swingbridges, 221, 249
Target, 39
Telegraphy, The Evolution of, 295
Transmission, Photography by, 32
Transmission Plant for the Ocean Coal Company, Treorchy, 798

Electrical (*continued*)
Windmills, 676
Wiring, Some Notes on, G. A. Clark, 343
Work in the Tropics, 617

Electric Lighting:
at Aberdeen, 31, 214, 358, 538, 563, 600, 607, 642, 751, 825
at Aberystwyth, 536
at Accrington, 69, 357
at Acton, 568, 643, 785
in Africa, 27, 186, 215, 236, 319, 469, 506, 508, 688, 860, 925
at Airdrie, 69, 357, 389, 336
at Aldershot, 546
at Alloa, 501
at Alnwick, 390, 429
at Amble, 823
in America, 39, 110, 111, 145, 146, 147, 506, 577, 725, 761; also Supplement, Nov. 14
at Amersham 67, 212, 925
at Arbroath, 571, 861
at Ardsley, 67
at Ashford (Kent), 67, 641
at Ashton, 104, 248, 429, 466, 537, 753, 926
at Aston, 465, 501, 555, 571
of Asylums, 356, 641
in Australia, 27, 103, 175
in Austria, 470
at Aylesbury, 136, 284
at Ayr, 104, 249, 284, 391, 572, 643, 717
at Bakewell, 675
at Ballymoney, 357
at Bangor, 248, 859
at Barking, 68, 96, 895
at Barnsley, 213, 319, 751
at Barnstaple, 32, 212, 247, 357, 642, 717, 860
at Barrow, 173, 501
at Barry, 173
at Barton, 428
at Basingstoke, 104
at Bath, 33, 136, 174, 212, 500, 608, 641, 754, 786, 898
at Batley, 389, 676, 825, 924
at Battersea, 67, 349, 389, 499, 572, 607, 716, 861
at Battle Abbey, 307
at Beckenham, 136
at Bedford, 103, 536, 715
at Bedwellty, 319, 642, 823
at Belfast, 135, 214, 536, 676
at Benwell, 465
at Bermondsey, 137, 173, 212, 465, 542, 577, 610, 676, 860
at Berwick, 103, 247, 499
at Bethnal Green, 537, 606
at Beverley, 103, 248, 284, 500, 571
at Bexhill, 32, 136, 284, 356, 429, 607, 715
at Bideford, 135, 752
Bills, etc., for, 174, 775, 784, 815, 825, 925
at Bilston, 32
at Bingley, 135
at Birkdale, 214, 249, 319
at Birkenhead, 68, 248, 349, 389
at Birmingham, 162
at Bishop Auckland, 66, 715, 752, 784
at Blackburn, 66
at Blackpool, 66, 174, 213, 249, 536
at Blockley, 825
at Bolton, 249, 859, 926
at Bo'ness, 895, 925
at Bootle, 34, 677
at Boston, 136, 429, 824, 859
at Bowness-on-Windermere, 571
at Bradford, 248, 609, 678, 773, 861, 925
at Brandon, 103
at Bray, 136, 212
in Brazil, 589
at Brechin, 642
at Brecon, 283
at Brentford, 247
at Brentwood, 136, 389, 429
at Bridgend, 318, 389, 571, 676, 685, 785
at Bridgwater, 104, 753, 895
at Bridlington, 355
at Brierfield, 103, 499, 571, 751
at Brierley Hill, 248
at Brighouse, 66
at Brighton, 67, 137, 168, 430, 465, 501, 609, 642, 678, 784, 861
at Bristol, 213, 237, 535, 715, 860, 895
at Brixham, 571, 784, 897
at Broadstairs and St. Peter's, 214, 318, 606
at Bromley, 356
at Broughty Ferry, 173, 248, 466
at Brownhills, 283
at Buckley, 642
in Burma, 642
at Burnley, 319, 357, 498
at Bursiem, 136, 896
at Burton, 103, 283, 429, 571
at Bury (Lancs.), 23, 536, 573, 859
at Bury St. Edmunds, 67, 96, 848
at Buxton, 175, 389, 567
at Caerphilly, 19, 248, 319, 389, 537, 607
at Calcutta, 132
at Camberwell, 148, 214, 608, 786, 896
at Camborne, 464, 498, 535, 925
in Canada, 74, 365, 580
of Canadian Arch, 104, 173, 248
at Cannock, 318, 499, 895
at Canterbury, 212, 390, 465
at Cardiff, 32, 103, 137, 173, 248, 464, 466, 471, 537, 571, 608, 643, 672, 717, 897, 926
at Carlisle, 136, 606
at Carnarvon, 69, 212, 248, 535, 717
at Carnoustie, 606
at Chard, 66
at Chelmsford, 98, 171
at Chelsea, 465
at Cheltenham, 103, 537, 609, 825, 845
at Chepstow, 213
at Chesham, 213
at Cheshunt, 135, 567
at Chester, 129, 135, 464, 925
at Chesterfield, 31, 63, 248, 717
at Chesterton, 861, 925
at Chichester, 34, 642, 859
in Chili, 530
in the City (London), 105, 137, 170, 174, 243, 537, 643, 717

Electric Lighting (*continued*):
at Clacton, 67, 173, 284, 715
at Clayton, 248
at Cleckheaton, 136, 248, 389, 535, 762
at Cleethorpes, 536
at Coatbridge, 285, 429, 716
at Colchester, 68, 212, 247, 289, 751, 824, 859
at Colne, 502, 677, 897
at Colombo, 751
at Colwyn Bay, 429, 607
Committees for, 674, 708, 743, 815, 853, 886
Companies, see COMPANIES' MEETINGS
Companies' Stock and Share List, see each Issue
Contracts for, see TENDERS
at Cookham, 676, 716
at Coventry, 33, 175, 465, 642, 715, 860, 926
at Cowes, 641
at Creswell, 862
at Crewe, 356, 499
at Criccieth, 536
at Cromer, 355, 716
at Crook, 66
at Croydon, 31, 238, 283, 500, 677, 678, 895, 925
at Cults, 214
at Cupar 103, 925
at Dalkeith, 572, 898
at Dalton, 248
at Darlaston, 823
at Darlington, 248, 355, 429, 537, 642, 862, 895
at Dartmouth, 103, 286, 429, 642
at Darwen, 571
at Dawlish, 66, 136
at Deal, 675, 823
Denham, J., Paper on, 194
at Deptford, 248, 823
at Derby, 31, 212, 537, 716, 823
at Devonport, 69, 429, 535, 572, 824
at Dewsbury, 66, 247, 283, 319, 429, 499, 568, 607, 925
at Dingwall, 135, 389, 568, 717
Distribution of Energy for, Supplement, Oct. 17
at Dodworth, 642, 784
at Dollar, 896
at Doncaster, 499, 569, 861
at Dorchester, 283, 859
at Dorking, 212, 428, 499, 572
at Dover, 283, 318, 784, 895
at Drayton, 676
at Dublin, 284, 501
at Dudley, 537, 751, 787
at Dumbarton, 283
at Dumfries, 571
at Dunblane, 676, 752
at Dundee, 33, 136, 283, 357, 501, 572, 607, 859
at Dunfermline, 284
at Dungannon, 173, 283, 355
at Durham, 212, 247, 715
at Ealing, 23, 33, 106, 249, 678, 752
at Earl's Court, 33
at Earsdon, 357, 499
at East Barnet, 390, 642, 784, 895
at Eastbourne, 249, 571, 641, 824, 895
at East Cowes, 31, 464
at East Ham, 566
at Ebbw Vale, 319
at Eccles, 97, 213, 537, 753, 859, 897
at Edinburgh, 137, 428, 464, 500, 607, 633, 716
at Edmonton, 430
at Eldon, 106
at Elland, 499, 642, 715
at Epsom, 174, 896
at Erdington, 499
at Erith, 283
at Eton, 716
at Exeter, 173, 498, 537
at Exmouth, 785
of Factories, 182, 228
at Failsworth, 571
at Falkirk, 173, 464, 642, 784
at Falmouth, 103, 499, 606, 752
at Fareham, 573, 744
at Farnham, 68
at Farnworth, 642
at Farsley, 135
at Faversham, 31, 464, 572
at Felixstowe, 248, 356, 824
at Fife, 754
at Finchley, 535, 896
at Fleetwood, 717
at Forfar, 607
in France, 242, 653
at Fraserburgh, 173, 355
at Frimley, 248, 429
at Frome, 104, 247, 536, 715, 752
at Fulham, 103, 138, 465, 499, 573, 896
at Fulmer, 135
at Gainsborough, 284
at Garston, 465
v. Gas, 537, 577, 579, 759, 814
at Gaywood, 608
in Germany, 291, 903
at Gillingham, 173
at Glasgow, 32, 66, 110, 213, 312, 358, 608
at Gloucester, 96, 500, 536, 823
at Goring, 247
at Gorton, 357, 676, 784
at Govan, 283, 751, 881
at Grangemouth, 135
at Grantham, 68, 247, 859
at Gravesend, 33, 173, 785
at Great Harwood, 319
at Greenock, 284, 319, 565, 607, 715, 859, 896, 926
at Greenwich, 31, 174, 536
at Grimsby, 136, 174, 206, 212, 319, 573, 753, 861
at Guildford, 213
at Hackney, 607, 716, 860, 898, 924
at Halifax, 499, 825
at Hamilton, 785
at Hammersmith, 174, 536, 600, 609, 677, 753, 825, 896
at Hampstead, 67, 137, 213, 643, 676, 753
at Hampton, 429
at Hamsteels, 466
at Handsworth, 571
at Hanley, 572
at Harrogate, 135, 389, 567, 609, 859, 896
at Hartlepool, 248, 356, 536
at Hastings, 610, 785, 859
at Hawick, 464, 568
at Hebburn, 103, 429, 608, 751

202597

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Electric Lighting *(continued)*:
at Heckmondwike, 137, 213, 355, 430, 465
at Henley, 212
at Hereford, 248, 571, 895, 926
at Heston and Isleworth, 103
at Heywood, 248, 535, 897
at Holyhead, 356, 675, 895
at Honley, 571, 676
at Hornsey, 319
at Horsham, 214, 571, 642
at Hove, 247, 925
at Hoylake, 283, 641
at Hucknall Huthwaite, 320
at Hucknall Torkard, 568
at Huddersfield, 319, 895, 925
at Hull, 174, 825
at Hythe, 464, 498, 895
at Ilford, 173, 751
at Ilkeston, 356
at Illogan, 895
in India, 33, 63, 577, 865
Installations, 434
at Inverness, 676, 716, 825
at Inverurie, 285,
at Ipswich, 284, 642, 715, 825, 895
at Irvine, 499, 676
at Islington, 33, 104, 175, 249, 343, 502, 572, 678, 752, 754
at Jedburgh, 896
at Keighley, 318, 355, 607, 671, 824, 896
at Kendal, 250, 330
at Kensington, 103, 136, 786
at Kettering 535
at Kildare, 356
at Kilmalcolm, 895
at Kilmarnock, 429, 863, 895
of Kingseat Asylum, 356
at King's Lynn, 386, 429, 574, 626, 717, 757, 898
at King's Norton, 247, 283
at Kingston-on-Thames, 32, 213, 573, 676, 685, 925
at Kingswear, 537, 567, 675, 784
at Kirkby Stephen, 357
at Kirkcaldy, 389, 896, 925
at Kirkintilloch, 785, 913
in Korea, 357
at Lambeth, 505, 530
at Lancaster, 96, 319, 499, 824
at Lanchester, 405
of Large Office Blocks, 310
at Launceston, 571
at Leatherhead, 213, 429
at Leeds, 502, 572, 607, 654, 693, 717, 846
at Leek, 676, 825
at Leicester, 428
at Leigh, 568, 715, 859
at Leven, 751, 784
at Levenshulme, 318, 784
at Leyton, 507, 608, 701
at Lichfield, 895
of Lighthouses, 703
at Limerick, 212, 318, 393
at Lincoln, 103, 535
at Liverpool, 138, 380, 536, 544
at Llandilo, 535, 571, 861
at Llandudno, 753, 925
at Llanelly, 245, 356, 429, 464, 862
of London Bridge, 608
and London County Council, 32, 69, 137, 175, 500, 536, 574, 643, 678, 687, 717, 752, 787, 825, 863
at Londonderry, 213, 464, 567
at Long Eaton, 67, 355, 536, 752, 896
at Longton, 105, 137, 535
at Loughborough, 135, 248
at Louth, 248, 536
at Lower Bebington, 716
at Lowestoft, 31, 67, 104, 137, 284, 572, 717, 752, 823, 897
at Luton, 206, 214, 501, 642, 785, 859, 925
at Lye and Wollescote, 535, 675
at Lyndhurst, 859
at Macclesfield, 466
in Madras, 33
at Maesteg, 173, 676
at Maidenhead, 72, 174, 429, 465, 535, 785, 823, 870
at Maidstone, 31, 136, 248, 464, 567, 823
at Manchester, 135, 212, 284, 313, 356, 499, 538, 642, 743, 786, 823
at Mangotsfield, 675
at Mansfield, 173, 284, 499, 643, 715, 785
at Margam, 136
at Market Drayton, 784
at Mexborough, 104, 535, 715
at Middlesbrough, 69, 569, 861, 827
at Middleton, 389
at Midsomer Norton 136, 283
at Mold, 248
at Monmouth, 355, 535, 715, 823
at Montrose, 567, 784
Moore System of, 212
at Morecambe, 465, 567
at Morley, 103, 213, 389, 752, 895
at Morpeth, 136
at Moss Side, 429
at Motherwell, 67
Municipal Supply of, 558
at Mutford, 752
at Nantwich, 103, 284, 319, 785
at Neath, 823
at Nelson, 66, 752
in the Netherlands, 541
at Newark, 67, 213, 355, 499, 607, 676, 753
at New Barnet, 751
in Newcastle-Emlyn, 717
at Newcastle-on-Tyne, 103, 249, 283, 319, 428, 483, 825
at Newcastle-under-Lyme, 213, 568
at Newhaven, 173
at Newport, 67, 104, 214, 389, 572, 717, 718, 785, 824, 925
New System of, 112
at Newton Abbot, 31, 137, 284, 573, 642, 753, 784
in New Zealand, 397, 389, 608, 614
at Northampton, 470, 607
at Northfleet, 392, 751, 862
at Norwich, 135, 173, 357, 925
at Nottingham, 66, 238, 535, 607, 823
at Nuneaton, 607, 714, 834
at Oban, 136, 429, 751
at Ogwen, 248
Electric Lighting *(continued)*:
at Oldham, 130, 675
at Ormskirk, 642, 784, 860
at Ossett, 248, 895
at Oswestry, 284, 676, 823
at Oulton, 823
at Oxford, 643
at Paddington, 573
at Paignton, 752
at Paisley, 753
at Pangbourne, 785
at Pemberton, 568
at Pembroke (Ireland), 823
at Penge, 66, 823
at Penrith, 641, 678, 751, 890
at Penzance, 104, 173
at Perth, 284, 500, 571, 823, 860
in Peru, 33
at Peterborough, 212, 715
at Peterhead, 247
at Plymouth, 464
at Pocklington, 860
at Pokesdown, 66
at Pontypool, 318, 355
at Pontypridd, 571, 676
at Poole, 173, 500
at Poplar, 465
at Portslade, 571, 715
at Portsmouth, 573, 672, 677, 753
at Preston, 464, 786
at Prestwich, 283, 429
Provisional Orders, etc., for, see "Bills"
at Pwllheli, 173
at Radcliffe, 464
at Radstock, 465, 824
at Ramsbottom, 429
at Ramsgate, 825
at Rathmines, 751
at Rawmarsh, 135
at Rawtenstall, 784
at Reading, 249, 319
at Redding, 715
at Redditch, 499
at Redruth, 212, 248, 392, 537
Regulations for, 161
at Reigate, 355
at Renfrew, 103
Returns, etc., 561, 740
at Rhondda, 895
at Rhyl, 429, 823
at Rickmansworth, 752
at Rishton, 284
at Rochdale, 212
at Rochester, 103, 753
at Romford, 389
at Ross, 66, 212, 537, 890
at Rossendale, 753
at Rotherham, 66, 173, 535, 785
in Roumania, 137
at Rugby, 135, 248, 571, 642, 716
in Russia, 283, 365, 391, 509, 537, 861
at Ryde, 752
at St. Albans, 464
at St. Annes, 390, 536, 677, 824, 860
at St Helens, 490, 499, 701, 752
at St Marylebone, 68, 502, 786, 895
at St. Pancras, 31, 205, 784, 896
at Salford, 129, 212, 499, 716
at Salisbury, 247, 716
at Saltburn, 716
at Sandal, 213, 676
at Sandgate, 429
at Sandwich, 66, 285
at Scunthorpe, 103, 499, 571
at Sevenoaks, 135
at Shardlow, 357
at Sheffield, 25, 66, 320, 391, 715, 784
at Shildon, 465
at Shipley, 356, 438, 784
of Ships, 389, 715
at Shoreditch, 785
at Shoreham, 567
at Sleaford, 248, 859
at Slough, 607, 714, 859
at Southampton, 128, 896
at Southend, 283, 568, 754
at Southgate, 715
at Southport, 430
at South Shields, 249, 356, 501, 608
at Southwark, 537, 677, 784
at Southwick, 897
in Spain, 32, 429, 500, 862
at Stafford, 135, 823, 861
at Stamford, 404
Stand-by Charges for, 110
Stations, Expenses of, 145
at Stepney, 32, 96, 676, 784, 825
at Steyning East, 390
at Stirling, 466, 536, 784; also Supplement, Dec. 12
at Stockport, 745
at Stockton, 572, 860
at Stoke Newington, 428, 753, 795
at Stoke-on-Trent, 173, 502, 898
at Stonehaven, 103, 430
at Stonehouse, 285
at Stourbridge, 31, 135
at Stratford-on-Avon, 751
at Strathpeffer (Dingwall), 606, 715
at Stretford, 571
at Strokestown, 390
at Stroud, 247, 715, 861
at Sudbury, 609
at Sunderland, 366, 389, 430, 465, 499, 860, 896
at Surbiton, 284
at Sutton Coldfield, 66
at Swadlincote, 283
at Swanage, 136
at Swansea, 32, 130, 429, 496, 538, 608, 677, 717, 753, 786, 861
at Swindon, 214, 715, 859, 871
at Swinton and Pendlebury, 248
at Tadcaster, 137, 676
in Tasmania, 610
at Taunton, 103, 173, 283, 430, 753, 824, 847, 892
of Tawstock Court, 105
at Teddington, 607
at Teignmouth, 68, 535
of the Temple Church, 319
Tenders for, see TENDERS WANTED AND ACCEPTED
Electric Lighting *(continued)*:
at Tipton, 499, 535, 897
at Tiverton, 137, 718, 862, 896, 926
at Tonbridge, 248, 319, 859
at Torquay, 355
at Tottington, 716
by Traction Companies, 39
of Trains, 700, 829, 903
in the Tropics, 617
at Trowbridge, 320
at Truro, 104
at Tunbridge Wells, 67, 530, 573, 843
at Tunstall, 536
at Twickenham, 137, 641
at Tynemouth, 319
at Upholland, 752
at Uxbridge, 32, 213, 318, 675
at Vicker-stown (Walney Island), 212
at Wakefield, 66, 247, 392, 499, 675, 717
at Walker, 67
at Wallasey, 213, 357, 465, 501, 536, 823
at Walsall, 285, 429, 860, 861
at Walthamstow, 607, 717
at Walton, 213, 389, 430, 860
at Wandsworth, 535, 677
at Warkworth, 66, 465
at Warrington, 67
at Watford, 33, 136, 356, 641
at Wath-upon-Dearne, 675
at Weardale, 499
at Wednesbury, 538, 572, 823
at Wellingborough, 389, 929
at Wells, 355
at West Bromwich, 67, 173, 312, 479, 513
at West Ham, 167, 785
at West Hartlepool, 32, 751
of Westinghouse Building, 310
at West Kirby, 173
at Weston-super Mare, 751
at Weymouth, 66, 104, 752, 823
at Whitby, 213, 751
at Whitefield, 714, 860, 896
at Whitehaven, 283, 429
at Whitstable, 66
at Whitworth, 784
at Wigan, 130, 318, 356, 499, 609
at Willesden, 66, 106
at Wimbledon, 32, 429, 715, 823, 925, 926
at Winchester, 860
at Windsor, 135
at Wirksworth, 465
at Wirral, 823
at Wolsingham, 464
at Wolverhampton, 104, 130, 716
at Wombwell, 135, 283
at Wood Green, 213, 499
at Woolwich, 69, 175, 607, 895
at Worcester, 278, 569, 609, 861
at Worksop, 31, 318, 537, 785, 795
at Wormit, 67
at Worsborough, 753
at Worsley, 136
at Worthing, 173, 213, 357, 536, 568, 675, 753
at Wrexham, 213, 675, 718
at Yarmouth, 66, 389, 574, 607
at Yeadon, 60
at Yeovil, 606
at York, 31, 174, 285, 356, 716, 927

Electric Traction:
at Aberdeen, 29, 65, 102, 141, 212, 282, 321, 393, 426, 497, 533, 568, 624, 644, 712, 748, 788, 820, 857, 894, 923
Accidents, see "Accidents"
at Accrington, 138, 496, 567
by Accumulators, 181, 473, 805
at Acton, 176, 567, 738
in Africa, 211, 215, 254, 281, 392, 393, 426, 506, 639, 688, 710, 857, 893, 925
at Ainsdale, 391
at Airdrie, 282, 391, 427, 490
at Alfreton, 533
in the Alps, 145
Alternating Current for, 472
at Altrincham, 605, 644
in America, 5, 39, 111, 113, 140, 181, 194, 217, 254, 289, 397, 435, 472, 506, 578, 580, 616, 651, 652, 688, 867
Amesbury Light Railway, 140
Arnold Single-Phase System, 120
at Ashby-de-la-Zouch, 175
at Ashton, 210, 246, 281, 426, 568, 748, 893
at Aston, 30, 140, 170, 211, 427, 604, 679, 712, 788, 892
at Auckland, 567, 569
at Audenshaw, 245, 532
in Australia, 109, 321, 364, 509, 545, 569, 644, 713, 788, 821
in Austria, 321, 470
at Ayr, 29, 175, 246, 392, 498, 567, 604, 645, 712, 857
at Bacup, 567, 856
Baker-street and Waterloo Railway, 208, 243, 750
at Bakewell, 64, 463, 644, 821
at Barking, 139
at Barnsley, 177, 533, 681, 714, 742
at Barrow, 29, 64, 100, 177, 210, 353, 569, 645, 703
at Barrowford, 605
at Barton-upon-Irwell, 645
at Bath, 29, 100, 177, 391, 426, 567, 624, 713, 797, 903
at Batley, 64, 100, 245, 392, 679, 712, 749, 789, 829, 842
at Battersea, 102, 139, 393, 787
Beare, Prof., Lectures on, 570
at Beckenham, 139, 679, 748, 820
Behr System, see "Monorail"
at Belfast, 65, 243, 281, 353, 496, 650, 751, 789, 829
in Belgium, 181, 352, 496, 604, 712, 902
at Bermondsey, 140
at Bexley, 427
Bills for 29, 31, 64, 65, 76, 97, 140, 141, 159, 176, 177, 211, 322, 601, 604, 615, 638, 751, 775, 782, 810, 893, 923, 924
at Bilston, 29, 64, 100, 246, 680
at Bingley, 644
at Birkdale, 29, 245, 320, 426, 533, 676
at Birkenhead, 64, 245, 354, 496, 532, 644, 789
at Birkenshaw, 140
at Birmingham, 100, 138, 240, 320, 353, 427, 475, 475, 534, 566, 644, 680, 681, 714, 751, 821, 857, 924
at Birstall, 176

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Electric Traction *(continued)*:
at Blackburn, 139, 341, 392, 462, 604, 645, 821, 923
at Blackpool, 176, 208, 211, 242, 246, 352, 391, 462, 533, 710, 821, 857
and Board of Trade Regulations, 322
at Bolton, 321, 393, 426, 493, 523, 559, 593, 595, 631, 644, 820
at Bournemouth, 29, 64, 131, 177, 182, 207, 211, 392, 462, 569, 604, 679, 712, 821, 858, 892, 920
at Bradford, 29, 65, 210, 281, 321, 352, 392, 427, 462, 496, 533, 569, 604, 645, 773, 789, 821, 857, 892, 923
Brakes for, 659, 703, 739
at Bray, 645
in Brazil, 589
at Brentford, 139
at Bridlington, 392, 429, 644, 679
at Brierley Hill, 280, 353, 568, 822
at Brighouse, 65, 354
in and to Brighton, 29, 64, 132, 139, 175, 176, 210, 285, 354, 393, 428, 497, 498, 532, 535, 568, 604, 645, 679, 680, 748, 820, 856, 892, 922
at Bristol, 100, 155
in British Columbia, 387, 491
at Broadstairs, 29
at Brockley, 29, 101, 892
at Bromley, 787
Brompton, etc., Railway, 131
at Broomhill, 100
at Broughty Ferry, 712, 748, 789, 856
in Buenos Ayres, 176
in Burma, 645
at Burnley, 246, 353, 393, 679, 713
at Burslem, 64, 712
at Burton, 285, 320, 567, 681, 749, 820, 894
at Bury, 65, 100, 139, 177, 246, 321, 392, 533, 679, 787, 857
at Buxton, 532, 713, 892
at Calverley, 354
at Camberwell, 139, 462, 605, 790
at Camborne, 533, 712
in Canada, 365
at Canterbury, etc., 893
at Cardiff, 30, 101, 139, 176, 178, 246, 281, 353, 392, 428, 433, 463, 497, 535, 570, 604, 646, 682, 748, 789, 822, 857, 922
Car Driving, E. W. Elsley, 199
at Carlisle, 139, 391, 542, 820
at Cavehill and Whitewell, 350
Central London Railway, 139, 140, 170, 207, 469, 893, 922
Charing Cross and Hampstead Railway, 569
at Chatham, 604, 682, 715, 752, 788, 923
at Cheadle, 280, 427
at Cheltenham, 533, 644
at Cheshunt, 680
at Chester, 64, 176, 462, 679, 713, 892
at Chichester, 462
in Chili, 530
City and South London Railway, 98, 132, 169, 858
at Clacton, 392, 533, 567, 713, 894
at Cleckheaton, 138, 532, 820
at Clydebank, 462, 712, 821
at Coedpoeth, 320
at Colchester, 210, 246, 606, 748, 856
Committees for, 674, 708, 743, 815, 853, 886
Companies' Meetings, see COMPANIES' MEETINGS
Companies' Stock and Share List, see each Issue
Contracts for, see TENDERS WANTED
at Cork, 568, 645, 748
at Coseley, 567, 748
Cosham and Horndean Light Railway, 353, 695
at Coventry, 712, 787
Covered Cars, 789, 821
at Crewe, 64, 352, 679
Crompton, R. E., Letter on, 19
at Crosby, 569
at Croydon, 31, 246, 350, 354, 355, 427, 644, 680, 749, 821
Crystal Palace Light Railway, 30, 606, 645
in Cumberland, 712
at Darlaston, 29
at Darlington, 102, 139, 210, 245, 392, 532, 679, 787, 856, 923
at Dartford, 532
at Darwen, 392
at Datchet, 567
at Davyhulme, 427, 922
at Deal, 280, 532, 788
in Denbighshire, 893
Denham, J., Paper on, 194
Depreciation Charges for, 472, 486, 493, 523, 559, 595, 631
at Deptford, 247, 462
at Derby, 29, 712, 822, 857, 893
at Devonport, 3, 29, 176, 247, 426, 498, 533, 567, 712, 893, 923
at Dewsbury, 64, 139, 245, 281, 321, 354, 428, 605, 680, 713, 748, 749, 893
Distribution of Energy for, Supplement, Oct. 17
Dolter System, 569; also see "Swansea"
at Doncaster, 29, 138, 210, 280, 391, 532, 604, 645
at Douglas, 100
in and to Dover, 281, 427, 568, 748, 787
at Drighlington, 281
at Dublin, 134, 169, 321, 818, 883
at Dudley, 97, 139, 392, 462, 532, 567, 712, 749, 789, 922
at Dumfries, 462
at Dundalk, 820, 922
at Dundee, 29, 65, 211, 280, 282, 353, 394, 462, 497, 532, 568, 603, 713, 750, 858, 866
at Dunstable, 820
and East Barnet Council, 645
at Eastbourne, 856
at East Ham, 534
at East Preston, 604, 679, 922
at Eastwood, 857
at Eccles, 29, 353, 426, 498, 748
at Edinburgh, 644, 714, 748, 821, 894
at Egham, 672
and Electrolysis, 189, 578, 814, 760
at Elland, 64, 393, 532
Engineering Hints on, 875
at Exeter, 29, 101, 177, 210, 246, 392, 463, 496, 568, 680, 712, 748, 787, 822, 893, 923
at Fareham, 644, 892
at Farnborough, 713
at Farnworth, 645
at Farsley, 139, 280

Electric Traction *(continued)*:
Field, M. B., Notes on Testing of Tramway Motors, etc., 220
at Finchley, 680
Flamborough and Bridlington Light Railway, 353, 604, 645
at Folkestone, 100, 391, 426
at Formby, 245
in France, 65, 145, 249, 401, 427, 437, 535, 568, 787, 790, 858, 866, 924
at Friern Barnet, 604
at Garston, 321, 352
at Gateshead, 65, 281, 321
at Geneva, 533, 568
in Germany, 21, 74, 231, 327, 355, 361, 473, 613, 614, 679, 721, 750, 760, 865
at Gildersome, 604, 893
at Gillingham, 176, 821
in Glamorganshire, 679
at Glasgow, 30, 211, 220, 280, 322, 328, 353, 393, 415, 425, 426, 428, 462, 496, 541, 559, 567, 570, 645, 680, 712, 749, 789, 857, 902, 924
at Glossop, 65, 101, 246, 462
at Gloucester, 210, 497, 645, 681, 820, 893
at Gomersal, 353, 713, 856
at Gorton, 462
at Gosport, 789
at Gravesend, 29, 212
and Great Central Railway, 210
and Great Eastern Railway, 748
Great Northern and City Railway, 4, 171, 207, 281, 565, 681, 888
at Greenock, 101, 893, 923
at Greenwich, 748, 821
at Guiseley, 320, 462, 497, 713
at Halesowen, 30, 321
at Halifax, 29, 64, 101, 176, 210, 321, 352, 393, 426, 496, 497, 533, 568, 605, 679, 712, 748, 783, 820, 857
at Hamilton, 497, 923
at Hammersmith, 210, 498, 682, 750
at Hampstead, 64, 211
at Hampton, 604, 712
at Handsworth, 427, 567, 892
at Harrogate, 245, 393, 496, 533, 605, 679
at Harrow, 426, 644, 892; also see "Middlesex County Council"
at Hartlepool, 100, 246, 712
at Haslingden, 604
at Hastings, 138, 532, 673, 749, 787, 856, 923
at Hawick, 352, 644
at Heaton Norris, 922
at Hebburn, 748, 892
at Hebden Bridge, 64, 822
at Heckmondwike, 100, 749, 788, 820, 923
at Heywood, 101
at Higham Ferrers, 748
High-Speed, 146, 435, 470, 613, 721
at Hindley, 100, 281, 604
at Hipperholme, 100
Hopkinson and Talbot, Messrs., Paper on, 704
at Horsforth, 749, 821
at Hove, 100, 247, 426, 463, 713, 748, 787, 820, 893
at Hucknall Torkard, 567
at Huddersfield, 29, 102, 140, 177, 183, 211, 282, 321, 350, 377, 427, 462, 497, 534, 595, 603, 713, 748, 759, 820, 857, 866
at Hull, 64, 175, 374, 462, 569, 644, 679, 714, 820, 892
at Hurst, 246
at Hyde, 856
at Ilford, 176, 748, 820, 892
at Ilkeston, 748
at Ince, 748
in India, 101, 109, 462, 505, 577
at Ipswich, 176, 211, 352, 567, 821, 923
at Irthlingborough, 679
in Isle of Man, 242, 281, 307, 604, 749
at Islington, 65
in Italy, 138, 253, 361, 605, 686, 751, 892, 893
in Japan, 253
at Jarrow, 102, 567, 604, 892
in Johannesburg, 159, 254, 281, 925
at Johnstone, 567
in Johnstown, 604
at Keighley, 245, 281, 392, 496, 713, 820, 893
at Kendal, 497
at Kensington, 605, 644
at Kilmarnock, 749
at King's Norton, 282, 353, 712, 923
at Kingston, 352
at Kingstown, 352
at Kirkcaldy, 353, 679, 713, 857
in Korea, 139, 281, 352
at Lambeth, 533
in Lanarkshire, 604
Lancashire Light Railways, 31, 65, 820; also see "South Lancs. Tramways Company"
and Lancashire and Yorkshire Railway, 139, 321, 426, 606, 788
at Lancaster, 176, 352, 497, 605, 749, 789, 820, 892
at Lancing, 605
at Lea Bridge, 788
at Leeds, 102, 139, 177, 210, 246, 282, 317, 321, 353, 394, 462, 463, 497, 532, 659, 679, 713, 750, 822, 856, 924
at Leicester, 497, 532, 644, 681, 894
at Leigh, 64, 393, 462, 496, 568, 858
at Leighton Buzzard, 283
at Levenshulme, 679
at Lewisham, 30, 534, 604, 679
at Leyton, 462
at Lincoln, 210, 604, 858
at Littlehampton, 391, 857
at Liverpool, 101, 139, 211, 242, 247, 281, 283, 352, 394, 402, 463, 496, 567, 568, 570, 605, 679, 680, 712, 750, 788, 789, 792, 892, 893, 924
at Llandudno, 281
at Llanelly, 210, 245, 280, 496, 856
and Local Veto, 178
and London, Brighton, and South Coast Railway, 712
and London County Council, 30, 102, 141, 142, 178, 247, 281, 354, 391, 400, 428, 462, 463, 496, 498, 534, 542, 571, 6 4, 625, 606, 615, 638, 645, 646, 652, 679, 680, 681, 682, 712, 714, 750, 788, 790, 822, 859, 893, 894, 923
and London and North-Western Railway, 712, 789
and London and South-Western Railway, 567, 749, 923
and London United Tramways Company, 29, 65, 139, 177, 393, 400, 427, 530, 570, 605, 681, 713, 748, 749, 821, 888, 892, 895

Electric Traction *(continued)*:
Long-Distance Transmission for, 616
at Long Eaton, 820
at Longton, 100, 140, 680
at Loughborough, 281
at Lourenco Marques, 533
at Lowestoft, 100, 176, 280, 426, 533, 605, 713, 857
at Luton, 787, 922
at Lye, 893
at Lyndhurst, 567
at Lytham, 712, 787
at Macclesfield, 462, 644, 679, 748, 923
at Maidenhead, 533, 787
at Maidstone, 604, 789, 856, 892
at Manchester, 61, 131, 168, 176, 210, 245, 247, 321, 352, 392, 427, 463, 497, 535, 568, 646, 679, 680, 790, 820, 858, 893
at Margate, etc., 177, 245, 854, 890
and Mersey Railway, 65, 317, 321, 350, 362, 815
at Merthyr, 210, 245, 462, 857
and Metropolitan Railways, 66, 139, 169, 207, 242, 496, 748, 790, 822, 888
at Mexborough, 102, 321, 748
in Mexico, 176, 321
and Middlesex County Council, 29, 100, 177, 281, 321, 352, 393, 533, 606, 644, 645, 681, 748, 821, 892, 923
at Middleton, 533, 923
and Midland Railway Company, 250, 604
at Mirfield, 246, 354
at Mitcham, 282
Monorail System, 427, 462, 568, 680, 892, 893
at Morecambe, 788, 892, 922
at Morley, 567, 892
and Mumbles Railway, 65, 532
Municipal, 556
at Musselburgh, 210, 392, 922
at Nelson, 29, 64, 140, 426, 569, 923
at Newburn, 532
at Newcastle, 100, 177, 281, 321, 355, 393, 462, 496, 567, 645, 713, 789, 820, 923
at Newport (Mon.), 102, 177, 247, 392, 567, 679, 712, 750
Newton Guard, 308
in New Zealand, 100, 101, 147, 176, 253, 394, 426, 614, 646, 857, 858
Nidd Valley Light Railway, 463
at Northampton, 280, 567, 857
and North-Eastern Railway, 148, 210, 243, 270, 282, 532, 644, 679, 722, 901
North-East London Railway, 30
at Northfleet, 569
and North Metropolitan Tramways, 243, 821
at North Shields, 281
at Northwich, 644
at Norwich, 462, 748
at Nottingham, 65, 321, 391, 426, 496, 532, 679, 714, 750, 789, 822, 894
at Oldham, 246, 354, 498
at Ormesby, 748
at Ossett, 139, 352, 392, 462, 603
at Oxford, 857
at Paddington, 604, 680, 894
at Padstow, 139
at Paignton, 352, 856
at Paisley, 139, 207, 392, 603
at Parkstone, 282
at Pemberton, 321, 712
at Penarth, 29, 532, 681, 788, 822
at Penge, etc., 427, 820
at Perth, 101, 243, 353, 392, 427, 644, 748, 821, 924
at Peterborough, 787
at Plymouth, 101, 280, 393, 567, 856
at Pontefract, 352
at Pontypridd, 29, 102, 176, 426, 679, 738, 822
at Poole, 29, 281, 748, 787, 821, 857
at Portslade, 139
at Portsmouth, 605, 750, 856, 892, 922
at Preston, 749, 787, 821
at Prestwich, 176, 281, 427, 682, 822
Provisional Orders for, see "Bills"
at Quarry Bank, 820
at Ramsbottom, 426
at Ramsgate, 427
at Rangoon, 181
Rasch, Dr., Paper on, 21
at Rawmarsh, 139, 176
at Reading, 393, 567, 712, 923
at Reddish, 426, 892
at Redruth, 391, 712
Regulations for Tramways, 17
at Renfrew, 603, 712
in Rhondda Valley, 29, 65, 100, 893
at Richmond, 100
Rider, J. H., Address on, 9
at Ripon, 644, 748, 822
at Rochdale, 177, 245, 532, 603
at Rochester, 280, 462, 567, 748, 857, 892
at Romford, 391
at Rotherham, 138, 281, 352, 394, 496, 821
at Rothesay, 100, 208, 283
at Rowley Regis, 140, 282, 532, 606, 894
at Rugby, 712, 892
in Russia, 322, 363, 758, 924
at St. Helens, 352, 496, 534, 748
at St. Marylebone, 498, 532
at Salford, 66, 210, 391, 427, 497, 532, 604, 750, 822, 858, 923
at Sandwich, 280
at Scarborough, 893, 924
Shallow Underground Tramways, 141
at Shanghai, 567, 603
at Sheffield, 101, 280, 322, 391, 400, 426, 427, 496, 534, 541, 567, 581, 645, 646, 679, 713, 787, 858, 893
at Shelf, 787
at Shipley, 29, 281, 353, 462, 498, 681, 787
at Shoreham, 210, 321
Signals for, 219, 254
at Slough, 29, 567
at Smethwick, 100, 210, 892
at Solihull, 788
at Southampton, 101, 352, 427, 462, 533, 820, 892
at Southend, 177, 281, 393, 426, 567, 709
South Lancashire Tramways Company, 246, 320, 352, 353, 393, 462, 463, 605, 644, 688, 748, 821, 859, 890, 924
at Southport, 100, 245, 893
at South Shields, 109, 139, 246, 426, 463, 497, 535, 605, 644, 679, 714

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Electric Traction *(continued)*:
at Southwark, 533
at Southwick, 391
at Sowerby Bridge, 352, 426, 532, 893
at Soyland, 820
in Spain, 170, 352, 822, 893
Speed Limits for Tramways, 5
in Staffordshire, 712
at Staines, 748
at Stainland, 29, 748
at Stalybridge, 100
at Standish, 391, 567
at Stapleford, 821
and Steam Railways, 148, 217, 270, 282, 321, 354, 427, 496, 567, 590, 679, 681, 712, 722, 748, 749, 750, 788, 789, 815, 821, 924; also see under names of Railways
at Steyning West, 246, 321, 391, 496, 679
at Stirling, 462
at Stockport, 139, 603, 679, 749
at Stockton Heath, 603
at Stoke-on-Trent, 29, 177, 645, 923
at Stourbridge, 65, 496, 534, 892
at Stretford, 29, 392, 498, 533, 820, 856, 894
at Stroud, 64, 281, 679, 820
at Sunderland, 29, 101, 176, 246, 281, 321, 462, 567, 679, 748, 820, 894
Surface-Contact System, A, 342
and Surrey County Council, 211
at Sutton Coldfield, 895
at Swadlincote, 281
at Swansea, 140, 176, 354, 393, 427, 496, 534, 604, 644, 680, 749, 787, 821, 857, 894
in Switzerland, 352
at Swinton, 246, 534, 748
and Taff Vale Railway, 243
in Tanat Valley, 177
at Teddington, 426
on Tees-side, 789
Telephony, 577
Tenders for, see TENDERS WANTED
at Tewkesbury, 923
Third-Rail System, W. B. Potter, 309
at Thornhill, 567
and Tilbury and Southend Railway, 210
Timekeeping on Tramways, 433
at Tooting, 102
at Torquay, 100, 280, 355, 496, 604, 681, 749, 894
Traffic Returns, see each Issue
Tramways Exhibition, 6, 42, 80, 157
in the Tropics, 617
in Turkey, 426
at Twickenham, 65, 245, 281, 496, 749, 821, 893
on Tyneside, 177, 391, 474
Union Internationale Permanente de Tramways, Supplement, July 16
at Upholland, 426
at Urmston, 392, 893
at Wakefield, 282, 353, 748
at Wallasey, 245, 463
Waller, J. E., Paper on, 118, 126
at Wallsend, 64, 210, 246, 352, 391
at Walsall, 100, 139, 245, 321, 427, 567, 569, 749, 788, 857, 892, 924
at Walthamstow, 462, 680
at Wandsworth, 176
at Warrington, 29, 65, 462, 497, 534, 568, 679, 787, 789, 820, 892
Waterloo and City Railway, 170, 353
at Wednesbury, 65, 533, 712, 821
at Wellingborough, 210, 391, 604, 748
at Welshpool, 176
at West Bromwich, 245, 463, 479, 513, 532, 712, 822, 857, 924
at West Ham, 101, 748
at West Hartlepool, 352
at Weston-super-Mare, 426, 748
West Riding Tramways, 789
and West Sussex County Council, 177
at Whitefield, 567, 788, 856
at Whitehaven, 427
at Wigan, 139, 210, 392, 496, 532, 787, 892, 922
Wike, C. F., Paper on, 114
at Willenhall, 533, 856
at Willington Quay, 246, 567, 856
at Wirral, 857
at Withington, 281, 426, 567
at Wolverhampton, 64, 101, 140, 210, 245, 320, 393, 463, 533, 569, 714, 749, 892
at Woodbridge, 462, 498
at Worcester, 210, 246, 353, 533, 892
at Worsborough, 280
at Worsley, 392
at Worthing, 65, 176, 352, 532, 679, 820
at Wrexham, 29, 64, 176, 210, 245, 320, 352, 787
at Yardley, 534
at Yarmouth, 65, 100, 245, 258, 281, 391, 427, 533, 679, 713, 749
at Yeadon, 391, 533
at York, 387, 532, 748
in Yorkshire, 101

Electrically-Driven Tea Factory, An, 687

Electricity:
in Agriculture, 433
in Canada, 580
in Coast Defence, 436
as a Divining Rod, 398
at Earl's Court, 33
in Factories, 213, 228, 441, 487, 518, 667, 687, 700, 728
v. Gas, 537, 577, 579, 759, 814
in Germany, 291, 294, 578, 587, 676, 687, 718
in Government Dockyards, 926
Hardening Armour-Plates by, 291
in the Human Life, 435
Instruction in, 292
Letter Stamping by, 433
Mail Vans, 568
in Medicine, 1, 3, 433, 435, 686, 757, 901
in Mining, 77, 329, 501, 508, 613, 677, 715, 716, 798, 866, 898
and Plant Life, 901
Purification of Sugar Juices by, 795
from Refuse, etc., W. F. Goodchild, Supplement, Nov. 14, 722, 775
in Russia, 508
on Shipboard, 903
Supply in Bulk, 509, 685

Electricity *(continued)*:
Supply Undertakings, 436
from the Tides, 689
Timing by, 253
in the United States, 221, 254, 397, 470
and Washington Navy Yard, 221, 254
Works, see under ELECTRIC LIGHTING

Electro-Capillary Properties of Organic Bases, 398
Electro-Chemical Notes, 508
Electro-Chemical Paradox, An Apparent, 580
Electro-Deposition of Copper, 688
Electrodes, Graphitising, 112

Electrolysis:
of Alkali Chlorides, 902
of Alkali Salt Vapours, 471
Aqueous Solutions, Electrolysis of, 361
Chlorate, Electrolytic Production of, 517, 615
Conductivity of Aqueous Solutions of Electrolytes, 362
Current Density, etc., of, 794
Cyanides, Electrolytic Manufacture of, 507
Electrolytic Actions, Evident, 577
Electrolytic Condensers, 109, 148
Electrolytic Lead and Oxides, 2
Electrolytic Oxidation of Naphthalene, 793
Electrolytic Phenomena, 758
Electrolytic Reduction, 544
Insoluble Precipitates, Formation of, 255
Oxalic Acid, Decomposition of, 325
of Silver Nitrate, 650
Sulphuric Acid by, 183
of Water-Pipes, 189, 578, 614, 760

Electromagnetic Rectifier, An, 146
Electrometallurgy of Iron and Steel, 831
Electrons, Sir O. Lodge, etc., 109, 812, 907
Electro-Pneumatic Railway System, 113
Electrostatic Wattmeter, The, 74
Elements, Researches on, 73, 616
Elsley, E. W., Electrical Car Driving, 199, 231
E.M.F. of Metals in Solutions of Cyanide, 181
E.M.F., Researches on, 254
Energy, Dissipation of, by Electric Currents in an Iron Cylinder, etc, E. Wilson, 226, 272
Engineering, Future of, 470
Engineering Hints on a Tramway System, W. Dalton, 875
Engineering, New Degrees in, 149
Engineering Standards Committee, 649

Engines:
Alternator Engine Speeds, 183
American, 328, 449, 866
Astor Turbine, The, 866
Atlas, The, 449
Belliss and Morcom, 510, 693
Correct Type for Large Generating Stations, A. A. Day, 48
Diesel, The, 724
at Electricity Works, see under name of town in ELECTRIC LIGHTING
Gas *v.* Steam, 867
Steam Turbines, S. E. Fedden, 47
Westinghouse, The New, 580

Ether from Acetylene, 795
Experimental Research in Workshops, 797
Explosions, Gas, see "Accidents"

F.

Factories, Ventilation of, 687
Fahie, J. J, Staite and Petrie's Electric Light, 297, 337, 374
Falmouth Exhibition, 320
Fedden, S. E., Steam Turbines, 47
Field, M., Notes on the Testing of Tramway Motors, etc., 220, 301, 333
Field, M. B., Some Novelties in Electrical Apparatus, 406
Field-Magnet Construction, 237
Fire Alarms, Automatic, 581
Fire Exhibitions, 361, 613
Fires, 68, 73, 105, 135, 249, 256, 284, 343, 451, 678, 784
Fleetwood, C. T., Retirement of, 38
Flywheel Accidents, 217
Flywheels, Power Lost in, 110
Fog Signalling, 829
Fogs and Smoke, Lecture on, 844
Forthcoming Events (Notices of Meetings), see each Issue
Fothergill Prize, The, 37
Fritz Medal, The, 757
Fundamental Principle, A, J. F. Moore, 484
Future of the Telephone in the United Kingdom, J. E. Kingsbury, 410

G.

Gas Explosions, see "Accidents"
Gas, Production of Natural, 543
Gases, Remarkable Phenomenon in, 795
Goldschmidt, R., An Instrument for the Determination of Alternate-Current Curves, 117
Goodrich, W. F., Electricity from Refuse, etc., 722, 775; also Supplement, Nov. 14
Graphite, Artificial, 723
Guttapercha, 433
Gyrostatic Action and its Bearing on Certain Points of Engineering Design, W. R. Kelsey, 86

H.

Heathman's Tower Wagons, 676
High-Speed Trials, 146
High-Tension Continuous-Current Systems, A. S. Barnard, 14
Honours List, The, 2, 865
Hopkinson, C. and B., and E. Talbot, Electric Tramways, 704
Human Body, Volts and Amperes in Relation to the, A. H. Mayer, 453
Humphreys, W. H., Electrolysis in Water Pipes, 189
Hutchins, S., The Conversion of Single-Phase into Multiphase Stations, 85
Hydrogen Electrode, Depolarisation of, 361
Hydrogen and Platinum, 613

I.

Incandescent Lamps:
Light of, 77
Maxim, The, 197
Nernst Lamp, The, 1, 277, 307, 716, 761, 818, 852, 854
Osmium, The, 542
Premier, The, 138
Rating of, 40
Tests of, 732

Indiarubber, 290, 649
Insulators for High-Voltage Lines, 218
International Fire Exhibition, 361
Ireland, Rainfall of, Dr. Mill, 409
Ireland, Water Power in, 409, 414
Iron and Steel Industries, Application of Electric Power in, D. Selby-Bigge, 667, 700, 728
Iron and Steel, Magnetic Properties, etc., of, 365, 831, 832
Ironsand, Metallurgical Treatment of, 400

K.

Kelsey, W. R., Gyrostatic Action and its Bearing on Certain Points of Engineering Design, 86
Kelsey, W. R., The Differentially Compounded Motor, 837
Kendal Electricity Works, 333
Kingsbury, J. E., The Future of the Telephone in the United Kingdom, 410
King's Lynn Electricity Works, 626
Kylberg, F., The Use of Electricity in Iron and Steel Works, 441, 487, 518

L.

Labour Rule, 289
Lace, Electroplated, 363

Leading Articles:
At the Society of Arts, 738
Birmingham Art Gallery Lighting, 162
British Association, 378
Collection and Transhipment, 126
Commercial Expansion, 846
Conferences and Cables, 666
Crompton and His Critics, 54
Depreciation of Tramways, 486
Education of Engineers, 450
Electric Railways, 270
Excellent Education at Chelmsford, 522
Experimental Research, 810
Honour to Whom Honour is Due, 90
Infantile Insurance, 234
International and Other Congresses, 18
London's Tube Railways, 198
Marconi's Transatlantic Telegraph, 914
Municipal Telephone Competition, 702
Pioneers, 306
Professional Etiquette, 594
Suburban Traffic, 415
Surface-Contact Systems, 342
Taunton, 774, 882
Truth *re* Municipal Undertakings, 558
Water Power in Ireland, 414
Where Ignorance is Bliss, 630
Wireless Telegraphy and the Daily Papers, 162

Lead Trust, A, 499
Leaves from a Testing Engineer's Notebook, F. W. Davies, 518, 554, 591, 624
Leeds Electricity Works, 654

Legal Intelligence:
Acetylene Patents, 782
Alcock *v.* Dellannis, 745
Barnsley Meter Case, 745
Battersea Smoke Prosecution, 349
Blackpool Trams, 242
Bournemouth Trams, 131, 207
Bright's Lighting, etc., 317
British Power, etc., Company (Winding-Up Action), 424, 782, 919
Brompton, etc., Railway, 131
Charing Cross Company *v.* Israel and Joel, 818
City of London Company's Actions, 709, 919
Croydon Tramways, 350
Dublin Trams, 818, 888
Electric Lamp Regenerating Company (Winding Up), 168
Electric Lighting Boards (Winding Up), 709, 919
Electric Railways (Winding Up), 709
Electric Tramways Construction Company's Action, 168, 672
Electro-Motion Corporation Case, 638
Ferranti Meter Patents, 745, 887
Galvanic Battery Patents, 853
Glasgow Corporation Tramways, 639
Great Northern and City Railway Case, 565, 888
Hastings Tramways, 672
Hiram Maxim Lamp Company (Winding Up), 673
Huddersfield Tramways, 350, 377
Isle of Man Tramways, 242
Leamington and Warwick Company, 98
Leeds Trams, 317, 377
London Electric Supply Company *v.* Greenberg and Lake, 242
London Gazette (Bankruptcy, etc.), 68, 104, 136, 174, 284, 319, 357, 465, 499, 571, 715, 751, 753, 824, 895, 925
London United Tramways Company's Cases, 530, 888
Manchester Tramways, 61, 131, 168
Mazarron Electric Light Company, 377, 424
National Telephone Company's Actions, 530, 709, 782
River Plate Electric Light Company (Reconstruction), 853
St. James's Company *v.* Postmaster-General, 279
Sandown Gas Company *v.* Isle of Thanet Electric Company, 854
Secondary Batteries Case, 131
Smoke Summonses, 349, 745
Southend Tramways Contract, 709
South London Corporation Wiring Case, 530
Stewart *v.* Murphy, 565
Toronto Corporation *v.* Bell Telephone Company, 168

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Legal Intelligence (*continued*):
Westminster Electric Company's Action, 919
Winding-up Petitions, 168, 424, 673, 709, 782, 818, 919
Wrongful Dismissal Case, 639

Legrange's Equations, Applications of, 469
Lighthouses, Communication with, 901
Lighting and Driving Textile Mills by Electricity, M. Osborne, 228
Lightning, etc., 109, 290, 421, 472
Light Railways, 3, 31, 64, 247, 282, 352, 462, 497, 534, 568, 569, 570, 603, 604, 606, 641, 645, 679, 681, 712, 748, 787, 789, 821, 858, 892, 893, 894, 922, 923, 924; also see ELECTRIC TRACTION
Light, Velocity of, 110
Liquid Air, 613
Liverpool Overhead Railway New Trains, 402
Loans, Repayment of, 40
Lodge, Sir O., On Electrons, 109, 812, 977
London Locomotion, 76, 689

M.

Magnetic Detectors in Space Telegraphy, E. Wilson, 415
Magnetic Liquids, Permeability of, 915
Magnetic Track Brake, 659
Maidenhead Electricity Works, 870
Manchester Municipal School, 550
Marconi's Wireless Telegraphy Station at Cape Breton, 271, 902, 914
Mavor, H. A., Design of Continuous-Current Dynamos, Supplement, Nov. 14
Mayes, A. H., Volts and Amperes in Relation to the Human Body, 453
Metallic Films by Cathode Projections, 901
Metals, Conductivity of, 686
Metals, Magnetic Experiments on, 316
Meters, Motor, Improvement of, 327
Mill, Dr., Rainfall in Ireland, 409
Moore, J. F., A Fundamental Principle, 484
Motorcars, see "Automobiles"
Motor, Electrical, see DYNAMOS
Moving Platforms, 145
Municipal Car Building at Sheffield, 581
Municipal Trading, 220; Supplement, July 18, 830
Municipal Tramways, 556
Murray, R. T. Ruthven, Double-Current Generators and their Application, 10

N.

Nernst Lamp, The, 1, 277, 307, 716, 761, 818, 852, 854
Newcastle Electric Light Company's New Station, 483
New Firms, etc., 68, 104, 213, 429, 716
Newton Tramcar Guard, The, 308
Nobel Prizes, 577, 829
Nuneaton Electricity Works, 834
Nursey, P. F., The Evolution of Electrical Telegraphy, 295

O.

Obituary:
Abel, Sir F., 362, 397
Bathurst, F., 521
Dennis, A., 174
Fearon, H. C. D., 291
Gladstone, Dr., 506
Short, Prof, 632

Oil for Dusty Roads, 534
Oil Fuel, 145
Operation of Traffic on Steam Railways, 590
Optical Illusion, An, 578
Osborne, M., Lighting and Driving Textile Mills by Electricity, 228
Osmium Lamp, The, 542
Osmotic Pressures, 614
Otis-Waygood Amalgamation, 358
Ozone, 361, 363

P.

Parliamentary Procedure, 219
Parsons Turbine Plant at Neptune Bank Station, 186
Partnerships, etc., 357, 358, 499, 717
Patent Law, etc., 37, 41, 398, 724
Patents, Provisional, see each Issue
Peace Exhibition, 865
Peat Bogs of Ireland, 3, 174
Peat Fuel, 579
Perkins, F. C., An American University Light and Power Plant, Supplement, Nov. 14
Perry, Prof., Address to Engineering Section of British Association, 443
Personal, 105, 176, 253, 285, 289, 356, 393, 429, 499, 604, 608, 676, 784, 759, 897
Petavel, J. E., Radiation and Absorption, 484
Petrie and Stalte's Electric Light, J. J. Fahie, 297, 337, 374
Photographic Exhibition, etc., 42, 289, 785
Physical Papers, 649
Platinum, 181, 505, 613
Poetry, 634, 773
Poisoned Arrow, The, 20, 163
Poles, Simple Test for, 721
Polyphase Motors, Notes on, 771, 803, 839

Portraits:
Arnold, F., 258
Cockerill, J. W., 258
Gibson, S. C., 834
Mackay, J., 800
Millington, H. A., 258
Montgomery, Mr., 800
Parker, J., 800
Petrie, W., 298
Short, Prof., 632
Stalte, W. E., 298
Turner, F. L., 258

Potential of Alloys, 903
Potter, W. B., The Electric Third Rail, 309
Power Bills, see POWER TRANSMISSION
Power Station Signalling Apparatus, 92

Power Transmission:
in Africa, 545, 617, 688
in America, 146, 185, 256, 399, 617, 725, 760, 829, 925
on the Bann, 113, 608, 643
Bills for, 31, 66, 283, 536, 754, 785
Burstall, Prof., Address on, 650
in Canada, 365, 580
Carmarthenshire Company, 785, 823, 925
Caurery Scheme, 109, 184, 618
Cheshire Scheme, 502, 677, 753, 823, 925
Clyde Valley Company, 725, 754
in Fifeshire, 754, 925
at Grenoble, 254, 507
in India, 37, 109, 184, 618, 721
in Ireland, 133, 409, 451, 608, 643
in Italy, 285, 825
Kent Syndicate, 753
at Niagara, 110, 725, 867, 925
in New Zealand 542, 613, 614
in North Wales, 650
Ocean Coal Company's Plant at Treorchy, 798
Osborne, Mr., Paper on, 228
in Russia, 537
in Somerset, 536
in Spain, 785

Presentations, 67, 101, 139, 177, 427, 429, 501, 572, 593, 608, 712, 923, 925
Private Bill Procedure, 797
Proctor, H. F., Notes on Earthing, 92
Professional Etiquette, 634

Q.

Questions and Answers, 24, 56, 87, 124, 164, 200, 239, 277, 313, 347, 380, 421, 454, 491, 524, 560, 595, 596, 634, 661, 706, 734, 778, 805, 848, 879, 909; also Supplements July 18 and Oct. 17.

R.

Radiation and Absorption, Some Experiments on, J. E. Petavel, 484
Radiations from Radioactive Substances, 758, 830
Radio-Conductor, A New, 73
Rainfall of Ireland, Dr. Mill, 409
Raworth, J. S., On the Prevention of Smoke, 628
Reduction Methods, 328
Removals, etc., 31, 66, 283, 319, 356, 429, 465, 535, 824, 896, 924

Reviews of Books, etc:
Advertisers' Guardian, The, 68
Books, etc., Received, 37, 67, 73, 217, 281, 289, 319, 356, 433, 454, 469, 571, 572, 607, 608, 665, 721, 753, 757, 793, 823, 824, 860, 868, 897
Electric Power Transmission, Dr. Bell, 379
Elementary Manual of Applied Physics, Prof. Jamieson, 811
Elementary Manual of Steam, etc., Prof. Jamieson, 811
Encyclopædia Britannica, 127, 452, 487, 884
Exercises in Electrical Engineering, M. Maclean, 415
Merck's Index, 487
Practical Engineer Pocket-Book, 786
Science Abstracts, 722

Rheostat, New Form of, 76
Rider, J. H., Presidential Address to Municipal Electrical Association, 8
Robinson, J. C., The Bristol Tramways Electrical Installation, 155
Ross Electricity Works, 800
Rothert, A., A Contribution to the Theory of Commutation, 694, 726, 769
Royal Aquarium, The, 677

S.

St. Louis Exhibition, 1, 434, 793
Science Exhibitions, 37
Scientific Research in India, 469
Secondary Distributing Circuits, Grounding, 75
Shah's Visit, The, 320
Shaw Prize, The, 218
Smells to Watts, From, 697
Smokeless Combustion of Bituminous Fuels, W. H. Booth, 552
Smoke Nuisance, The, 214, 349, 362, 745
Smoke Prevention, J. S. Raworth, 628
Snell, J. F. C., The Relative Advantages of Two and Three Wire Distribution, 120

Societies and Institutions:
American Association for the Advancement of Science, 109, 111, 148
American Electro-Chemical Society, 184, 508, 829
American Electro-Technical Society, 580
American Electro-Therapeutic Association, 1
American Institute of Electrical Engineers, 74, 255, 397, 580, 613, 757, 829
Armour Institute, 217
Association of Municipal and County Engineers, 155, 438, 536, 626
Battersea Polytechnic, 149
British Academy, 289
British Association, 217, 257, 293, 376, 378, 397, 406, 407, 409, 410, 415, 416, 443, 483, 485, 523, 552, 628, 829, 846, 865
British Association of Waterworks Engineers, 189
British Electrical Friendly Society, 789, 894
British Empire League, 866
British Medical Association, 182
Canadian Electrical Association, 37, 74
Chemical Society, 181, 254, 255, 325, 758, 794
Chemical Society of South Africa, 217
City and Guilds of London Institute, etc., 146
Civil and Mechanical Engineers' Society, 434
Coopers Hill College, 182
Coventry Engineering Society, 901
Crystal Palace School of Engineering, 181, 925
Dundee Institute, 797
Electrical Engineers (R. E.) Volunteers, 1, 145, 212, 721, 773
Electrical Trades Union, 536
Electro-Harmonic Society, 469, 505, 577, 649, 685, 829
Faraday Club, 704

Societies and Institutions (*continued*):
Faraday House, 181
Finsbury College, 469
Forthcoming Events, see each Issue
Franklin Institute, 1, 73, 413
German Electro-Chemical Society, 326
Glasgow Technical College, 578
Institute of Carriage Manufacturers, 289
Institution of Civil Engineers, 541, 689, 704, 865, 925
Institution of Electrical Engineers (London), 1, 4, 5, 290, 594, 595, 613, 685, 701, 722, 729, 757, 812, 841, 844, 885, 907, 915
Cape Town Section, 194
Dublin Section, 109, 228, 758
Glasgow Section, 222, 301, 333, 343, 649; Supplement, Nov. 14
Manchester Section, 541, 686, 697, 722; Supplement, Nov. 14
Newcastle Section, Supplement, Dec. 5
Institution of Junior Engineers, 69, 146, 613, 651, 687, 868
Institution of Mechanical Engineers, 613
Iron and Steel Institute, 218, 336, 667, 700
King's College, 181, 724, 730, 832, 866
London Chamber of Commerce, 832
London Day Training College, 217
London Electrical Contractors' Association, 214
Manchester Technical School, 552
Municipal Electrical Association, 2, 9, 18, 46, 92, 120, 433
National Electrical Contractors' Association, 67, 537
National Physical Laboratory, 174
Northampton Institute, 361, 814
North-East Coast Institution of Engineers, 290
Physical Society, 40, 671, 776, 913
Rontgen Society, 577
Royal Cornwall Polytechnic Society, 33
Royal Institution, 67, 650, 793, 830, 868
Royal Meteorological Society, 757, 901
Royal Photographic Society, 541
Royal Society, 226, 272, 685, 722, 794, 832
Royal Statistical Society, 685, 867
Shoreditch Technical Institute, 829
Society of Arts, 37, 38, 218, 253, 397, 649, 738, 796, 925
Society of Electro-Chemists, Proposed, 579
Society of Model Engineers, 137
Society of Working-Men Rifle Clubs, 573
Traction Engine Owners' Association, 857
Tramways, etc, Association, 352
Union Internationale Permanente de Tramways, 21; Supplement, July 18
University College, Liverpool, 37
University College, Sheffield, 685
University of London, 253
Western Society of Engineers, 109, 398
Yorkshire College, 103

Some Limits in Heavy Electrical Engineering, J. Swinburne, 841
Sparkless Commutation, How to obtain it, F. W. Davies, 235
Sparks, Variation of the Spectrum of, 543
Speed Trials, 317
Sports, 67, 136, 139, 284, 429, 825, 897
Stalte and Petrie's Electric Light, J. J. Fahie, 297, 337, 374
Stamford Electricity Works, 404
Steam Railways, Operation of Traffic on, 590
Steam Turbines, S. E. Fedden, etc, 47, 437, 615
Steel Cable Towers, 542
Steel, Electrical Resistance of, 181
Steel Hardening Process, A New, 213
Stewart, A. T., Underground Cable Laying, 152
Stock Exchange Notices, see COMPANIES' MEETINGS
Submarine Boats, 73, 291, 357, 469, 793
Sulphur, Electrochemical Behaviour of, 829
Sunderland Electricity Works, 366
Sun Fan Company's Works, 861
Supplements, July 18, Nov. 14, Dec. 5, Dec. 12
Surges in Transmission Lines, Prof. Baum, 182, 188
Swinburne, J., Presidential Address to Institution of Electrical Engineers, 841, 915
Switches, Future Types of, W. Warrilow, 340
Synchronism, Indicator of, 253
Synchronous Motors, W. M. Thornton, Supplement, Dec. 5

T.

Talbot, E., and C. and B. Hopkinson, Electric Tramways, 704

Telegraphy:
in and to Africa, 136, 404, 607, 642
All-British, 76, 793
in and to America, 147; also see "Pacific Cables"
Anomalies of, 69
in the Bahamas, 685
Bright, Mr., Address on, 832
Cablegram Facilities, 757
Cable Rates, 183, 253, 572, 613, 721, 860
Cables, Durability of, 541
Cables in Wartime, 469
in the Cameroons, 325
and Chamber of Commerce, 105
Evolution of, P. F. Nursey, 295
in and to France, 433
and Geography, 436
in Germany, 26, 319
at Hull, 248
in India, 181
Multiplex, 291
New Instrument for, 433
in New Zealand, 398
Pacific Cables, 109, 147, 212, 247, 249, 289, 319, 361, 389, 469, 536, 607, 642, 649, 659, 666, 757, 785, 823, 830, 832, 860, 866, 895, 897
and the Post Office, 105, 248, 256, 289, 399, 537, 543, 649
Railway Metal, Supplement, Nov. 14
Statistics of the World, 393
Steljes Typewriting Telegraph, 428
Telegrams, Transmission of, in London, 507, 543
Wireless, 2, 33, 55, 97, 68, 73, 90, 105, 109, 112, 136, 145, 149, 162, 213, 254, 255, 268, 271, 289, 290, 307, 325, 356, 389, 394, 401, 415, 433, 434, 486, 472, 543, 544, 614, 649, 677, 685, 721, 730, 784, 793, 794, 818, 830, 861, 865, 902, 914

Digitized by Google

Telephony:
at Aberdeen, 607
in Africa, 538
in America, 1, 39, 289, 723
Anomalies of, 69
Antiseptic Treatment for, 470
Armstrong-Orling System, 183, 213
at Barrow, 541
Batteries for, 146
at Battersea, 362, 397, 506, 722
at Belfast, 357
in and to Belgium, 361, 572, 642
at Bournemouth, 135, 567
at Bridgwater, 465
at Brighton, 285, 356, 465, 535, 642, 895, 926
at Bristol, 271
at Cardiff, 429
at Colchester, 465
Companies' Meetings, see COMPANIES' MEETINGS
Conference on, 506
Currents, Relaying, 364
for Divers, 255
for Fire Brigade, 865
in and to France, 389, 464, 535, 677, 752, 721, 794, 896
in and to Germany, 214, 572, 577
at Glasgow, 66, 135, 186, 238, 249, 390, 536, 862
at Grantham, 247
at Hastings, 285
at Huddersfield, 136, 284, 428, 465, 643
at Hull, 66, 104, 136, 174, 429, 500, 607, 676, 861, 925
Independent, 219
Inductance Coils for, 275
in and to Italy, 752, 890
Kingsbury, Mr., Paper on, 400, 410
at Leicester, 751
Light, 796
at Liverpool, 544
at Llandudno, 464
and London County Council, 678, 825
London Rates for, see "Post Office"
Long Distance, 829
at Manchester, 70, 536
Messages by, 794
in New Zealand, 398
at Oldham, 248
at Portsmouth, 248, 573
and the Post Office, 148, 213, 249, 257, 319, 391, 397, 429, 501, 651, 678, 722, 752, 794, 926
at Rochester, 135
at Rotherham, 355, 465
at Scarborough, 429, 537
at Sheffield, 320, 391, 537
at Southport, 356
at Swansea, 103, 466, 499, 538, 717, 786, 861, 855, 883
in the Temple, 325, 501
Tenders for, see TENDERS WANTED
at Tunbridge Wells, 67, 111, 135, 174, 464, 677, 690, 702, 731, 766, 775, 793, 811, 861, 869, 883, 895
Tunnels for, 723
at Uckfield, 66
at West Hartlepool, 675
Wireless, 290
at Worcester, 356, 389

Tenders Wanted and Accepted:
at Aberdeen, 209, 674
at Accrington, 63, 172, 259, 352
for Admiralty, 531
in Africa, 99, 279, 318, 352, 387, 389, 426, 461, 532, 674, 675, 746, 747, 819, 891
at Amsterdam, 280
at Andover, 495
in Argentine, 318
for Ashford Schools, 388, 675
at Aston Manor, 530
in Australia, 245, 280, 675, 856
at Aylesbury, 640
at Barking, 64, 495
at Barrow-in-Furness, 495, 674, 820, 890
at Bath, 28, 135, 209
at Batley, 460, 530, 784
at Battersea, 64, 532, 711
at Bedford, 317
at Belfast, 425, 460, 747
in Belgium, 495, 710
at Bethnal Green, 783
at Bexley, etc., 134, 244, 425, 461, 747
at Bishop Stortford, 63
at Blackburn, 388, 711
at Blackpool, 209, 279, 425, 531, 566, 855, 890, 922
at Bootle, 495, 531
at Bournemouth, 28, 388
at Bradford, 99, 172, 245, 460, 819, 856, 891, 922
at Brandon, 171
at Brechin, 566
at Bridgend, 711, 783
at Brighton, 28, 135, 783, 891
at Bristol, 28, 210, 244, 317, 351, 566, 602, 746, 783, 820, 890
at Broompark (near Durham), 711
at Burnley, 675, 819, 820
at Burton-upon-Trent, 100, 351, 565, 856
at Bury, 244, 351, 388, 460, 531, 675, 711
for Caledonian Railway Company, 711
at Camberwell, 64, 891
at Canterbury, 711, 921
at Cardiff, 28, 819
at Cheltenham, 172, 531, 640, 711
for Cheshire Lines Committee, 711
at Chester, 172, 566, 922
in China, 351
at Chorlton, 351
for City of London School, 172
at Clacton, 747
at Colchester, 425, 495, 820
at Coventry, 134, 461
at Cromer, 921
at Croydon, 783, 922
at Darlington, 388
at Darwen, 856
at Deptford, 531
at Derby, 210, 891
for Devon County Council, 28, 495
at Devonport, 172, 922
at Dewsbury, 64, 215, 640, 747, 819
at Doncaster, 244, 280, 388
at Dover, 351

Tenders, etc. *(continued):*
at Dublin, 99, 747, 783
at Dudley, 531
at Dumbarton, 603
at Dumfries, 603
at Dundee, 134, 135, 351, 425
at Dungannon, 388, 820
at Ealing, 99
at Eccles, 210
at Edinburgh, 63, 244, 531
at Elmton, 171, 245
at Epsom, 351
at Erith, 640, 746, 856
at Exeter, 388
at Falkirk, 172
at Farnworth, 99, 351
at Finchley, 63, 711, 856
in France, 317, 352, 460, 494, 495, 640, 641
at Fulham, 135, 531, 560, 711, 784
at Gateshead, 426
at Gillingham, 531
at Glasgow, 461, 531, 855
at Gravesend, 603
for Great Western Railway, 494
at Greenwich, 99
at Grimsby, 209, 387, 460, 641, 783
at Guernsey, 63
at Hackney, 100, 603, 921
at Halifax, 209, 640
at Hammersmith, 63, 172, 566, 674, 675
at Hampstead, 64, 209, 461, 495
at Hapton (Lancs.), 63
at Harrogate, 209, 461, 496, 855
at Hawick, 99
at Hebden Bridge, 783, 819
at Heckmondwike, 746, 820
at Hendon, 99
at Huddersfield, 244, 425, 712
at Hull, 746
for Hungarian Government Railways, 28
at Ilford, 28, 134, 425, 461
at Ipswich, 426, 495, 820, 891
in Italy, 28, 279, 531, 855, 921
for Kinfauns Castle (N.B.), 245
at King's Norton, 280
for Kingseat Asylum, 426
at Kirkaldy, 279, 317
for Lancashire and Yorkshire Railway Company, 891
at Lancaster, 566
at Leeds, 641
at Leicester, 134, 425, 641, 675
at Leyton, 603, 711
at Limerick, 279
for London County Council, 28, 64, 100, 134, 135, 172, 461, 566, 603, 641, 784, 819, 855, 856
at Londonderry, 856
at Lowestoft, 63, 280, 640, 855
at Luton, 922
at Maidenhead, 172, 495, 532, 747
at Maidstone, 351
in Malay States, 64
at Malvern, 63, 711, 856
at Manchester, 28, 99, 134, 172, 279, 460, 531, 674, 783, 855
at Mansfield, 566, 747, 783, 922
at Medomsley, 27
for Mersey Railway, 747
for Metropolitan Asylums Board, 244, 388
at Mexborough, 388
for Middlesex County Council, etc., 279, 425, 641
at Middleton, 640
for Midland Railway Company, 640
at Mile End, 352
at Montrose, 675
at Morley, 99
at Motherwell, 99
for National Telephone Company, 675
at Newcastle-on-Tyne, 28, 172, 244, 495, 566, 641, 747, 783, 820
at Newport (Mon.), 171, 209, 245, 388, 855, 922
in New Zealand, 856
for North-Eastern Railway Company, 134, 819
in Norway, 209, 244, 317
at Norwich, 856
at Nottingham, 495, 566
at Nuneaton, 100, 245
at Oban, 641
at Oldham, 921, 922
at Partick, 890
at Pemberton, 426, 566, 674
at Peterborough, 318, 425, 531
at Plymouth, 171
at Pontypridd, 27, 674
at Poplar, 244
at Portsmouth, 820, 891
at Prescot, 172
at Radcliffe, 640
at Reading, 244, 351, 532, 820
at Rochdale, 99, 171
for Rochford Rural District Council, 461
at Rotherham, 64, 210, 461, 675, 855
in Roumania, 99, 710, 890
at Rugby, 172
in Russia, 279
at St Pancras, 783
at Salford, 640, 819
in Servia, 27, 99, 317, 351
at Shanghai, 244, 388, 603
at Sheffield, 531, 747, 856
at Sidmouth, 747
at Southampton, 351, 425, 495, 603, 640, 820, 891
at Southend, 64, 426
at Southport, 245
for South Wales Electrical Power Distribution Company, 461, 856
in Spain, 64, 99, 279, 317, 318, 351, 388, 460, 530, 531, 890
at Spennymoor, 245
at Stalybridge, 245, 318, 425, 711, 747, 855
at Stepney, 531, 890
at Stockton-on-Tees, 245, 496
at Stoke-upon-Trent, 855
at Stratton St. Margaret (Wilts), 63
at Stretford, 28, 351, 531
at Sunderland, 318, 566, 640, 819
at Surbiton, 922
at Swansea, 27, 135, 244, 318, 425, 641, 710, 819, 855

Tenders, etc. *(continued):*
at Sweden, 495
at Swindon, 351, 352, 425, 426, 460, 565, 603, 783, 855
in Tasmania, 192
at Tonbridge, 28
at Trimdon Grange, 819
at Tunbridge Wells, 64, 495
at Tynemouth, 99
at Wakefield, 495
at Wallasey, 819
at Walsall, 135, 280, 711, 890
at Walton, 850
at Wandsworth, 783, 922
for War Office, 675
at Warrington, 135, 245, 351, 674
at Watford, 461
at Wellingborough, 747
at West Ham, 100, 135, 244, 280, 426, 461, 531, 641, 891
at West Hartlepool, 244
at Wigan, 27, 64, 460, 855
at Wolverhampton, 209, 352, 426
at Woolwich, 747
at Worksop, 495
at Worthing, 64, 135, 352
at Wrexham, 280, 352

Technical Education, 37, 75, 111, 326, 434, 651, 830
Tesla's Laboratory, 542
Thompson, Prof., Specific Utilisation of Materials in Dynamo Design, 407
Thornton, W. M., Experiments on Synchronous Converters, 813; also Supplement, Dec. 5
Through Traffic on Tramways for Passengers and Goods, J. E. Waller, 118, 126
Timber, World's Supply of, 689
Toddie's Electrocution, 917
Trade Notices and Novelties, 122, 197, 275, 311, 345, 420, 449, 484, 529, 564, 599, 633, 670, 742, 776, 816, 852, 886
Trades Unionism, 217
Tramcar Builders' Conference, 321
Tramcar Letter-Boxes, 541
Tramway Employes, 652
Tramway Motors, Notes on the Testing of, M. Field, 222, 301, 333
Tramway Regulations, 17
Tramway Track Maintenance, 651
Tramways Act, 322
Tramways and Light Railways Exhibition, 6, 42, 80, 157
Tramways, Notes on the Wear and Maintenance of, C. F. Wike, 114
Tramways, Through Traffic on, J. E. Waller, 118, 126
Transformers, Heating of, R. C. Clinker, 906
Transformers, Protection of, 434
Transmission Line, Calculation of, 614
Tube Railways, 31, 97, 141, 159, 198, 206, 254, 293, 364, 394, 462, 469, 535, 565, 568, 570, 601, 615, 638, 644, 652, 681, 682, 689, 714, 788, 822, 893, 902
Tunbridge Wells Corporation Telephones, Sale of, 690, 731, 766; also see TELEPHONY and CORRESPONDENCE
Tunnels, Ventilation of, 796
Turbo-Generators, 74, 111
Tweedy, Mr., Presidential Address, 616
Two and Three Wire Distribution, Relative Advantages of, J. F. C. Snell, 120
Tyneside Tramways, 474

U.

Ultra-Violet Light Screen, 902
Underground Cable Laying, A. T. Stewart, 152
Union Internationale Permanente de Tramways, 21: Supplement, July 18
United States Electrical Exports, Decline in, 328
Use of Electricity in Iron and Steel Works, F. Kylberg, 441, 487, 518

V.

Ventilation of Factories, 687
Ventilation of Tunnels, 796
Voltaic Polarisation, Some Phenomena of, 181

W.

Waller, J. E., Through Traffic on Tramways for Passengers and Goods, 118, 126
War Honours, 650
Warrilow, W., Future Types of Switches, 340
Washington Navy Yard Equipment, 221, 254
Water Power in Ireland, F. J. Dick, 409, 451
Water Power Plants, see POWER TRANSMISSION
Water Power Rights in Africa, 545
Weddings, see "Personal"
West Bromwich Lighting and Tramways, 479, 513
Westinghouse Company's Works, etc., 145, 434, 537
Westinghouse Steam Turbine, The New, 530
Whitworth Scholarships, 325
Wike, C. F., Notes on the Wear and Maintenance of Tramways, 114
Wilson, E., Dissipation of Energy by Electric Currents induced in an Iron Cylinder, etc., 226, 272
Wilson, E., Electrical Conductivity of Aluminium Alloys, etc., 483
Wilson, E., Magnetic Detectors in Space Telegraphy, 415
Wilson, E., Wireless Telegraphy, 730
Wireless Telegraphy, see under TELEGRAPHY

X.

X Rays, 3, 73, 135, 897

Y.

Yarmouth Tramways, 258

Z.

Zinc Sulphate, Inversion of, 325

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THE

ELECTRICAL ENGINEER.

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NOTES.

American Electro-Therapeutic Association—We are informed that the American Electro-Therapeutic Association will hold their twelfth annual meeting at Kaaterskill, Catskill Mountains, New York, from Sept. 2 to 4 next. The programme includes scientific papers and discussions, local excursions, and various forms of entertainment. The president of the association this year is Dr. Fred. H. Morse.

Franklin Institute.—The current number of the *Journal* of the above institute has just reached us. Of its contents, the following papers and notes may be mentioned as of interest: "The Gases of the Atmosphere," by Dr. H. F. Keller; "The Construction and Inspection of Steam-Boilers" (discussion); "The Question of the Divisibility of the Atom," by Mr. A. S. Mackenzie; "Electrolytic Lead and Oxides"; and "Fuel Oil on Southern Pacific Railroad."

Electrical Engineers Volunteers.—It is announced in the *London Gazette* for the 24th ult. that temporary Lieutenant E. H. Leaf, second lieutenant in the Electrical Engineers (Volunteers) has been granted the temporary rank of captain in the army whilst serving in South Africa; also that Sergeant G. W. Peart, from the Electrical Engineers (Volunteers) has been granted the temporary rank of lieutenant in the army whilst serving in South Africa. Both appointments are dated as from March 24, 1902.

Manufacture of the Nernst Lamp.—It is announced from Berlin that the Allgemeine Elektricitäts-Gesellschaft has concluded an agreement with the Nernst Electric Light Company, Limited, of London, whereby the latter agrees to abandon for a series of years the manufacture of the Nernst lamp. Under the agreement the London company also consents to procure from the Berlin concern all the lamps required by it for the purpose of meeting the entire demand for Nernst lamps in those countries which were reserved to it some time ago. It should be remembered in this connection that the Nernst Electric Light Company has only Colonial and certain foreign rights of the Nernst patents, and that for England the Electrical Company is the sole agent for the Nernst lamp.

St. Louis Exposition.—We are informed by the resident representative in London that the opening of the Universal Exposition at St. Louis, fixed for May 1, 1903, has been deferred for one year. This has been done for many reasons, but the principal ground for the postponement to 1904 is, we understand, that since its inception the scope of the exhibition has enlarged. While the postponement was under discussion, assurances were received from nearly all the leading foreign countries, and from many States of the American Union, that the postponement would be welcomed by them in an official capacity; by the business men and manufacturers who generally exhibit, and also by those elements among the people who will furnish visitors. More time was also needed for making and perfecting arrangements for the congresses and meetings, now such important features of all universal exhibitions.

Street Public Telephone.—What is reported to be the first street public telephone station in the States has just been brought into every-day use at Bridgeport, in the United States. The junction of two of the most important streets in the town was selected for the experiment. An ordinary form of call-office box made of iron is used, inside of which the telephone apparatus attached to an iron standard is installed. To open the door, the person intending to use the instrument inserts a nickel in a slot and the door automatically opens. To call the central office, the button is pressed as on any other instrument, and in the event of the desired number being available, the person making the call deposits a nickel in the slot designated on the telephone. The telephone is a long-distance instrument, and is intended for out-of-town use as well as for local calls. The box is lighted by a small incandescent electric lamp for use at night time. We have had similar boxes in London for some years.

Institution "Journal."—The June number of the *Journal* of the Institution of Electrical Engineers, just issued, contains the following papers: "Problems of Electric Railways," by Mr. James Swinburne and Mr. W. R. Cooper; "Automatic Relay Translation for Long Submarine Cables," by Mr. S. G. Brown; "Electric Traction on Steam Railways in Italy," by Prof. C. A. Carus-Wilson; "Some Notes on the Influence of the Sub-Station Equipment and Transmission Line on the Cost of Electricity Supply," by Mr. Andrew Stewart (Newcastle Section); "Notes on Irish Water Power and its Electrical Development," by Mr. W. Tatlow (Dublin Section); "Some Points in the Equipment of Electric Tramcars," by Mr. W. G. Rhodes (Manchester Section); and "Tests on the Nernst Lamp," by Mr. R. P. Hulse (Birmingham Section). The volume also includes the two following original communications: "Notes on the Teaching of Electrical Engineering in the Technical High Schools of Charlottenburg (Berlin) and Darmstadt," by Mr. D. K. Morris; and "Sparking in Switches," by Mr. Alexander Russel and Mr. Clifford Paterson.

Electrical Treatment of Lead-Poisoning Cases. Some time ago a proposal was formulated in the Potteries district for the establishment of electric baths and other electrical apparatus at the Hartshill Infirmary, Stoke-on-Trent, for the treatment of cases of lead-poisoning and paralysis, and a committee of medical and other gentlemen was appointed to take the scheme in hand. Owing to the efforts of this committee a considerable sum of money was raised, with the result that the infirmary now has a department for the electrical treatment of these cases. Information which has reached us shows that the work has been very thoroughly carried out, and at the present time cases of lead-poisoning, which are very common to the Potteries district owing to the nature of the industry carried on there, are being treated at the infirmary at Stoke. A good

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part of the work fell upon the Potteries Electric Traction Company, which spent a considerable sum in connecting the building with their electrical mains so that current could be taken from this source. Apparatus for the treatment of cases by the Röntgen rays has also been installed at the infirmary, which adds considerably to the usefulness of the new department.

Electrolytic Lead and Oxides.—At a recent meeting of the newly organised American Electrotechnical Society, Mr. P. G. Salom read a paper describing a process of his invention for electrolytic lead reduction which is in operation at Niagara Falls. The principle lies in the use of ead sulphide as cathode in an acid solution, the hydrogen cation forming with the sulphur gaseous hydrogen sulphide, and thus reducing the lead sulphide to lead in spongy form. The form and construction of the cell used were described and the difficulties discussed which had been encountered. The principal difficulty was that the reduction was not complete, and the degree to which the ores are reduced varies with apparent reasons. It was stated that at present 92 to 95 per cent. of the sulphide is reduced. Another difficulty is that the workmen's eyes are affected in the operation of the process. Two pounds of lead are produced per horse-power hour, 48 cells in series being electrolysed at 130 volts. Specimens were shown of spongy lead, compressed sponge, litharge, and other materials made by Mr. Salom's company. Owing to the spongy form, the material is very readily transformed into litharge. The company intends to take up later the manufacture of storage battery plates.

Electric Automobiles.—A report has reached us to the effect that Messrs. Siemens and Halske have just completed the building of an electric motorcar for experimental purposes with the object of attaining a speed of 105 miles an hour. No particulars are given, but it is mentioned that if the tests prove successful, a high-speed electrical system between Berlin and Hamburg will be seriously considered. The subject of electric automobiles in their relation to storage batteries has been much discussed recently, especially in the New York periodicals. In that city there is now being provided by one company a regular service of electric motorcars. As many as 300 vehicles are in operation daily, the average number of cab miles run per diem being 5,000. The one important factor, however, which tends to somewhat lessen the otherwise undoubted popularity of the service is the high rates charged. These are said to be far higher than those for the best class of horse service. One and a half batteries of cells are provided for each vehicle, each battery supplying a current of 36 amperes for three hours, so as to allow of spares for recharging during the working day. A voltage of 84 is used, and under average conditions the maximum speed of the cars is 30 miles. Everything, save the high rates enforced, seems to point to the success of the electric automobile service in New York.

Municipal Electrical Association—An advance copy has reached us of the programme of the smoking concert arranged by the Incorporated Municipal Electrical Association to be held this (Friday) evening in the large banqueting hall of St. James's Restaurant, Regent-street. The first item is timed for 8 o'clock precisely, and will consist of Meyerbeer's "Coronation March," given by a small string orchestra. This will be followed by the overture "Poet and Peasant" (Suppé), also by the orchestra, after which the song "Love's Coronation," by F. Aylward, will be rendered by Mr. Thos. H. Harrison ('cello obligato, Mr. Preuveneers). Dr. Byrd Page wil then show some experiments in the "Arts of Deception," followed by a violin solo by Mr. T. E. Gatehouse, entitled "Rhapsodie Hongeroise" (Hauser). "Do Sing Something s the title of a humorous sketch by Mr. Tom Clare, and the first part of the programme is brought to a close by a performance by the orchestra of Michiel's "Czardas." The composition of the second half of the programme is as follows: Instrumental (*a*) "Intermezzo" (Mascagni), (*b*) "Benedictus" (Mackenzie), by the orchestra; song, "When the Boys Come Home" (Frances Allitsen), Mr. Thos. H. Harrison; "Ancient and Modern Mysteries," Dr. Byrd Page; violin solo, "Nocturne in E flat" (Chopin-Sarasate), Mr. T. E. Gatehouse; "Musical Burlesques,' Mr. Tom Clare; and march "A Frangesa" (Costa), given by the orchestra.

The Honours List.—It is very gratifying to the profession as a whole to find in the "Coronation" honours list, which was issued at the end of last week, the names of many leading men in the electrical and engineering industries. At least there are a dozen who come under this category, and it is most pleasing to note that the name of Lord Kelvin, who now becomes a member of his Majesty's Privy Council, is at the head of the list. Other well-known men in touch with the profession who have received appointments by command of the King include Sir Andrew Noble, who takes a baronetcy, and Mr. Wm. Mather, M.P.; Prof. Arthur Rücker, F.R.S., principal of the University of London; Mr. John Thornycroft, F.R.S.; and Mr. J. L. Wilkinson, general manager of the Great Western Railway, all of whom have been invested with the honour of knighthood. Appointments to be knight commanders include Prof. Wm. Ramsay, F.R.S.; Mr. George Whitehouse, engineer-in-chief of the Uganda Railway; Mr. Alan Cole, of the Board of Education; Mr. G. W. Smyth, assistant secretary, General Post Office; and Mr. B. W. Legge, M.D., F.R.C.P., chief inspector of factories. The King has been pleased to institute an Order of Merit, the first appointments to which include such distinguished men as Lord Rayleigh and Lord Kelvin It is interesting to note that all lord mayors, lord provosts, mayors, and provosts in the United Kingdom will receive like treatment in the matter of decoration, with very few exceptions, it having been decided to present each with a medal, the design of which will, of course, be special to the occasion.

Marconi's Nova Scotian Station.—Interesting details of a technical nature are to hand of the new Marconi wireless telegraph station which has been erected at Cape Breton, on the other side of the Atlantic. There are four wooden towers, each measuring 28ft. across at the basis and from 9ft. to 11ft. at the top, and attaining a height of 215ft. from the earth. These stand at the corners of a square, whose sides are 210ft. long. From each of the four horizontal bridges which connect the tops of the towers are suspended 50 copper cables. Outwardly these cables look like single wires at short distance, but in reality there are 350 wires, there being seven strands to each cable. It will thus be seen that the solitary vertical wire of the original Marconi experiments has now been enormously increased. The 50 cables of each of the four groups converge a little as they go downward, and also incline slightly toward the centre of the quadruplex edifice. The lower ends, therefore, are arranged along the sides of a square much smaller than that formed by their supports at the top. It is stated that in the experiments shortly to be commenced of transmitting wireless messages across the Atlantic, Mr. Marconi will retain the coherer as his receiving instrument. In the transmitting apparatus transformers will be substituted for the old-fashioned

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induction coil. The spark gap will be scarcely more than an inch long, but the spark itself will be widened, or thickened greatly by the shortness of the interval. It will be produced between globular terminals 2in. in diameter. Alternating current at a voltage of 2,000 will be generated by a 40-h.p. dynamo, run by gasoline engines, and this voltage will be raised to 20,000 by the transformers. Condensers and other electrical appliances will increase this still further until a voltage of from 50,000 to 70,000 is secured.

X-Ray Practice.—The following rapid and simple method of localising foreign bodies by the X-rays is described by Dr. J. Wishart Little in the current number of the *Lancet*. It is recommended for use especially in military surgery in active service, where both time and means of transport are limited. The patient is placed on a couch or a table fitted with the usual drum and cross-wires in such a position as to allow the foreign body, the presence of which has previously been determined by the screen, to be as nearly as possible over the meeting point of the wires. The vacuum tube is fixed at a height of 15in. or 20in., measuring from the plate to the anode, and as nearly as possible vertically over the crossing point of the wires. This position of the tube is known as the zero point. Two photographs are now taken on one negative, the first exposure being given from a point 2in. to one side of the zero. The tube is then moved through a distance of 4in. to a point 2in. on the other side of the zero, in a horizontal direction, from which the second exposure is given. On developing the plate the cross-wires and two shadows of the foreign body are seen. By means of a sliding caliper scale, the actual depth of the foreign body from the plate may be immediately read off from the instrument, after placing the fixed jaw of the scale on one part of the first shadow, and sliding the movable jaw along till it points to the corresponding part of the second shadow. It is often, however, found advisable in cases where the foreign body is less than 1in. from the surface, to increase the distance through which the X-ray tube is moved to 8in. instead of 4in. By this means the distance between the shadows is increased, and consequently a more accurate result obtained, but some distortion of the images. It must be remembered, of course, that by doubling the distance through which the tube is moved, the reading on the scale must be halved to give the true depth of the foreign body from the plate.

Electrical Legislation.—Not the least important matter brought before Mr. Gerald Balfour by the deputation which waited upon him from the Institution of Electrical Engineers recently was in regard to the strengthening of the electrical staff of the Board of Trade, and it will be recalled that Mr. Balfour promised to give the matter his consideration. From this it must not be concluded that the deputation found any fault whatever with the constitution of the staff at present. They purely and simply urged that the development of the industry all over the country demanded an increase of members. In effect, it was with the view of emphasising this point that Mr. J. Swinburne, who headed the deputation to Mr. Balfour, wrote a letter to the *Times* of the 21st ult. As Mr. Swinburne humorously puts it in this communication, the only fault to be found with Mr. A. P. Trotter, the present electrical inspector of the Board of Trade, is his inability to work more than 24 hours a day. At the same time, Mr. Swinburne points out a curious anomaly of the Board of Trade—namely, that the electrical inspector is partly a subordinate of the Fisheries and Harbours Department and partly of the Railways Department. He urges that a department of the Board should be created to deal with the electrical industry as a whole. Such a department should have a man of Mr. Trotter's calibre as head, not merely as an inspector. Turning from this subject, Mr. Swinburne goes on to discuss the question of municipal trading, speaking on his own responsibility as an engineer and not as president of the Institution. He points out that the burden of complaint of electrical engineers does not lie against the Board of Trade, but against legislation, which has taken hold of their needing the use of streets for mains and rails to burden them with compulsory purchase, and to get them among the tentacles of misdirected municipalism. The mere accident of their needing the use of streets has been used as "an excuse for plundering, crippling, and—must it be said—blackmailing the industry." Mr. Swinburne concludes: "What we want is not a couple of Bills promoted by the Board of Trade brought on some day, but a full and impartial enquiry into the whole effect of legislation on the electrical industry in the country. Such an enquiry ought to be outside the influence of the local authorities, and it ought to have sufficient weight to guide Parliament. A Royal Commission seems most likely to be efficient."

The Peat Bogs of Ireland.—Under the title, "The Coming of a New Era for Ireland," Lieut.-General R. H. Sankey writes a letter to the *Times*, in which he compares the present state of electrical power development in Ireland with England and Scotland. The real question debated, however, is one of fuel, and the writer attributes the fact that there are 13 electrical power distribution companies authorised, or very soon to be authorised, in England and Scotland, as compared with only one in Ireland, to the presence of a cheap and abundant supply of coal in the case of Great Britain. This leads up to the question whether Ireland, which has in its bogs fuel reserves apparently inexhaustible, and hitherto practically untouched, could utilise its natural resources to better advantage. Hitherto, owing to its bulk and cost of carriage, making its employment uneconomical for steam-engines generally, turf or peat has been unable to compete with imported coal as a fuel, but the writer sees no reason why, with suitably placed generating stations, it should not prove quite capable of competing in every way with coal for the production of electrical energy. To this end it is indispensable that an economical means of transport should be employed, and he thinks that by following up the idea of canalisation in immediate connection with any selected site for a generating centre, this could be effected. Channels radiating from, say, a centre on the well-known bog of Allan, and worked by electric barges, would supply the station with fuel at a mere nominal cost, probably not more than the equivalent of 5s. a ton for coal. As an example of the cheap rate at which electricity can be generated in this country, the writer mentions the case of the Newcastle-upon-Tyne Company, which with its improved load factor has been enabled to reduce the cost of generating electricity to 0·37d. per unit, and he sees no reason why by the utilisation he suggests of the Irish bogs the same results might not in time be obtained. Here, then, is an open field for promoters of private enterprise, but, excepting in some carefully selected localities, where industries have already made some progress, it cannot be reasonably assumed that immediate profitable returns for capital could be looked for. Some exceptions, however, can no doubt be found, and the writer urges that these should be examined with a view to the promotion of companies on the same footing as those already in existence in England and Scotland.

An Interesting Arbitration.—We are indebted to Mr. F. W. Spark, the borough electrical engineer of

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Devonport, for a copy of an award given in an arbitration under the Devonport and District Tramways Act as to the price to be paid by the tramways company for a supply of current from the Corporation's mains for working the electric cars in the town. The case is somewhat prominent in interest. For nearly 12 months before the price was fixed the Corporation have been supplying energy to the company, during which time negotiations took place with a view to agreeing upon the price to be paid. The company's original offer was on a sliding scale—viz., 1¾d. per unit for the first 100,000 units, 1½d. for the second, 1¼d. for the third, and 1d. for all over and above. The Corporation's charge was a flat rate of 2¼d. per unit, influenced no doubt by the fact that the sister town of Plymouth charged its tramways department 3d. per unit. To avoid, if possible, going to arbitration, the Corporation reduced their charge to 2¼d., but the company would only advance their offer to 1¾d. per unit all round. As neither party could see their way to agree to the other's figure, they went to arbitration, Major Cardew being appointed arbitrator by the Board of Trade. The award has now been issued, and provides that the company shall pay the Corporation for the electrical energy supplied at the following rates—*i.e.*, a minimum charge equal to one hour's supply per diem of the maximum current (which is not to exceed the limit of 1,000 amperes) at 500 volts pressure at 3d. per unit, and for any quantity in excess of such amount at the rate of 1¼d. per unit. It will thus be seen that the award as regards price is given on the rebate system, and we understand that the Corporation feel somewhat strongly on the point that while the maximum demand the company can make on the Corporation is 550 kw., the units chargeable on the higher rate of 3d. is only on the basis of 500 kw. Under the present working of the tramways in Devonport, the net result of the award is equivalent to a flat rate of 1·8d. per unit, so that the arbitrator's decision is all in favour of the company, who will now pay less for their current than they were prepared to pay under their first offer. As is characteristic of all Devon, the town of Devonport is very undulating, and all the tram routes have steep gradients, the steepest being 1 in 11. The company have 25 cars ready for service, but at present only 18 run on an average. The average number of units consumed per week of 129 hours is 17,000. The Corporation supply the energy in bulk, and provide and maintain cables to a feeding point some 1,100 yards from the works where the energy is metered.

The Great Northern and City Tube.—The construction of tubular railways offers many points of great interest to the engineer. In the case of the Great Northern and City Railway, which is now at an advanced stage of construction, there are several features of exceptional interest, inasmuch as it differs in many particulars from the forms of construction which have previously been adopted, notably by the Central London Railway, the City and South London Railway, and the City and Waterloo Railway. In the first place, the tubes of the Great Northern and City Railway are of much larger size, measuring 16ft. internal diameter, which is 3ft. bigger than the standard suggested by the Board of Trade for the numerous tube schemes which have come before Parliament this session. At wayside stations the diameter of the tunnels is 21ft., and at terminal stations 23ft. The tubes of the Central London Railway are only 11ft. 8½in. in diameter, and those of the City and South London are still smaller. One advantage of the larger-sized tunnels is that they are capable of accommodating the ordinary rolling-stock of any steam railway in the country. Another special feature of the Great Northern is that the tubes are not built entirely of iron, as has been the practice followed hitherto, but the lower half is formed of brickwork and concrete, the upper part being made of iron segments as usual. One of the results expected from this mode of construction is the diminution of vibration. The permanent way, too, is of somewhat peculiar design, consisting of flat-bottomed rails supported by chairs, which are carried on longitudinal sleepers. In the electrical equipment of the line two separate insulated conductors will be provided, one carrying the return current back to the power-house, instead of utilising the running rails for this purpose. The power-house occupies a central position on the Regent's Canal, and will supply current at 550 volts direct to the motors on the trains. In the first instance four generating units, each capable of an output of 800 kw., will be installed. They are combined with vertical cross-compound engines of 1,250 h.p. each, made by Messrs. Musgrave, of Bolton. One of the engines is already in position. The boilers, which are also in place, are of Messrs. Davey, Paxman, and Co.'s "Economic" type. The coaches resemble those at present in use on the Central London Railway, but they are wider and loftier. They will be made up into trains of seven, capable of accommodating 500 passengers. Three coaches in each train will be equipped with two motors each. The tube itself runs from Finsbury Park Station on the Great Northern main line to the City at Moorgate-street, and the journey is expected to be performed in 13½ minutes. The time of opening the line has not yet been fixed, but it will probably be at a comparatively early date.

The Institution Conversazione.—There has not been such a large and representative gathering at the annual conversazione of the Institution of Electrical Engineers for many a year as that which attended last Tuesday's function at the invitation of the President and the Council. To say that the magnificent central hall and upper galleries of the Natural History Museum, where the conversazione was held, were unduly crowded would be incorrect, for, notwithstanding the unusually large numbers present, no discomfort was experienced on this account. All those members who are possibly able, as a rule put in an appearance at the annual conversazione of the Institution, where they are sure of meeting old friends whom otherwise they would probably not have an opportunity of seeing year in year out, but at Tuesday's function their numbers were greatly swelled by the presence of the foreign delegates to the annual congress of the Union Internationale Permanente de Tramways, which is being held this week at the Agricultural Hall. Also large numbers of provincial ele trical engineers were present this year, who in attending the seventh annual convention of the Incorporated Municipal Electrical Association had an excellent excuse for visiting London this week. So that altogether the date of the conversazione could not have been more appropriately fixed, and the result was that the function passed off in a highly successful manner The President and Mrs. Swinburne received the visitors in the centre of the Great Hall up to 10.30. On entry each guest was handed a special notice in which it was stated that during the evening a resolution of joy at the rapid progress to recovery the King is making would be proposed. Just about 11 o'clock this arrangement was carried out in a very neat manner, the company expressing their assent by joining in the first verse of the National Anthem, which was played by the string band of the Royal Engineers in the hall and the Leoni Ladies' Quintette band in the gallery of fossil mammalia. The wording of the resolu-

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tion, which was afterwards wired direct to the King himself, is as follows: "That the members and guests assembled at the conversazione of the Institution of Electrical Engineers in the Natural History Museum, South Kensington, hereby express their great joy that his Majesty the King has been spared in a time of grievous peril, and their earnest prayer that his Majesty's restoration to health may be rapid and complete, and that he may long live to reign over an united and loyal people; and, further, that they hereby give expression to their sincere sympathy with her Majesty Queen Alexandra and the Royal Family in the great anxiety to which they have been subjected, and in which, indeed, the whole Empire has shared." By the way, we desire to congratulate the Institution on the excellent arrangements made for refreshments during the evening, which, it may have been remarked, were far above the average.

Teaching of Electrical Engineering.—At the request of the Editing Committee of the Institution of Electrical Engineers, Mr. D. K. Morris, associate member, has prepared some notes gathered during the visit of the Institution to Germany in 1901, on the teaching of electrical engineering in the technical high schools of Charlottenburg and Darmstadt. As a matter of fact the notes were ready for publication with the reports of the sectional committees on the Institution visit, but owing to unavoidable causes they could not be printed at the time those reports were presented to the members. They have now been embodied in the *Journal* of the Institution in the form of an original communication, and are of considerable interest as giving a general idea of the conditions of electrical engineering in Germany. In the first place, the course of study is remarkable for its length. The diploma course extends normally through a period of four years, but by special arrangements the course can be covered in three and a half years. At least half a year, and usually a whole year's previous work in a machine shop is required as a condition of entry to the course. Students, however, are on the average, from two to three years older than students of corresponding subjects in England. As giving some idea of the special lecture courses recommended to the more advanced electrical engineering students, the following were the subjects dealt with in Darmstadt during the session 1900-1: water-power machinery, gas-engines, machine tools, planning of central stations for light and power, electric mains and feeders, wiring, electric tramways, telegraphy and telephony, arc lamps and meters, patent laws, etc. Students are expected to take up three or four of these special subjects. The course of study in Germany is remarkable also for the high standard in non-technical subjects insisted upon on entry, enabling thorough treatment and consistent arrangement of the technical courses; and also for the opportunities for specialisation which it affords in the last two years, these being almost exclusively devoted to technical subjects. Owing to the greater scale of the institutions as compared with similar ones in England, the services of several professors and of a large staff are available for the department. Thus, in Darmstadt the electrotechnical department includes three professors and eight assistants, with three mechanics. In addition to the full lecture and laboratory courses in electrical engineering, two shortened courses are held in this subject, one attended by electro-chemists and mechanical engineers, and the other by architects and civil engineers. The electrical machinery at Darmstadt is of all types, including many of the most recent designs. It ranges in size from about 100 h.p. downwards, and includes a large number and variety of the smaller machines, rotary converters, and direct-current, single-phase and polyphase motors. There is a correspondingly great number and variety of measuring instruments. The proportion of students studying electrical engineering to those specialising in civil and mechanical engineering is about half.

Speed Limits of Tramways.—The question of the limitations enforced on the speed of electric tramways and light railways in this country is not one which has been very largely discussed up to the present time, municipal corporations and promoters of private companies being content apparently to accept the dictum of the Board of Trade in the matter. The speed of the cars is usually fixed by the Board of Trade officials with due regard to the prevailing local conditions, and not much opposition to their decisions has been manifested. The normal limit of speed for tramways is about 10 miles an hour, but in some extreme cases this is often reduced to four miles an hour. On the other hand, there are instances where a speed greater than 10 miles an hour has been sanctioned, and one in which 14 miles an hour has been fixed as the maximum speed. Our attention is called to the matter by a letter appearing in the *Times* from Mr. E. Benedict, the secretary of the Tramways and Light Railways Association, in which he puts forward a powerful plea for higher rates of speed for tramways and light railways. In the course of this letter the writer mentions a case in which, when descending a hill, the impossible speed of two miles an hour has been prescribed as the maximum. These limitations, compared with the normal 14 miles an hour allowed to the motorcar, he characterises as ridiculous. No such restriction is imposed in any other country. He also very truly claims that the electric tramcar can go safely at much greater speed than any other vehicle which moves on the road. It is better under control—it has a greater brake power. The injury which low speed limits inflict on both municipalities and companies who own electric tramway systems is very great, if only from the point of view of the operating costs. These in England work out at about 6d. per car mile, of which wages account for about $2\frac{1}{2}$d. If the permitted speed were as great as in other countries, this could be reduced to $1\frac{1}{2}$d, or a fraction more, representing a saving of at least 1d. per car mile, a sum about equivalent to the total cost of the electricity to move the car. The writer also shows that the law only allows Englishmen to get about 60 per cent. as much work out of the same machine as Americans can, in face of the fact that the day's work of an electric tramcar in the States is about 160 or 180 miles, as compared with 90 or 100 miles in this country. He also contends that the tramcars over here are actually condemned to go slowly, lest they should attract too many passengers away from the railways, and concludes with the observation that tramways in this country are rendered more expensive than in any other, by reason of the requirements of the Board of Trade and of the local authorities. With reference to the comparison made by Mr. Benedict of the speeds allowed in England with those in America, it is only fair to say that in the latter country there are very few curves in the tramway systems, which allows of the cars attaining with safety a higher rate of speed than is possible in many cases in this country. There are, however, in the States many intersections at right angles, and although these naturally require a reduction of speed where they exist, they do not introduce that element of danger which has to be guarded against where sharp curves in the line have to be rounded. Moreover, in America, the tramways, or street railways, as they are termed, radiate out of the cities for miles into the open country, where high speeds may be indulged in without much risk to life or property.

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TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

After the inauguration in connection with the congress of the Union Internationale Permanente de Tramways (reported elsewhere) the Right Hon. Gerald Balfour, M.P., proceeded to open the second biennial Tramways and Light Railways Exhibition. The speeches, which were exceedingly short, were completed before we were able to leave the Berners Hall. After the distinguished guest had inspected the exhibition a lunch was served to all present. Mr. J. W. Courtenay, the chairman of the Exhibition Committee, presided, and was supported at the high table by leading representatives of the tramway world both in this country and on the Continent.

After the usual loyal toast, Mr. GERALD BALFOUR proposed "The International Tramways Union." He said the present age was notable for international congresses, which were practically unknown 50 years ago. He trusted that this was a sign of the brotherhood of nations. It was on this general ground that he valued these international congresses, apart from their special functions in bringing together distinguished men who were interested in the arts and the sciences and the industries—in bringing these men together, and making them acquainted with one another, and with the development and progress of the industries and arts and sciences in which they were interested. Turning to the immediate industry represented by the International Union, he was afraid that they in that country must allow that they had probably more to learn from the distinguished friends who had come from the other side of the Channel than these had to learn from them. At all events, this was what he was assured by a deputation which not very long ago he received from the electrical engineers of that country, who deplored the backward state of electric traction in the United Kingdom, attributing it chiefly to legislative restrictions. Nevertheless, he ventured to doubt whether that explanation was quite sufficient to account for the fact, although he was most perfectly ready to admit the accuracy of the fact. He hoped, however, that this inferiority was not going to last very long. He thought he saw signs of an awakening. The development of tramway and light railway enterprise all over the world might be said to be at the present time in its third stage, and it might be of some interest to recall how rapid that development had been. Within less than 30 years they had seen steam replace animal power for the purpose of traction, and they were now seeing electricity rapidly replace steam. In this country it was not until about the year 1877 or 1878 that any other power was used on tramways than animal power. About that date a few lines were equipped with locomotives, and shortly after steam came in with a rush. But already a new and all-conquering power was knocking at the gates, and it was a very remarkable fact that the first warning note which heralded the approach of this power was struck, not in the busy industrial centres of England, as one might naturally have expected it to be, but in a quiet out-of-the-way part of agricultural Ireland. The first electrically-equipped tramway in this country belonged to the tramway company of the Giant's Causeway in Ireland. It was a very primitive affair, and the electric current was conducted along a low rail which the public were warned not to sit upon. He believed they did occasionally sit upon it, with very unpleasant results to themselves, and this line was worked continually until two years ago, notwithstanding that there were numerous accidents, in most of which animals, and not men, were the sufferers. It was some testimony to the leniency with which the Board of Trade imposed its regulations, on the stringency of which so much has been said, that it allowed this company to continue running on a system of that description until the year 1900, when this primitive system was replaced by the overhead trolley system. It was with the introduction of the overhead trolley system that the real supremacy of electricity was fairly established. He admitted that this system was not so quickly appreciated in the United Kingdom as it had been by their neighbours, and the consequence of that was that they had undoubtedly got a little behind. But they meant to make up for lost time, and to make good the distance by which they had fallen behind. The advantages of cheap and rapid transit were coming to be more appreciated in this country, and in electrical traction he thought there was the most satisfactory solution of that most difficult problem of their later-day civilisation—viz., the housing of the working classes who thronged their great cities. He coupled the name of M. Janssen, the director-general of the Brussels tramways, with the toast.

Mr. LEON JANSSEN said he had great pleasure in rising to respond to the toast on behalf of the organisation of which he had the honour to be president—the International Union of Tramways. They were deeply grateful to Mr. Balfour for his kind words, and he desired to say that, as themselves, the absent members of the union throughout the world would be delighted when they heard of the grand welcome they had received in England. They saw before them the results of English work, and they congratulated them upon the fine results being attained.

Mr. JAMES SWINBURNE then proposed "The Tramway Industry." He said that the tramway movement might be divided into two parts. It first supplied the need of getting about from one part of a town to another, which he might say was a small matter, but it was now gradually supplying the people with means of getting from the towns and cities outside into the country. That did not mean that the importance of towns would diminish; it simply meant that the population would gradually get evenly spread over the country. When they thought of it, the only reason for the existence of towns was that people could get about and see one another easily; everything else in a town was a disadvantage. Now, those gentlemen present who were provided with wealth had the means of getting about easily, and, therefore, did not feel the disadvantage of a town. One of the results of electrical tramway enterprise undoubtedly would be that outside large cities scattered towns would spring up where working people would live. With the toast he coupled the name of Mr. D. Boyle, chairman of the Manchester Corporation Tramways Committee.

Mr. BOYLE, in his reply, looked to municipal enterprise to make up our leeway, and gave details of the progress of electric traction in Manchester.

The meeting was closed with a vote of thanks to the chairman, Mr. Courtenay.

In the following notices of the exhibits in the Tramways Exhibition at the Agricultural Hall we have not followed the numbers of the stands, but have arranged the matter in the order in which we viewed the various stands, which order was largely determined by the fact that we were able to get interviews with the prominent engineers in charge at the time we went round.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, who have Stall No. 29, have arranged a most complete exhibit of the cables, street boxes, tramway feeder pillars, and other accessories for which the firm is noted. In connection with tramway systems, interest will be taken in the high-voltage cables for three-phase work, which the firm have standardised, and which have been used successfully already on the main routes of the Newcastle-upon-Tyne Power Supply Company, and for connecting up the Central Electric Company's works in London with those of the Westminster and the Pall Mall Electric Lighting Companies. These cables, which are intended for high voltages up to, say, 10,000, consist of three circular stranded cores, all of which are insulated with paper, and then built up into a circular form by means of jute packing, and lead sheathed over all. Another interesting exhibit which we have not noticed before in the *Electrical Engineer* is the new type of street-box connection which Messrs. Callender are now introducing largely for their new contract work. In Figs. 1 and 2 we give a half plan and section of a four-way box, which shows the details of the connectors. It will be seen that the connecting link between two cores of the same polarity is made by means of a bolt with a shoulder which slips down between two vertical forks. The middle of the bolt is square in section, and has a hole in which the handle

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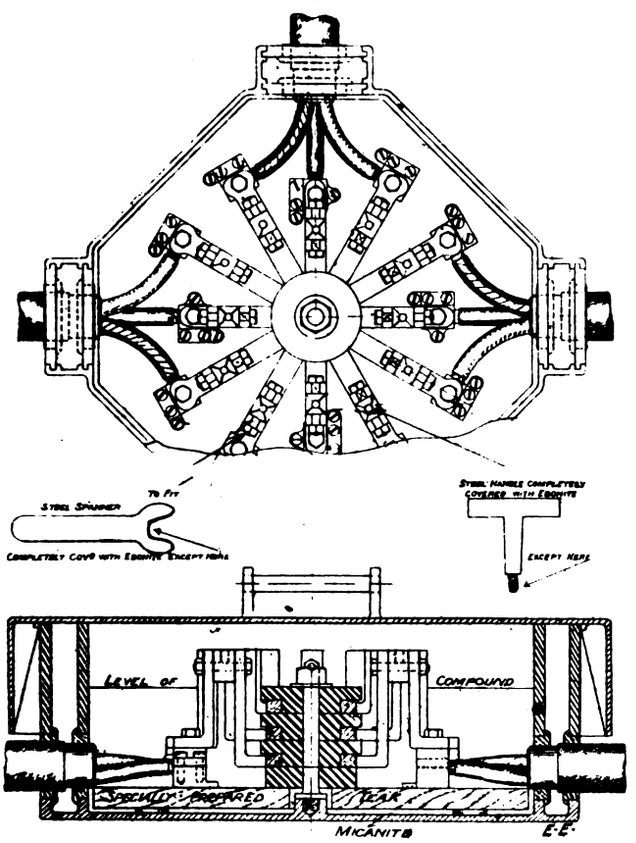
in the illustration can be screwed. A single nut on this bolt clamps up the connections, which is much simpler than the older method of having a horizontal link with a set screw at either end. It also is much less liable to give an accidental short-circuit when completing connections. To lift the key for removing the connection requires only a vertical pull, and hence is not likely to make a short-circuit on to the box. Both this key and the spanner for slackening the nut are insulated with ebonite except in the screw and jaws respectively. The lid of the box is arranged with a depth of almost 6in., and the makers state that with this diving-bell type the box can be flooded with 6ft. of water without any obtaining access to the inside. The firm also show their double-sheathed cables for laying at the bottom of harbours, such as were used at a number of towns on the East Coast, and their street fuse-boxes for tramways, one of which is equipped with the Ward fuses, described in one of our issues last year. Mr. A. C. Ward, who was then the mains superintendent of the Glasgow electric lighting department, has now joined the staff of the Callender Cable and Construction Company. An interesting feature



FIGS. 1 & 2.—Plan and Section of the Callender Three-Wire Four-Way Street Box

of this stand is the railing, which is built up of samples of cable arranged vertically, with their ends projecting through a horizontal brass rail.

Messrs. GRAHAM, MORTON, AND CO., who have the advantage of being the holders of Stand No. 1, have their exhibit in the entrance hall, consisting entirely of a display of photographs illustrating the various types of conveyors and labour-saving appliances installed by them for handling coal, ashes, and other materials in and about electric lighting and tramway stations. We noticed amongst these photographs one of the works at Leeds, at which the firm have recently added a second elevator and conveyor. The two units now supplied by them, when working simultaneously, are able to lift 80 tons of coal out of the barges on the River Aire into the bunkers of the electric lighting station. It speaks well for the design of these apparatus that the cost of handling the coal in this case works out at just about 1d. per ton. This cost includes all charges from the time the coal leaves the barge until it is fed into the boilers. A glance through the interesting photographs hung up round the stand leads to the idea that there is no universally best system of conveying coal. For instance, we noticed examples of the following characteristic types of conveyors: rubber belt conveyors, steel belt conveyors, push plate conveyors, tray conveyors, and gravity bucket conveyors. We understand that some exceedingly good work has been done abroad with these indiarubber belt conveyors, and that they are specially applicable for places in which the cost of transport is of vital importance. It is obvious that the method of exhibiting by photographs is really the only one available to Messrs. Graham, Morton, and Co., as it would be impracticable to show conveyors at work within the limited space available for each stallholder at the Tramways Exhibition.

The stand of Messrs. J. HOPKINSON AND CO., LIMITED, only requires a ring steam-pipe to make it complete. The backbone of the exhibit, of course, is of steam-valves of the parallel-slide type. Of these an erection has been made in the form of two vertical uprights supporting a horizontal cross-bar. The elements of this construction are valves of all conceivable types, and they are all of considerable dimension. They illustrate the various positions in which these safety valves can be fixed in a pipe range, and the numerous ways in which inaccessible valves can be worked from the floor-level. In these we noticed several important improvements in detail which will be of interest to central-station engineers in going through the exhibition. Another exhibit consists in the front plate of a 9ft. Lancashire boiler intended for a working pressure of 200lb. per square inch.

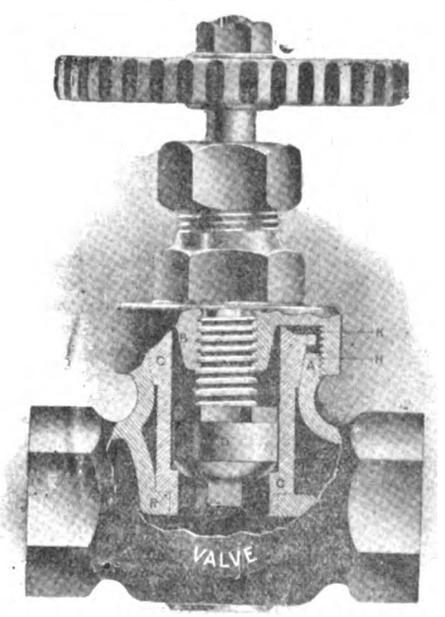


FIG. 3.—The Ris Valve as made by Messrs. J. Hopkinson and Sons.

In this case also the boiler front is equipped with all the most modern appliances made by the firm, and we especially noticed improvement in the cocks of the water-gauges. The object of this improvement is to prevent the pin being blown out owing to the thread which tightens up the packing becoming stripped from frequent use. In connection with the larger straight-through valves there is also a modification of the by-pass arrangement, which is exceedingly simple, and prevents a trouble which often occurs in practice. Instead of bringing the by-pass up the one side of the valves, straight across, and down the other side, two right-angle bends are made in the rising pipes, which give a by-pass of sufficient spring to make up for the difference in expansion between the cast steel of the valve bodies and the gunmetal by-pass pipes. In this way the leaking in the joints, so frequently met with, is entirely avoided. The by-pass valve is of the type illustrated in Fig. 3, which is known as the "R. I. S." valve. The letters in the illustration have the following significance: A is the valve body with conical mouthpiece forming metallic joint at H; B is the valve cover, which holds the valve-seat cage, C, in position, and forms metallic contact at K, H, R; C is the renewable seat cage; and D the renewable valve. It will thus be seen that by removing the cover, B, the seat cage, C, and valve, D, are removable from the body, enabling new parts to be inserted in about a minute's time, the only

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tools required being an ordinary spanner. The advantage claimed for this valve is that all the joints are made by metallic contact without the use of joining materials. We need hardly say that the most careful workmanship alone allows of the success which Messrs. Hopkinson and Co. have attained with this type of removable seating.

Messrs. G. F MILNES AND CO. have the bulk of their exhibits on their own stand, but they also show tramcars on the stands of the British Thomson-Houston Company, the British Westinghouse Company, and Messrs. Witting Bros. Of course, in these latter cases the car equipments are supplied by the companies in question. We found that the single-deck bogie car which the firm has built to the order of the Bournemouth Corporation for use on special State occasions a most comfortable one for resting in while acquiring information from the representative of the company. This car is most elaborately finished, the interior walls being entirely of Chippendale mahogany, with beautiful mouldings and gilt enrichments. Basket chairs are used throughout, accommodation being provided for only 12 persons. After inspecting this car it was instructive to turn to one made by the same firm for the Tyneside Tramways and Tramroad Company, which carries 83 passengers. In this case the "Milnes exhibition stair" is used to obtain access to the upper platform. We were struck, however, with the stair which has been used on the car for the Bradford Corporation, exhibited on the stand of Messrs. Witting Bros. In this case the spiral is reversed, as can be seen in Fig. 4, so that when people are coming down from the top of the car they do not obstruct the exit from the inside. This Bradford car, which is of the single-truck type, provides sitting accommodation for 22 inside and 29 out. It is mounted on a Milnes four-wheel truck, and is provided with powerful slipper and wheel brakes. Messrs. G. F. Milnes and Co. are especially interesting themselves in the manufacture of trucks, of which no less than three distinct types are on view at their stand. We found from their representative that they are in favour of a truck of four wheels of equal size rather than those of the standard maximum traction type. In Fig. 5 we illustrate one of these trucks, the workmanship of which appears to be all that can be desired. We are informed that the firm take great care in the selection of the steel used in their construction. In the maximum traction truck the driving wheels are 2ft. 6in. in diameter and the pony wheels 1ft. 8in. The side frames consist of pressed steel with flanged section. Spiral cushion springs are provided on each side of the axle boxes at the driving wheels. The bolster consists of channel steel, with seating for spiral bolster springs mounted upon a steel swing bolster suspended from bogie cross-bars by steel links and pins. A radial plate is arranged, with top and bottom plates for connecting the truck to body of car, and radial side bearings are fixed at each end of bolster to take any undue weight off the car body. A lifeguard plank is arranged at the headstock end.

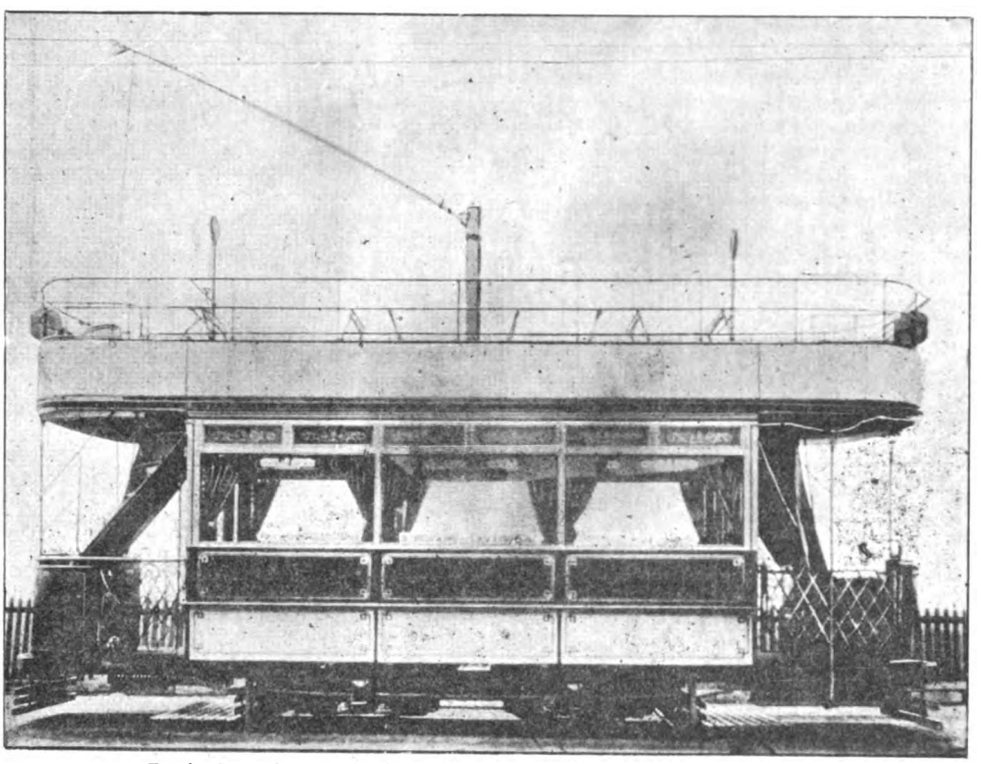

FIG. 4.—Car made for Bradford by Messrs. G. F. Milnes and Co., with Reversed Stairs.

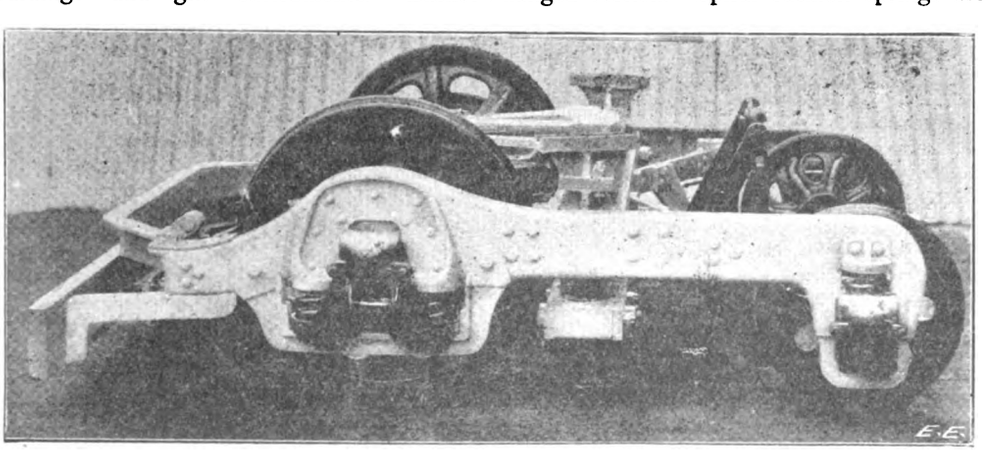

FIG. 5.—The Milne Maximum Traction Truck.

(To be continued.)

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The seventh annual convention of the above association was opened at the Institution of Mechanical Engineers, Westminster, on Wednesday this week, under the presidency of Mr. J. H. Rider, the electrical engineer for the London County Council tramways. At the appointed hour (10 a.m.) a large number of the members assembled in the lecture theatre of the institution, and received a hearty welcome by Sir JOHN MCDOUGALL, the chairman of the London County Council. As Sir John, in the course of a short address, remarked, it was very fitting that the chairman of the central authority of the Metropolis should welcome the members of the Incorporated Municipal Electrical Association. There were many reasons for this—perhaps because of self-interest—for the London County Council were looking for very great things from the president of this association in reference to the electrical matters in London. The comfort and convenience of electric lighting and of electric tramway locomotion were of very great concern to the Metropolis. The County Council would look to the energy and the skill of the municipal engineers to lead London, so that it might make progress in the great branches of the profession which this association represented. In London they did not get the union together that they would get if they were a smaller community, but if they looked at the area of the Metropolis—some 120 square miles—and considered that in this area there were some five millions of inhabitants, they would see the great need there was that their locomotion should be of the very best, and he was quite sure it was to the benefit of London that this association should meet together with the object of considering the best means of assisting them to get about in their business. As chairman of the London County Council, he was extremely pleased to welcome the members of this association there that day, hoping that they would throw some light upon this subject. In London, perhaps the greatest problem at present was the housing of the working classes, and therefore he looked upon it that while the electric light might be for the comfort of the richer classes in London, municipal electric tramways, which they hoped to see developed very soon, and which he regarded as the poor man's carriage, would be for the comfort and convenience of the poor. He hoped that this association would encourage the municipalities, not only in London, but all over the country, to progress and push forward electrical matters. Referring to the continual opening up of the streets in London for the purpose of laying electric light cables and other connections, he remarked that in this matter the London County Council were perfectly helpless, and, in conclusion, expressed the opinion that electrical enterprise would be far better in the hands of the municipalities, than that it should be engineered for the advantage of companies and not for the benefit of the great ommunity.

The PRESIDENT expressed the sense of gratitude of the association for the welcome which Sir John McDougall had given them that day. In proposing a hearty vote of thanks, Mr. Rider congratulated Sir John on the honour which the King had recently conferred upon him.

The motion was carried with acclamation.

Presidential Address.

BY JOHN H. RIDER, ELECTRICAL ENGINEER, LONDON COUNTY COUNCIL TRAMWAYS.

In occupying the presidential chair at the seventh annual convention of the Incorporated Municipal Electrical Association, my first duty is to thank the members for the honour they have done me in electing me to such a high and responsible position. It is no small thing to be the president of a body which is now representative of nearly 150 municipalities in the United Kingdom. Taking, as I did, some little part in the formation of the association, it has been a matter of great personal gratification to me to watch its gradual growth from 1895, when some 25 engineers modestly formed themselves into the Municipal Electrical Association, up to the present, when we number not only about 210 municipal electrical engineers but also 120 municipalities themselves, among our members.

The record of work done is not a great one. It is fully set out in the various annual reports of the council, and I do not propose to deal with any of the points here. As the association grows, its influence is bound to grow with it, but its sphere of usefulness is largely determined by the funds at its disposal. This is a matter about which more will probably be said at the annual business meeting on Saturday next. There is one important feature, however, which has never been mentioned in any of the annual reports. I refer to the great good which the association has done, and is doing, in bringing not only municipal electrical engineers, but also chairmen of committees, from all over the country into personal acquaintance with each other. Valuable though our papers and discussions often are, yet, in my opinion, the informal chats, the personal experiences, and the comparing of notes which take place during the conventions are worth all the rest put together. These are matters which do not appear in our printed *Proceedings*, but, to me, they form probably the most enjoyable part of the whole convention. At nearly all our previous conventions we have had a paper from a chairman of committee, and this year one on "Repayment of Loans" was to have been given. In consequence, however, of the subject having been so fully discussed at our special meeting in February last, it was decided to withdraw it. I hope, notwithstanding this, that the engineering matters which will be brought before you in the papers which follow will not prove uninteresting, even to the layman.

One of the subjects with which the municipal electrical engineer of to-day has to deal, and which has developed in this country almost within the life of this association, is that of electric street tramways. In 1895 there were but five at work, and, with the solitary exception of Blackpool, they were all owned and operated by companies. At our 1896 convention I read a paper in which the possibilities of a combined tramway and lighting load were pointed out, and in which attention was drawn to the economies which were likely to result from such an arrangement. To-day there are 36 electric street tramways in operation which are owned by municipalities, and 16 others in progress of construction. Of the former, 28 are, and of the latter 11 will be, supplied with current from a municipal combined lighting and tramway station. There are also four instances in which the municipal station is supplying current to tramways owned by companies. These figures bear testimony to the appreciation in which the principles of combination are held by municipal electrical engineers, principles which this association has taken no small part in emphasising from time to time. If evidence be required of the economies to be obtained from a combined lighting and tramway load, we need only turn to a recent issue of the *Electrical Times*. In a list which is there given of those towns holding the record for lowest costs, the seven lowest have combined stations.

Without in any way wishing to draw invidious comparisons, I cannot help mentioning two towns, the costs of which are analysed in the issue above mentioned. I will refer to them here as A and B, and I set out in parallel columns the figures relating to each.

For year ending March 31, 1902.	A.	B.
Supply started	Oct., 1894	Jan., 1893
8-c.p. lamps connected	90,057	130,550
Units sold for lighting	1,121,069	1,490,099
Units sold for tramways	1,999,640	—
Average price obtained for lighting	3·41d.	3·83d.
Average price obtained for tramways	1·5d.	—

So far, therefore, as lighting goes, B has a greater lamp connection, a larger output, and a bigger price per unit. But A has a combined lighting and tramway load, while B has a separate tramway station. Now let us look at the financial results. B has a deficit for the year of £2,783, with a total cost per unit of 2·35d. A has a net surplus of £4,752, and holds the record with a total cost per unit of only ·96d. That these excellent results are largely due to the tramways, I am sure the authorities at A would be the first to admit.

With about three exceptions, the whole of the electric tramways in this country are worked by the trolley system, and it is worthy of note that no company (whose first aim, after all, is to pay a dividend) has adopted any other. The Wolverhampton Corporation is experimenting with a surface-contact system, the Bournemouth Corporation is putting down a short length of underground side-slot conduit as part of a general scheme of overhead traction, and the London County Council has adopted the centre-slot conduit for practically the whole of its lines. The members of this association are invited to inspect some of this latter construction on Friday next. The costs of the road construction for these three distinctive types of electric traction vary largely according to the local conditions, but are generally somewhat as follows—viz.:

Overhead construction	£5,000	per mile of single track, including rails and paving in each case.
Surface-contact construction	10,500	
Conduit construction	13,500	

In the face of the very great saving in capital expenditure which can be made by adopting the overhead system, what are the conditions which would warrant the use of the conduit

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system? In the first place, in my opinion it is not warranted unless a car service can be maintained with not greater than a two minutes' headway. The capital charges on the road construction are so heavy that the only way to bring down the cost per car mile is to increase the number of car miles as much as possible, by working the lines for all they are worth. Several corporations have recently been considering the use of the conduit in a similar manner to Bournemouth—viz., for a small portion in the centre of the town, with the overhead system outside. I do not think the conduit is warranted under such circumstances. Certainly the additional cost for such a short length may be very small when compared with the cost of the whole length. But is it worth while burdening the undertaking with a combined system merely for æsthetic considerations? It may be argued that such combined systems are working satisfactorily in Washington, Paris, Berlin, and other places, and that the change from the conduit to the overhead wire, and *vice versâ*, can be made in a very few seconds. That is quite true, but they mean (1) the constant additional labour of at least one man at each changing place; (2) the carrying of the idle trolley over the conduit section; and (3) either separate machines and feeders for the conduit conductor bars, or the permanent earthing of the negative bar because of the rail return of the overhead section.

With regard to the carrying of the idle trolley over the conduit system, this is quite an easy matter when single-decked cars are used, as the trolley arm can lie down flat on the car roof, and thus hardly be seen. But with double-decked cars there are several practical difficulties, since the arm must be kept out of the way of the passengers. The use of separate machines and feeders for the conduit section means considerable additional expense, but this cannot be avoided, if the advantages of an insulated negative conductor bar are to be retained. The abandonment of the overhead for any other system, merely for æsthetic reasons, is, in my opinion, not justifiable. The examples of overhead construction, to be seen in several towns in the United Kingdom, are anything but pretty. Some of them are even ugly. But that is the fault of the designer, and not of the system. It is perfectly easy and practicable to design and erect an overhead line which shall look well in almost any locality. Neat, and even artistic, work costs very little more than rough and unsightly work.

When, then, are we justified in adopting the conduit system? (1) When the traffic over the lines is so great that the heavy capital charges do not make any serious addition to the costs per car mile. This is a condition of things only met with in metropolitan cities, and, after all, is no reason why the overhead system should not be used. (2) When the powers for the tramway can only be obtained on the condition that the conduit is used. (3) When the system of lines is so complicated that the overhead construction becomes cumbersome and dangerous. Both (2) and (3) are again controlled by (1), since, unless the traffic can be guaranteed, the line cannot pay, and had, therefore, better not be constructed. One of the principal difficulties in designing neat overhead construction is that of guard wires. Many an otherwise neat line is entirely spoiled by them. Acting apparently with a view to the safety of the public, but really to protect the telegraph and telephone interests, the Board of Trade has recently issued a new set of regulations, based practically upon those adopted by the Post Office. In order to hear the views of the various tramway authorities upon these regulations, a conference was held a week or two ago at the offices of the Board of Trade. On the advice of the officials of the Post Office, and of the National Telephone Company, the Board of Trade refused to allow the principles of guard wire protection to be discussed, and would only permit remarks on the various regulations which were proposed. As is well known to those with the largest experience in overhead traction work, guard wires may be a protection in some few cases, but in the large majority they are the means of causing the very accidents which they are intended to avoid. Being of necessity only small wires, they are a constant trouble to maintain. They are very liable to break when heavy telegraph or telephone wires fall upon them.

A number of automatic devices have recently been placed upon the market, with the object of cutting off the current should any other wire fall across the trolley wire. But neither guard wires, nor any of these devices, strike at the root of the matter, which is to prohibit entirely uninsulated wires of any kind crossing the trolley wires. If telegraph and telephone wires must be erected overhead, they should only be allowed to cross the streets at right angles, the spans should be kept exceedingly short, and the wires carried as high up as possible, in order that a broken wire may not reach the street. They should be insulated at such crossings, and, if guards are insisted upon, in addition to the above, they should be provided by a netting or similar arrangement under the telephone wires, and not over the trolley wires. The recent accidents which have happened in Liverpool and other towns have been caused just as much by the telephone wires as by the trolley wires, but in the mind of the public they are called trolley-wire accidents, and nothing else. If local authorities would insist on all telephone wires being placed underground, there would be no necessity for guard wires or such like unsatisfactory half measures.

Before bringing these somewhat rambling remarks to a conclusion, perhaps I may be permitted to say a few other words, more particularly to our younger engineer members. A visit to a number of electricity works in this country leads one to the conclusion that in too many cases plant of too small a size has been put in. By this I do not mean not enough plant, but generating sets for too small an output. Those responsible for the design of the works did not seem to have been very sanguine as to the future of the undertaking, and so they put in sets for as small as 50 kw. output, and in some cases even smaller. In the course of a few years, when the station has grown, these sets have become too small, and are either never used or are sold at a loss. Surely, if we expect the business of electricity supply ever to approach the extent of gas supply, we should lay out our power stations on generous lines, and put in plant with an idea to its future economical use, rather than to its suitability for just the number of customers we may have for the first year or two. I do not mean that we should put in plant enough to supply the town for the next 10 years. Such a thing is the prerogative of those gentlemen who are paid by commission. But we should select such sizes that they will form a useful part of a well-designed whole, even though they may be apparently much too large for immediate purposes. The generating stations which we are able to visit and the systems which we are able to inspect during our conventions are great object lessons to us. We can learn not only how to improve our own works, but also, in many cases, what to avoid. No one among us has a monopoly of skill or ideas, and the most able can learn something, even from the beginner. Electrical engineers are too apt to stay at home, to be content with their own plant, and to become even fossilised. In such a progressive science as electrical engineering, we must keep up with the times, or we shall certainly fall behind in the race. My advice to the municipal electrical engineer is to travel (at the expense of somebody else, if he can), to inspect other people's stations and systems, and to discuss with other engineers the numberless points which arise in everyday work. This association has already done a great deal in affording facilities for this. I know what it has done for me, and I cannot think I am alone in the matter.

I thank you, gentlemen, for the patience with which you have listened to these wandering words of mine, and I hope that this, our seventh annual convention, may be no less enjoyable and instructive than those which have preceded it.

After a vote of thanks to the president, the following paper was read:

Double-Current Generators and their Application.

BY E. T. RUTHVEN-MURRAY, ELECTRICAL ENGINEER TO THE WILLESDEN DISTRICT COUNCIL.

Previous to the year 1896 it might be said truly that continuous-current distribution was only employed when a small compact area had to be supplied. The superior limit of low pressure for continuous current, as defined by the Board of Trade regulations, then stood at 300 volts, and already many of the larger undertakings had reached the limit of economical supply from their existing works. It having been recognised that the limit of voltage set was undesirably low, and that it might be increased with safety to the public and the consumer, and to the mutual advantage of both the latter and the proprietors of the undertakings, the Board of Trade was petitioned to amend the regulation defining the limit of low pressure. After a lengthy conference with the engineers in charge of supply works and others interested, the definition was amended to read, "Where the conditions of the supply are such that the pressure may at any time exceed 500 volts if continuous, or 250 volts if alternating, but cannot exceed 3,000 volts whether continuous or alternating, the supply shall be deemed a high-pressure supply." It appears at first sight that alternating-current distribution is handicapped, but this is not the case, since the first regulation provides that "the pressure of a supply delivered to any consumer shall not exceed 250 volts at any pair of terminals, except with the express approval of the Board of Trade." From this it is evident that a three-wire, continuous-current system with 500 volts across the outers is a low-pressure system, but a three-wire alternating supply with the same pressure is a high-pressure system. If, however, the middle wire is earthed and only one outer conductor is brought into each consumer's premises so that the 250-volt limit cannot be exceeded, the supply is at low pressure.

The alteration of the limit to 500 volts enabled existing works to double their supply pressure and to deliver four times as much power from their existing mains with the same line loss as before and without additional capital expenditure. But what was perhaps more important, is that it also enabled supply to be economically given to consumers four times as distant

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from the works, and by this circumstance it opened a new field for continuous current. The satisfactory result has been a very large increase in the number of works supplying on this system. But many of these are now finding the limitations of direct supply, and a flexible and economical means of dealing with the increase in area, output, and number of consumers is being eagerly sought.

One method of dealing with the increase is to build additional generating works, but this is neither an economical nor a satisfactory solution of the difficulty. The advantages of concentrating plant in large works and in large units is being more and more recognised, and a scheme in which this is possible will generally secure preference. It becomes economical to use high-pressure transmission to the more distant parts of the area of supply, and for this purpose either continuous or alternating current may be employed. The former is either generated in special machines delivering the full-line pressure, or by lower-voltage machines connected in series. Obviously the high-tension machines are the more convenient and efficient arrangement, although a considerably higher line pressure has been obtained safely from armatures in series. It is probable that 3,000 volts is the safe limit of pressure to generate in a single armature, since at a higher pressure the risk of flashing over on the commutator is considerable.

Alternating current, either single or polyphase, is generated either by simple alternators or by double-current dynamos, the latter being machines designed to supply alternating or continuous current from one armature. If generated at low pressure, step-up transformers are used to get any economical line pressure required. The necessity for supplying beyond the economical limits of low pressure generally comes gradually, and the tendency is, therefore, to put in small units of the special type of plant chosen when the demand arises. The double-current machine may be put in for use entirely as a continuous-current dynamo until the necessity for long-distance transmission requires it to be employed as an alternator, and it therefore may be installed even in the earliest days of the undertaking. In construction, such a machine is identical with a rotatory converter. It may be regarded either as a continuous-current dynamo with the addition of slip rings, from which alternating current may be taken, or as an alternator with the addition of a commutator, from which continuous current may be taken. It is, of course, well known that every armature generates alternating current, and that to obtain continuous current a commutator must be used to cause the generated currents to flow always in one direction. In the case of the double-current dynamo, as the armature windings are connected to both commutator and slip rings, both alternating and continuous current may be taken simultaneously from the machine.

The frequency, or periodicity per second, of the uncommutated current generated in the armature of a two-pole dynamo will be the same as the number of revolutions per second, so that in the case of a machine running at, say, 375 revolutions per minute, it will be 6·25. In a multipolar dynamo there will be as many periods per second for every revolution of the armature as there are pairs of poles, therefore

$$\text{Frequency per second} = \frac{\text{poles} \times \text{revolutions per minute}}{60 \times 2}.$$

Frequencies of less than 25 per second have seldom, if ever, been used, but 25 periods per second not only has been recommended by the Institution of Electrical Engineers as the lower "uniform standard frequency" for use, but possesses many advantages for the purposes recommended in this paper. To obtain this frequency only certain speeds are available, since it will be seen the product of pairs of poles × revolutions per minute must be 1,500, therefore :

A 2-pole	dynamo	would	require	to run at 1,500	revs. per min.
4-pole	,,	,,	,,	750	,,
6-pole	,,	,,	,,	500	,,
8-pole	,,	,,	,,	375	,,
10-pole	,,	,,	,,	300	,,
12-pole	,,	,,	,,	250	,,
14-pole	,,	,,	,,	214	,,

and so on.

To obtain a single-phase alternating current from the armature of a two-pole dynamo, two tappings must be made 180deg. apart ; for two-phase, four tappings 90deg. apart ; for three-phase, three tappings 120deg. apart ; or if the dynamo is of multipolar type, there must be the same number of tappings and the same angular relationship per 360 electrical degrees or per pair of poles.

The relationship of the continuous and alternating virtual voltages and currents is practically fixed, and will be as shown by the following diagrams, if it be assumed that the magnetic flux is distributed as a sine function with respect to the periphery of the armature, and that the circuits are non-inductive. In applying these figures in actual practice, drop of voltage due to the resistance of the winding must be allowed for.

Figs. No. 1, No. 2, and No. 3 are respectively the cases of single-phase, two-phase, and three-phase, in which

V = E.M.F. between continuous-current brushes ;
A = current from continuous-current brushes ;
v = virtual volts between adjacent slip rings ;
a = virtual amperes in armature winding between adjacent slip rings ;
$a\,e$ = virtual amperes flowing to external circuit from each slip ring ;
n = number of slip rings.

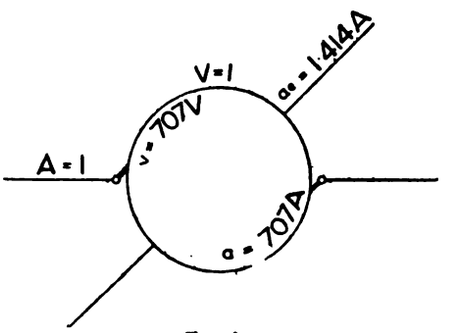

Fig. 1.

The general formulæ for obtaining these values are as follows—viz. :

$$v = \frac{1}{\sqrt{2}} V \sin \frac{\pi}{n}$$

$$a = \frac{\sqrt{2}\,A}{n \sin \frac{\pi}{n}}$$

$$a\,e = 2\,a \sin \frac{\pi}{n}.$$

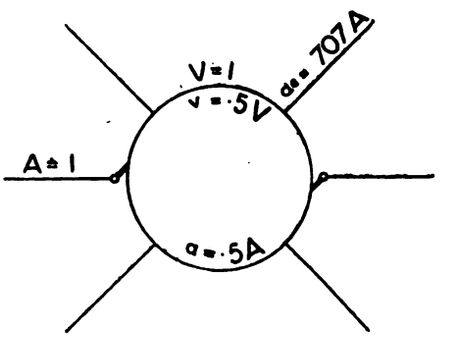

Fig. 2.

For single-phase double-current generator or rotatory converter :

$(n = 2)$

$$v = \frac{V}{\sqrt{2}} \sin 90\text{deg.} = \frac{V}{\sqrt{2}} = \cdot 707\ V$$

$$a = \frac{\sqrt{2}\,A}{2 \sin \frac{\pi}{n}} = \frac{\sqrt{2}}{2} A = \cdot 707\ A$$

$$a\,e = 2\,a = \sqrt{2}\,A = 1 \cdot 414\ A.$$

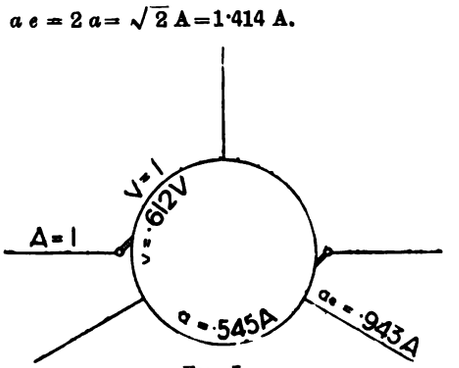

Fig. 3.

For two-phase double-current generator or rotatory converter :

$(n = 4)$

$$v = \frac{V}{\sqrt{2}} \sin 45\text{deg.} = \frac{V}{2} = \cdot 5\ V$$

$$a = \frac{\sqrt{2}\,A}{4 \sin 45\text{deg.}} = \frac{A}{2} = \cdot 5\ A$$

$$a\,e = 2\,a \sin 45\text{deg.} = \frac{A}{\sqrt{2}} = \cdot 707\ A.$$

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For three-phase double-current generator or rotary converter :

$$(n = 3)$$

$$v = \frac{V}{\sqrt{2}} \sin 60\text{deg.} = \frac{\sqrt{3}\,V}{2\sqrt{2}} = \cdot 612\ V$$

$$a = \frac{\sqrt{2}\,A}{3 \sin 60\text{deg.}} = \frac{2\sqrt{2}}{3\sqrt{3}}\ A = \cdot 545\ A$$

$$a\,e = \sqrt{3}\,a = \frac{2\sqrt{2}}{3}\ A = \cdot 943\ A.$$

The ratio of the alternating to continuous voltage will remain practically constant as in the case of the continuous-current motor-generater, in which a double-wound armature rotates in a single field, and any variation required must be obtained by the use of regulators in conjunction with the transformers.

The double-current generator may have either separate, shunt, or compound field excitation. If the machine be required to supply both lighting and traction circuits simultaneously, or other similar rapidly varying loads, separate excitation will give the best regulation. It is also of great importance that the engine should govern as closely as possible consistent with good parallel running of the dynamo as an alternator, and that the turning moment should be even. If rotatory converters or synchronous motors are to be operated from the circuits, experience shows that the maximum variation from absolutely even angular velocity must not exceed one-fourth of 1 per cent. per revolution. Fig. 4 represents diagrammatically a compound-wound double-current generator, with three-phase, mesh-grouped, step-up transformers for supplying the transmission lines.

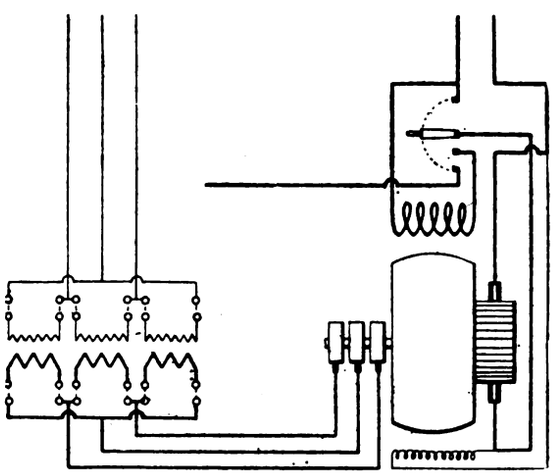

Fig. 4

The slotted-core, drum-wound armature, as used in most modern continuous-current dynamos, is especially suited for generating alternating current at low pressure, since by reason of the distributed winding the voltage curve will be very nearly a sine curve, and the armature reaction will be much less than in the usual monotooth alternator windings, and the regulation will be much better. The latter type of winding frequently results in a saw-tooth curve, which, having a higher maximum value, will subject the insulation of the cables, transformers, etc., to greater stress. Demagnetisation of the fields due to lagging current, arising from an inductive load, is also minimised in the distributed type of winding.

From every point of view the double-current dynamo is a good alternator, but mechanical considerations make it a less easy problem to commutate for continuous current if the voltage is not low. This arises from the fact that the peripheral speed of the commutator must be kept within practical limits, so that there may be no risk of the segments buckling on the one hand, but, on the other hand, the voltage between adjacent segments and the width of these must be such as to ensure satisfactory operation. The problem, although by no means very simple, has been successfully solved by a few engineers who have built this type of machine. Its special sphere of usefulness is in the economical supply of large areas in which continuous current is to be distributed. It may be employed with advantage where otherwise separate continuous and alternating machines would be put down, and by its employment economy in both capital expenditure and running expenses will result. The former, because one such machine will be a spare for either class of service, and the latter because by combining the outputs larger units of plant may be adopted, since it is quite feasible to take continuous and alternating current from the same machine simultaneously.

A number of large double-current generators are now in use in America for both lighting and tramway service; in several cases the frequency of the alternating current being 60 per second. It is within the writer's knowledge that there will shortly be at least four electricity supply works in this country using double-current machines. The largest will be of 1,200 kw. capacity. Three generators of this size—32-pole machines running at 94 revolutions per minute—are being put down to operate the Mersey Railway. The frequency will be 25 per second, and the continuous-current voltage 650.

The author is putting down two 300-kw. double-current generators at the present time, some particulars of which may be of interest. Each dynamo will deliver continuous current from the commutator and three-phase alternating current from the slip rings, and is capable of giving (1) the full output as a continuous-current dynamo with either shunt or compound excitation; (2) the full output as a three-phase alternator; (3) any proportion of continuous or alternating current up to the full output of the machine. Each machine will carry 20 per cent. overload for two hours, 40 per cent. overload for short periods, and, while delivering full load on either alternating or continuous current side, will be capable, at the same time, of delivering 50 per cent. of full load on the other side for one hour without injurious heating. From no-load to 20 per cent. overload, collection will be sparkless with no alteration to the lead of the brushes. The working pressure on the continuous-current side will vary between 480 and 560 volts as shunt, and 500 to 550 volts as compound, the voltage on the alternating-current side being ·61 per cent. that of the continuous. The dynamos will be 12-pole, running at 250 revolutions per minute, and the frequency will be 25 per second. At a later date the author hopes to give some particulars of the performance of these machines, and also of the rotatory converters to be used in conjunction with them.

Where step-up transformers are required to raise the alternating voltage for transmission lines, three-phase will be preferred in most cases. From the unalterable ratio of the alternating and continuous current voltages, it is evident the excitation of the machine must be varied to meet the needs of one class of output only, and it will probably be found most convenient to regulate the field for the continuous-current output as if the machine were a simple continuous-current dynamo. The regulation on the alternating circuits may be then effected at either end of the transmission line, as may be most convenient. Unless a very high line voltage is employed, it is preferable to arrange the transformers in mesh connection rather than star, with the transformers fused at both ends of each winding, as with this arrangement the supply may be maintained to two-thirds full output on the remaining transformers and lines in the event of one transformer or line failing. For the transmission lines multiple-core cables should be used; concentric cables, by reason of the difference in the conductor capacity, give rise to troublesome unbalancing effects. To convert the alternating current to continuous at the sub-stations, motor-generators (having either induction motors or synchronous motors), or rotatory converters may be used. An advantage possessed by the motor-generator is that the full line pressure may be taken, in many cases, into the motor and the use of transformers avoided. The induction motor enables easier starting from the alternating-current side, but will produce a lagging current. The synchronous motor may be excited to give unity power factor at all loads, as by under-exciting the fields a lagging current, and by over-exciting a leading current, will be produced. The effect of the former on the generator is to weaken the field strength, and of the latter to increase it. As a wattless current reduces the useful output of both plant and mains, it is very desirable to secure a good power factor, which may be obtained by the use of either synchronous motor-generators or rotatory converters.

The motor of a motor-generator set may obviously drive a dynamo of any type—series, shunt, or compound wound—or a pair of dynamos for balancing on a three-wire system. The efficiency of the combined machines will not be so high as if a rotatory converter and group of step-down transformers is used by from 5 to 7 per cent., although the voltage of the continuous-current machine will be quite independent of the variations on the alternating circuit. When rotatory converters are used, step-down transformers must form part of the equipment, and where lighting service is given, in which widely-varying voltages are required, special apparatus must be used either on the step-up transformers to the line or on the step-down transformers to the rotaries to get this variation. In one arrangement tappings are taken from either the primary or secondary winding of the transformer, and connected to a multiple-contact switch of somewhat similar design to a battery regulator. The contacts must be numerous, so that the increase or decrease in the secondary pressure, as the switch is moved from contact to contact, and the ratio of the transformation is varied, is not noticeable.

Another arrangement may be employed, in which the transformers are of the usual constant-ratio type, and induction regulators are used to increase or decrease the pressure by producing a change in the phase relation of the primary and secondary voltage. This regulator is practically an induction motor with a very small air-gap in which the rotor does not

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revolve by itself, but may be moved through a small angle. The secondary winding is on the stator and the primary on the rotor. With this arrangement a perfectly gradual variation of voltage is obtained, although the range of variation will be less than in the method previously described. There is a very interesting application of the rotatory converter and also of the double-current generator for balancing on a three-wire, continuous-current circuit. If the alternating-current circuits of either machine are connected to star-grouped transformers, the middle wire of the three-wire circuit may be taken to the centre of the star, and balancing be effected in the machine. With transformers suitably proportioned and wound, an out-of-balance current up to as much as 75 per cent. of normal full load capacity of the machine may be dealt with in this manner. In the matter both of efficiency and cost the rotatory converter, including the necessary transformers, will show a considerable advantage over any type of motor-generator, and either or both may be used to convert the alternating to continuous current. The rotatory converter has also an enormous overload capacity which renders it invaluable in certain cases.

Within the limits of this short paper no attempt has been made to deal exhaustively with the whole problem of combined continuous and alternating systems, as the author's main object has been to direct attention to some of the uses and advantages of the special type of machine known as the double-current generator.

The PRESIDENT, in calling for discussion on the above paper, complimented the author on his work, and remarked that although he had made use of a great number of formulæ and expressions—such as x, y, z—the excellent quality of the paper would have been lost if these had been omitted.

Mr. C. H. WORDINGHAM remarked that the author was also the hon. secretary of the association, and he wished to congratulate him on the extremely neat way in which the papers to be read at this conference were presented this year. Bound into one complete volume they were extremely handy and useful. As to the paper in question, the author had done very valuable service in bringing forward the merits of a double-current machine. It certainly was very little known in this country, and it was rather a surprise to him to find from the paper that there were already four stations in which these machines had been put down. It would be interesting to know whether the designs of these stations were English, or whether they originated from abroad. For a long time he himself had been very much surprised with the merits of the double-current generator, but he did not think he could add much to what had been stated in the paper. It certainly was most attractive to be able to have one machine to do everything, and it obviated the necessity in distributing over wide areas of having separate isolated machines. He was rather interested to find that Mr. Murray had assumed that the only current worth distributing was continuous current. He need hardly say that he entirely agreed with the author on that point. He was not so sure as to the merits of a single station in all cases. One might say this, however, that there were certainly cases in which the single station was the best that could be adopted, and in such cases it did seem to him that the double-current generator was the right machine to use. The author seemed to have an open mind as to the relative merits of motor-generators and rotary converters. He did not appear to entertain that extraordinary prejudice against rotary converters which many in this country had. It was interesting to note, however, that they had to pay for this prejudice in a loss of efficiency of from 5 to 7 per cent. The chief difference between the motor-generator and the rotary converter was the serious difficulty of regulating the pressure with the latter machine. He thought probably the best solution of this difficulty was to keep the loss of pressure in all the lines very small, to have the sub-stations close together, to employ heavy distributing network, to have as few low-tension feeders as possible, and where you must have a large variation of pressure, to employ boosters. Of course, if it were possible to keep the pressure so low that it was not necessary to employ any of these special methods, all the better. Mr. Murray had stated that he was about to instal some of these machines Personally he should look forward to the results of their performance with the greatest interest

Mr. A. B. MOUNTAIN, of Huddersfield, said he was naturally in opposition to Mr. Wordingham, and he rather thought that the disappointing thing about this paper was that they had two distinct currents. He should like to see one only. He did not think the arrangement would work well if you were generating both continuous and alternating currents at the same time. He did not see how you were going to regulate the pressure at the outlying districts. Suppose, for instance, you required to increase the pressure on the alternating side, it not being necessary to increase the pressure on the continuous side, but you wanted to increase the field which would do this. He should like to ask Mr. Murray to say how this regulation is done.

Mr. W. B. ESSON was most surprised to hear from Mr. Wordingham that continuous current was the only current worth distributing. He was bound to say that, coming from the lips of an eminent electrical engineer, this was a very extraordinary thing to say. The remark was worthy of an electrical Rip Van Winkle. The only possible justification for it was that up to the present they had been unable to use alternating current for tramway purposes. Mr. Murray had said nothing in the paper about three-phase currents, and he (Mr. Esson) assumed that this was so because there was no distribution with three-phase currents worth speaking about. With regard to the question of balancing, he maintained that the best way of accomplishing this was by using a fourth wire, and so reduce the section of the mains by 60 per cent. He did not consider that Mr. Murray's arrangement of the double-current machine was a good one, for the simple reason that you wanted to regulate your alternating pressure quite independently of the continuous current. The most obvious way of doing this was to boost up or boost down, as the case might be, the alternating current by passing it through an alternating armature and exciting the field magnets. He added, in conclusion, that he protested generally against converting into continuous current at all.

Mr. H. FARADAY PROCTOR, of Bristol, had no criticisms to offer, but he asked a question with regard to a certain remark in the paper to the effect that "if rotary converters or synchronous motors are to be operated from the circuits, experience shows that the maximum variation from absolutely even angular velocity must not exceed one-fourth of 1 per cent. per revolution." He wanted to know whether that law held good, no matter how many poles or cycles there might be in the current. He should have thought that the percentage variation would have varied more as regards the angle between poles than as regards the percentage of the whole revolution of the machine—that was to say, taking a high frequency, he should have thought that a less angular variation would have been permissible than with a two-pole machine.

Mr. A. S. BARNARD referred to the author's remark that the special sphere of usefulness of the double-current generator was in the economical supply of large areas in which continuous current was to be distributed. He thought that this was quite open to question. Many engineers would say that large areas where continuous current had to be distributed were best served by separate generating stations; others would favour continuous-current high-tension stations. He, however, agreed that the double-current generator could be employed with advantage where otherwise separate machines would have to be put down. He was much interested in this paper, because of the way it set forth some of the advantages of three-phase work.

Mr A. GAY, of Islington, remarked that the paper went a "long way towards" fulfilling a prophecy which he made some years ago. Asked what was the future system for electrical distribution, he replied, "High-tension-low-tension-alternate-continuous-current system." He could not help thinking that that prophecy would be fulfilled, if not immediately, certainly before very long. This was a subject of very vital importance, and one which he was very pleased had been brought before this association. He only hoped that the suggestions in the paper would be fully considered, and that great fruit would be the result.

Mr. L. ANDREWS, of Hastings, asked Mr. Esson what was the gain in using a rotary booster for alternating currents over the ordinary stationary booster? Was it merely that the power factor of the stationary booster was so low, or was there any other gain?

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Mr. ESSON explained that if you wanted to raise the pressure of an alternating current, you simply put it through the armature.

Mr. ANDREWS: Surely that could be done with a stationary booster?

Mr. RAPHAEL was sorry to note that so little had been said by municipal engineers about the double-current generators. The discussion had rather turned upon side issues. Very little was known or circulated about these machines before Mr. Murray's paper. The whole object of the double-current generator was to obviate the necessity of having another machine. But unless you were able to employ the system of balancing which the author mentioned briefly in his paper, you must have, in addition to the double-current generator, a balancer for the district taking continuous current. There was not much difference in expense whether you put in a steam-driven balancer or a motor-driven balancer, and in that way you saved the continuous-current machine.

Mr. SCOTT, a member of the American Institute of Electrical Engineers, considered the paper a most interesting one, as it touched upon one of the questions of electrical engineering which excited discussion not only in America, but in England. He took it that they in America had rather the advantage of English engineers, so far as practical use of generators of this type was concerned. The paper itself had covered the general question in a very adequate manner. Really, the double-current generator was a very commonplace and sensible machine, and the practical value of it would appeal to those laying-out plant. While both the continuous current and the alternating current were most valuable, neither of them would do everything that was required, and if one could be made to help the other it was a most excellent arrangement. As regards American practice, all the larger plants that were being laid down for supplying direct current were putting in alternating generators. These were principally for supplying energy to electric railways. Taking the case of the Edison Company, they were now putting in large alternators in their lighting stations, ranging from 3,000 kw. to 5,000 kw. Alternating currents were generally used to get from one large generating centre to a number of distributing points, but there were other conditions, such as, for example, where both alternating current and direct current had to be supplied from one plant. The condition often arose where direct current had to be distributed over a certain portion of an area and alternating current in the outlying districts. In cases of this kind the double-current generator was very advantageous. Again, where direct current had to be supplied to a number of points, as was contemplated in the scheme described in the paper, the generators could distribute their current immediately and also supply direct current to distant stations. This method was in use in a number of small railway plants in the States. In other cases the double-current generator was advantageous where there was a shifting load. These were only a few examples to show that this machine was now used to solve many problems which were otherwise quite insoluble. In America the rotary converter was largely used, and had proved itself to be a very excellent machine. He was rather inclined to think that it must be somewhat through ignorance of its capabilities that there were certain prejudices in this country against this type of apparatus. With regard to the induction motor, he remarked that it was a type of apparatus which was most simple, and would stand wear and tear more than any other type of electrical machine. In conclusion, he expressed the opinion that the double-current generator would be found of greater use in this country than even in America.

The PRESIDENT thought that Mr. Murray was to be congratulated on being practically the pioneer in this country of the use of double-current machines, and he wished him every success in his use of them. While he quite agreed with the principle of his distribution, say the possibility of being able to send out direct current into the immediate vicinity of the station, and at the same time to transmit high-tension three-phase currents to other parts of the district, he was not altogether in agreement with the author that the double-current machine was the right thing for the purpose. After all, it was nothing more than a rotary converter steam-driven. For a sub-station the rotary converter was the right thing, but when you came to couple it to a steam-engine you brought another difficulty in—*i.e.*, the speed at which you could drive the combination. The trouble was that you could not get your periodicity because you had not enough poles on the machine, and if you increased the number of poles in order to get a frequency of, say, 25, in his opinion you would get a bad alternator and a bad direct-current generator. The double-current machine was practically a compromise between the two, and numerous troubles would arise from it. He had to tackle a question of this kind at Plymouth, and in that case he employed a distinct generator for the continuous-current side and a distinct alternator at the other end. In his opinion, there was very little extra expense in putting in two separate machines together, each the best of its kind, over installing one double machine. He thought in any case that the extra expense was warranted.

Mr. RUTHVEN-MURRAY, in reply, stated, with reference to Mr. Wordingham's question, that the four stations that were proposing to use these special machines were those of the Mersey Railway, Willesden, St. Pancras, and Trafford Park. He believed that in the latter case it was experimental. Several speakers had raised the question of the regulation of the pressure. Mr. Wordingham had referred to the fact that in transformers of large size the middle contact switch would be very cumbersome, but this difficulty was easily overcome by a special arrangement of the switch. Mr. Esson practically wished him to admit that he believed in alternating currents for distribution as well as continuous. He could not agree to this. He was rather inclined to agree with Mr. Wordingham that there was nothing else worth distributing but continuous current. As regards three-phase currents, the subject was hardly raised by the paper, and that was why he had said nothing about it. Then Mr. Esson had pressed the advantages of the induction motor, and also contended that his (the author's) scheme of regulation was bad. Mr. Esson preferred to regulate by an alternate-current booster. He (the author) knew that arrangement was in use on the Berlin tramways, but he did not consider it a good arrangement. Practically you had two machines, and the expense was about the same as that of a motor-generator. Mr. Scott's remarks were very valuable. He (the author) was struck with the fact that he rather favoured the use of induction in preference to synchronous motors. He should like to ask him whether his objections to synchronous motors applied to rotary converters as well?

Mr. SCOTT said his objections were common to both synchronous motors and rotary converters, and that was why he favoured the induction motor.

Mr. MURRAY, in concluding his reply, referred to the fact that the president thought that with the double-current generator neither the alternator nor the direct-current generator would be good. Of course, he (Mr. Murray) was not able to speak from experience, because his machines were not yet installed, but he could assure the meeting that he entertained no nervousness in regard to their performance, or that they were good machines both as alternators and direct-current generators. He thought the president's objections were more theoretical than practical.

High-Tension Continuous-Current Systems.

BY A. S. BARNARD, CITY ELECTRICAL ENGINEER, HULL.

A few years ago the expressions high and low tension systems were practically synonymous with alternating and continuous current systems. A high-tension system implied a single-phase alternating generator supplying from house to house through separate transformers fixed for each consumer or group of consumers. Equally a continuous-current system implied continuous-current dynamos generating at a pressure of probably 200 to 250 volts, supplying the low-tension network to which the service cables were attached, there being no intermediate machinery between the dynamos and the lamps on the consumers' premises. So far as regards the distributing network and appliances on consumers' premises, continuous current now seems to have completely beaten alternating current out of the field; and, on the other hand, in the matter of generators and feeders to the network, the alternating current appears to

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be rapidly becoming universal, though generally three or two phase plant is installed instead of single-phase.

The object of this paper is to show that those engineers who have pinned their faith to continuous-current plant are able to offer a reliable alternative to the three-phase generator and transformer. As far back as the year 1890 direct-current generators and transformers working at a pressure of 1,000 volts, were installed at the Crystal Palace. The dynamos were of the ordinary two-pole type, rope driven, and separately excited from smaller machines driven off the main generators. Transformers, which were also of the two-pole type, with high and low tension windings on the same armature, were erected in conjunction with storage batteries on the low-tension side, and were started as motors off the low-tension network, and were switched into parallel with the high-tension generators when they had attained their proper working speed. In 1892 a great advance on this system was made at Oxford, where the works were designed to control the various transformers from one central switchboard, the transformers being started as motors from the high-tension side, and switched into circuit on the low-tension network by means of electrically-controlled switches operated from the central switchboard. When starting the transformers a very heavy current was called for from the high-tension generators, which caused fluctuations of the light at the instant of switching in. To obviate this, a series winding was put on the transformers, which carried the high-tension current the whole time the transformer was at work. This arrangement had the drawback that it decreased the efficiency of the transformer, and was also costly in copper. It is now the usual practice to retain the series coil in circuit only until the transformer has attained its proper speed, when it is cut out by an electromagnetic switch excited by means of the current passing round the shunt winding of the transformer.

The next important step in the use of high-tension continuous current appears to have been made when the municipal station at Walsall was opened with direct-coupled high-speed generators working at a pressure of 2,000 volts. At the present day there are central stations at work on the Oxford system, or modifications thereof, in addition to those already mentioned, at Wolverhampton, Morecambe, Barrow-in-Furness, Bromley, Folkestone, Guernsey, and Hull, as well as a number of private plants owned by railway companies and others, where the pressure at the generators is from 1,000 to 3,000 volts. Some of the London companies have also adopted continuous-current transformers for raising the pressure of particular feeders to 2,000 or 3,000 volts, transforming down again to low tension at the other end of the feeder, and a small proportion of the plant at Manchester is, the writer believes, operated on this system. At Hull the main generators are of the four-pole type, coupled direct to high-speed engines, and giving an output of 510 kw. each at 2,250 volts. These appear to be about the largest high-tension continuous-current generators in use in this country, but from their satisfactory behaviour there really seems no reason to anticipate difficulty in designing dynamos for very much larger outputs at the same or higher pressure.

The continuous-current generator appears to be less expensive to make than the three-phase alternator, as the following figures from recent tenders show :

Output. Kw.	Speed. Revs.	Type.	Price.	Price per kw.
480	375	Enclosed engine, three-phase alternator	£4,360	£9 1 8
510	270	Enclosed engine, four-pole, high-tension continuous-current dynamo	4,231	8 6 0

In this comparison it will be noticed that the output is almost identical, and that the speed of the continuous-current machine is considerably the lower, and it might have been expected, therefore, that the price would have been the higher of the two.

Fig. 1 shows an efficiency curve of a 510-kw. four-pole generator at the Hull works, and while, perhaps, this is not so good at some loads as the curve of a three-phase generator of similar output, there does not appear to be any very great advantage in either.

When we consider the transformers, the continuous-current plant appears to have a decided advantage over the polyphase plant. In the first place, a transformation from 3,000 to 220 volts on the continuous-current system is effected by one machine. On the three-phase system there is generally, in addition to the motor-generator, a static transformer, and the two together occupy more space and represent more capital outlay than does the one rotatory transformer of the continuous-current system. In each case there are parts which require lubrication, and, therefore, a certain amount of attention whilst running, but the attention required at the continuous-current sub-station appears to the writer in practice to be considerably less than that required at a three-phase sub-station with motor-generators. It must be remembered that as the transformers are started and stopped, and entirely controlled, by an attendant at the central switchboard (in Hull this is at the generating station), there is no need for an attendant at the sub-station to manipulate switchgear. In a recent paper before the Institution of Electrical Engineers in London, Prof. Carus-Wilson estimates the wages at seven rotary sub-stations on an Italian railway system as *not more than* the wages at the generating station—*i.e.*, £4,000 per annum. In the writer's opinion this item would be *not more than* one-half of the wages at the generating station, and probably a good deal less, if the system in use were high-tension continuous-current.

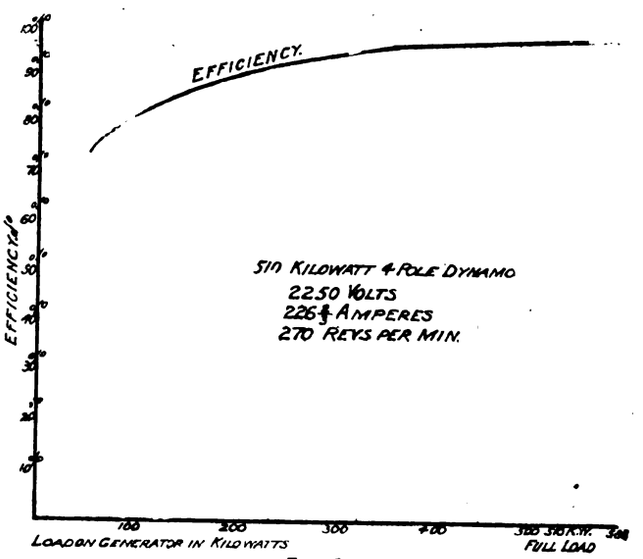

Fig. 1.

Another advantage of the continuous-current transformer is that there is no phase difference between the E.M.F. and the current, and consequently no excess of current is demanded at light loads, as is the case with the polyphase converters, and there is no possibility of the transformers "hunting," but each takes its own load steadily, and the proportion it takes can be adjusted by the attendant at the central switchboard so as to keep the pressure level on the low-tension network as he chooses. In this connection it may also be pointed out that in the high-tension continuous-current system the momentum of the moving parts is a very important advantage. When a sudden fluctuation of load occurs on the low-tension side, the momentum of the armature causes it to act to a considerable extent as a generator.

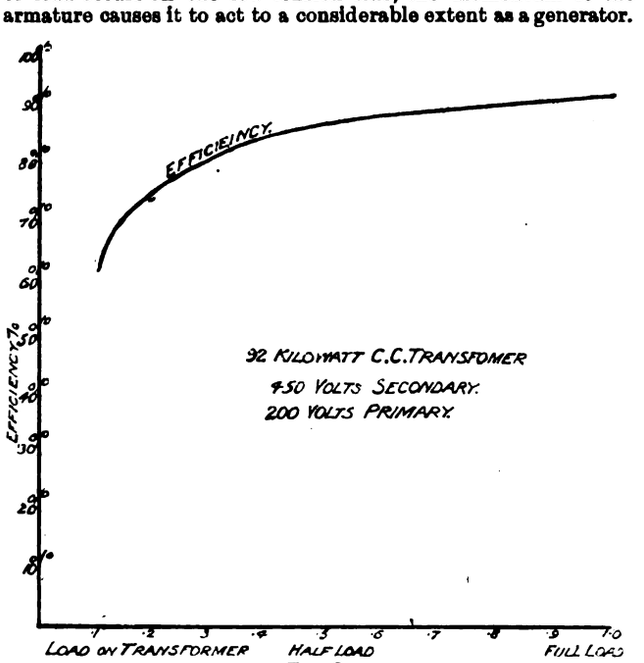

Fig. 2.

This renders the whole system more flexible, and mitigates the strain on the engine. The momentum of the armature of a rotatory converter, however, would appear to be absolutely disadvantageous, as tending to throw the machine out of step with the generator.

In starting up a continuous-current transformer there is never any difficulty with regard to polarity on the low-tension side, as is the case with polyphase converters when these are not started from the continuous-current side. The efficiency of the continuous-current transformer is not so high as that of a three-phase rotary converter, but it must be remembered that, in addition to the converter, the polyphase system generally

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employs a static transformer, and it is the combined efficiency of the two which has to be compared with the efficiency of the continuous-current transformer. The efficiency of the three-phase rotary converter is probably about 96 per cent. and that of the static transformer the same. The combined efficiency, therefore, is only about 90 per cent., whereas that of the continuous-current transformer is as high as 92 per cent.

Fig. 2 gives the efficiency curve of one of the Hull 92-kw. continuous-current transformers, and this compares very favourably with the guaranteed efficiencies of some of the Tyneside 500-kw. three-phase transformers, which are described in *Lightning* (June 20, 1901) as being 89 per cent. at full load and 73 per cent at one-third load.

Modifications of the Oxford system in which the transformer is used rather as a throttling valve between the high and low tension mains without their being absolutely separated from each other, can show much higher efficiencies than those given above, and any reasonable sized machine would give at least 96 per cent. at full load, dropping to about 90 per cent. at quarter load. This, of course, is owing to the fact that a portion only of the energy is actually transformed, the remainder passing through the motor armature in series with the load. Several plants have been installed on such a system with the most satisfactory all-round results, the feeders having an effective voltage of double the network pressure. Some of the plant on the City and South London Railway may be cited as an example of this system. A comparison of the cost of rotatory transformers for continuous, and motor-generators for three-phase, current shows a similar result as that of the generators:

Output. Kw.	Speed. Revs.	Type.	Price.	Price per kw.
92	500	High-tension continuous-current rotatory transformer	£705	£7 13 3
100	500	Three-phase to continuous-current motor-generator	1,050	10 10 0

With three-phase rotary converters the cost per kilowatt can be as low as £4. 10s.; equally with continuous-current "reducer" transformers, where a portion only of the high-tension current is transformed, and when there is no necessity to absolutely separate the low-tension mains from one pole of the high-tension mains, the cost per kilawatt will come down to about the same figure.

Perhaps the most interesting part of high-tension continuous-current work is the switchgear employed at the generating station and sub-stations. Briefly, there are required at the generating station a number of dynamo panels, corresponding to the number of dynamos to be run in parallel, and transformer panels to correspond with the number of transformer circuits controlled at the generating station. For everyday working, when all the plant and mains are in perfect order, the switches on either class of panel can be of the simplest, and merely have to control comparatively small currents and very low pressures. This is due, of course, to the fact that the rotatory transformers take an appreciable time to come to rest after being disconnected, and so the switches open a circuit having for the pressure across their contacts only the *difference* between the pressure of the 'bus bars and the back E.M.F. of the rotatory transformer, which is temporarily acting as a generator. In the event of a fault occurring, however, such as a short-circuit on a high-tension feeder, it is necessary that the switch controlling that circuit should open automatically, and this time it will have to open with a considerable current and the full E.M.F. of the system. Now, the difficulty of opening a circuit with even 20 kw. or 30 kw. passing at 2,000 volts pressure is considerable; and if the circuit be (as it generally is) a fairly inductive one, the rise of E.M.F. will depend very largely on the type of switch adopted, and the writer has found that with an instantaneous, non-arcing switch opening a circuit where 10 amperes were passing at 2,000 volts, the rise was no less than 600 volts, and possibly more. With a carefully designed flare switch, where the arc is gradually allowed to die away, this effect can apparently be entirely overcome, and from experiments made the writer is of opinion that the difficulties are by no means insuperable, and that the switching arrangements can be made as reliable and safe as in a low-tension system. Indeed, there are advantages in the high-tension switches, owing to the proportionately smaller currents to be carried and the smaller risk of heating from bad contacts.

The switchgear in use for controlling the transformers has been very carefully worked out, and is, of course, the subject of several patents. The most important item is the "long-range" switch, which consist of a single-pole, low-tension switch whose moving part is actuated by an electromagnet, the coil of which is placed in circuit, through a pilot wire, with a voltmeter at the generating station. By short-circuiting this voltmeter, the resistance of the whole pilot circuit is sufficiently reduced for a predetermined current of, say, five amperes to pass. This is enough to suck up the armature of the electromagnet, and in so doing to close the low-tension switch. Opening the voltmeter short-circuit drops the electromagnet armature again, and the next operation of the electromagnet is arranged to open the low-tension switch, thus disconnecting the low-tension side of the transformer. In Hull, three-core pilot wires are used—one wire being connected to the negative low-tension mains (which are also permanently connected through a plug-board to the negative side of the transformers), one to the positive low-tension main, and one to the positive side of the transformer. By means of a two-way switch at the generating station, the attendant can assure himself that the E.M.F. of the transformer is the same as that of the mains before operating the long-range switch. The third pilot wire is a valuable adjunct, as while it is necessary to have one wire permanently showing the pressure on the mains, yet in the event of a breakdown, when the low-tension mains were "dead," there would be no power available on that wire to operate the long-range switches. With the three pilot wires from each, a number of transformers may be started up, and switched simultaneously on to a "dead" network, although they are fixed in sub-stations possibly a couple of miles apart.

While there are many details of interest of which no mention has been made above, the writer is in hopes that sufficient has been said to provoke a useful discussion, and to show that for pressures of 2,000 to 3,000 volts at least there are some advantages to be gained by using continuous current. In conclusion, he gives a record of the actual results achieved on the ordinary daily load on two of the high-tension feeder circuits in Hull. These tests show the actual efficiency of conversion and transmission from the high-tension omnibus bars at the works, to the low-tension distributing mains 3,000 yards away.

First Test. *Circuit No.* 10. March 3, 1902.

Length of feeder—approximately 3,000 yards each way.
Conductors—$^{19}/_{16}$ S.W.G. concentric cable.
Transformer—92-kw. "Parker," 500 revs. per minute.
Duration—One hour.

Average—High-tension amperes ...	38·23
,, High-tension volts	2,156·23
,, Low-tension amperes ...	156·47
,, Low-tension volts	462·48
High-tension kilowatt-hours	82·43
Low-tension kilowatt-hours	72·36

Efficiency of circuit and transformation, 87·78 per cent.

Second Test. *Circuit No.* 11. March 8, 1902.

Length of feeder—approximately 3,000 yards each way.
Conductors—$^{19}/_{16}$ S.W.G. concentric cable.
Transformer—92-kw. "Parker," 500 revs. per minute.
Duration—One hour.

Average—High-tension amperes ...	40·00
,, High-tension volts	2,154·60
,, Low-tension amperes ...	162·03
,, Low-tension volts	459·00
High-tension kilowatt-hours	86·18
Low-tension kilowatt-hours	74·35

Efficiency of circuit and transformation, 86·28 per cent.

Instruments. — Kelvin electrostatic voltmeters, Crompton ampere-meters, all newly calibrated to 0·2 per cent. maximum error.

Mr. J. SNELL (of Sunderland) opened the discussion on the above paper, and said that it would be of interest to all engineers who had to distribute electricity over large areas. His chief objection to the high-tension continuous-current system, as described by Mr. Barnard, was the question of attendance at the sub-stations. He did not think the Board of Trade would allow these to be run without supervision. He had recently to consider the extensions of the area of supply in Sunderland, and after investigation had rejected the above system on the grounds that it would be necessary to have an attendant in all the sub-stations. He did not consider the author's figures correct with regard to the first cost of three-phase plant, and had found that there was little to choose between this system and that described by Mr. Barnard either as regards the cost per kilowatt of the plant, the efficiency of the plant, or the space required in the sub-station. With respect to the pilot wires which were required for the high-voltage continuous-current system, these in his experience were apt to go wrong. He also thought the voltage which could be used was limited by the use of a commutator. Would the author kindly inform him how much he paid for coal and if the sub-stations were rated? He saw that in Hull the power factor was as low as 8·3 per cent., which seemed to him to be a strong argument in favour of supplying both the electrical lighting and electric tramways from a single station instead of two, as was done. He also gathered from the Hull accounts that the average cost of plant worked out at £73 per kilowatt. It seemed to him that in the author's figures and cost per unit and average price obtained, the capital charges should

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be given. He calculated that the sinking fund worked out at a high charge per unit.

Mr. A. WYLLIE, of Walsall, agreed with Mr. Barnard that the high-voltage continuous-current system was quite as good and efficient as the three-phase. He had had seven years' experience of the system at Walsall, and found it reliable. He had had no commutation troubles. With regard to the last speaker's query, he had found no trouble in starting up again after a temporary short-circuit, neither had the pilot wires given any trouble; in fact, he had started up after certain breakdowns without sending round to the sub-stations. The system was found to be serviceable for supplying a traction load.

Mr. C. E. C. SHAWFIELD, of Wolverhampton, said he had had considerable experience with the Oxford system before making a change from it to the three-wire system. He thought that a great deal of their trouble was due to their switchgear. They had used Ferranti oil fuses, which interrupted the circuit exceedingly rapidly, and caused large rises in voltage, which broke down the insulation. They also had found no difficulty in starting up after a breakdown, and on one occasion he had burnt out by slowly increasing the voltage a short-circuit caused by an iron spanner lying across 'bus bars.

Mr. A. B. MOUNTAIN, of Huddersfield, complimented the author on his plucky defence of the high-voltage continuous-current system. Their capital cost at Huddersfield averaged £65 per kilowatt, and their cost per unit was 1·53d., as against 2·40d. at Hull. Their transformers cost 30s. per kilowatt, as against 90s. for the continuous-current ones. In the face of these figures, he could hardly call the continuous-current system successful.

Mr. H. R. BURNET, of Barrow-in-Furness, said that while the efficiency of the direct-current transformer was reasonably high at full load, it was much lower at small loads than the alternating-current transformers. He had frequently found the increase of voltage in a continuous-current system immediately after breaking the circuit sufficiently high to jump from the brush-holders on to the frame through a very considerable air-gap.

Mr W. A. CHAMEN, of Glasgow, expressed the hope that those gentleman who had remarked on the increase of voltage on breaking the circuit would give information as to the type of main used in each case.

Mr. S. Z. DE FERRANTI remarked that the high-voltage continuous-current system was the first to be experimented with. It was 20 years ago since Mr. Marcel Deprez had experimented on electrical transmission over a considerable distance in France. These experiments, and those which followed it, were all made with high-voltage direct-current systems, and in several cases the dynamos and motors were worked in series. In his opinion, while there was good work to be done on any system, the single-phase alternate current was the most simple. The only case in which it was behind was in lift work, and only 3 per cent. of the load on a central station was provided by lifts. He thought these could be supplied through small converters. It was most imperative that the cost of supplying electric light and power should be reduced considerably, and for this to be done they must have the most simple system.

Mr. C. H. WORDINGHAM said he considered the direct-current high-voltage system failed to meet modern requirements because of the limit in voltage, which he took to be about 3,000 volts. He failed to see, however, why the system for small areas should not be made more simple by giving up the controlling of the moving machinery in the sub-stations from the main switchboard. He was sure that the Board of Trade would require skilled attention in the sub-stations.

Owing to the time being limited, Mr. A. S. BARNARD said he would forward his reply to the discussion in writing.

(To be continued.)

TRAMWAY REGULATIONS.

Representatives of a large number of local authorities in the United Kingdom, including Manchester, Glasgow, Sheffield, and Cardiff, had a conference on Wednesday at 8, Richmond-terrace, Westminster, with Sir Francis Hopwood and Sir Herbert Jekyll, of the Board of Trade, to discuss the question of the alteration of the regulations as to tramways, especially in their relation to the speed limit of 10 miles an hour at present imposed. The delegates also urged certain objections to the regulations with reference to the governor and speed indicator, life-guards, lights, etc.

Sir FRANCIS HOPWOOD, in his reply, dealt with the questions *seriatim*. With reference to the governors, he stated that the Board of Trade had already abandoned them wherever they had any discretion. As to the requirement of speed indicators on the trams, that question was not settled, but it was regarded as being bound up with the question of speed generally, which was to receive very careful consideration with a view to seeing how far the Board could meet the wishes of the corporations. Though the deputation had argued that the 10-mile rate of speed was unworkable if they were not allowed to go beyond it in open country, they must remember the difficulty of fixing an average speed, as desired by some of then. He, however, was disposed to recommend the President and the Department to strike out the present prescribed maximum, and leave a larger discretion to the inspecting officers to sanction different rates of speed according to the varying gradients and differing conditions of each particular case. As regards the regulation prohibiting the use of trailing carriages, it appeared that the deputation did not require the use of trailing carriages for the purpose of carrying either passengers or merchandise, but only to run two cars together in the case of emergency, when one of them had broken down and the second car was used to push the first. That being so, he would see that the regulation was revised so as to meet the emergency cases. Then they had made a point as to the regulation calling for a red light to be fixed at the rear of each car. This regulation had been made by the Board of Trade, acting in harmony with the Home Office, who controlled the use of lights on road vehicles, and had made it a universal practice to require a red light at the rear. The Board of Trade was under a pledge to the Home Office not to vary that requirement except in conference with the Home Office; but he would take an opportunity of bringing their representations before the Home Secretary. Certain revisions had already been made on other matters, which he hoped would be acceptable to the deputation

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English and General Tramways Company, Limited.—Capital, £5,500. Objects: primarily to construct and maintain rail and tram roads, to be worked by steam, electricity, or other power, etc.

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CONTENTS.

Notes	1	Sheffield Electricity Accounts	23
Tramways and Light Railways Exhibition	6	Ealing Electricity Accounts	23
Incorporated Municipal Electrical Association	9	Questions and Answers	24
Tramway Regulations	17	Appointments Vacant	26
New Companies Registered	17	Legal Intelligence	27
International and Other Congresses	18	Companies' Meetings and Reports	27
Correspondence	19	Contracts for Electrical Supplies	27
"The Poisoned Arrow"	20	Traction Notes	29
The Union Internationale Permanente de Tramways	21	Lighting Notes	31
Forthcoming Events	23	Provisional Patents, 1902	34
Bury Electricity Accounts	23	Traffic Returns	36
		Companies' Stock and Share List	36

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INTERNATIONAL AND OTHER CONGRESSES.

We would commend to all rising engineers the speech made by the Right Hon. Gerald W. Balfour, M.P., at the inaugural luncheon of the Tramways Exhibition last Monday. We refer particularly to the opening part of his speech, in which he commented on "the comparatively small and trivial circumstances which serve completely to distinguish one kind from another kind, and one age from all other ages which have preceded it." Mr. Balfour proceeded to comment on the international unions and associations for the promotion of useful objects, which, he said, were characteristic of the present age. As a statesman, he looked on these unions and congresses as signs of the brotherhood of nations. Even from a lower point of view these congresses are actual examples of the brotherhood of men of science, while we may especially claim that in engineering the exchange of knowledge, courtesies, and trade are increasing actualities. In one of the subsequent speeches reference was made to this fact, when the chairman of the Manchester Tramways Committee remarked on the valuable information his committee had obtained during a tour of inspection on the Continent. It was to the kindness of the tramway engineers of the Continental towns that the committees were allowed to have free access to the valuable experience which these engineers had acquired. We are accordingly highly pleased that these same tramway engineers should now be in England, and that the Tramway Exhibition should afford them an opportunity of seeing the latest developments in the details of tramway plant. The various excursions to electric railways, tramways, etc., in and around London which have been arranged by the committee will also be interesting to these Continental engineers. The deep-level electric lines will be especially so, but we say without fear of contradiction that these engineers will be able to learn much from the ordinary electric tramways of the London area. This brings us to the individual advantage to be gained from congresses of specialists in any particular profession, whether international or not. We have in our minds the meetings of the Incorporated Municipal Electrical Association, which are also being held in London this week. Although a comparatively young association, it has now two hundred and ten municipal electrical engineers as members, and also one hundred and twenty municipalities. It is the debates on the papers read at these annual congresses which have such a high educational value on the individual engineers taking part in or listening to the same. In fact, they are meetings of specialists in a particular branch of electrical engineering, and in consequence there is a much keener interest taken in the subjects of the papers by all present than can be the case in larger institutions, such as the parent Institution of the Electrical Engineers. Perhaps the best evidence of the value of the association is to glance through the lists of those present and to look for absentees, who either do not belong to the association or who never attend the meetings. While these names are necessarily few, it will be found that they contain the class of electrical engineers noted for their self-sufficiency and a firm belief in the inferiority of other engineers. It is curiously also true that an impartial observer will find many instances of inferior design and management in the works of these same absentees. The converse is equally true, as those members of the Municipal Electrical Association who freely give hardly-earned information to their *confrères* will be found to be not only in charge of the best-managed undertakings, both from financial and engineering points of view, but also the best informed on all subjects relating to their work. The same men are directly the cause of

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large extensions in their undertakings, and hence they are responsible for the good progress which the industry is making in this country at the present time. It is rather late in the day to make the suggestion, but another year it would be well for the Council of the Institution of Electrical Engineers to attend the Municipal Electrical Association's meetings *en bloc*, with the proviso that they should not speak, but should try and ascertain from what they hear how they can induce their members to be equally free in discussion, and to give their information concisely. During the last session nothing has been more marked in the Institution discussions than the absence, when a particular subject is being discussed, of the engineers who are doing actual work in the same. For instance, the Institution of Civil Engineers found sufficient interest in the problem of electric railways to occupy three or four evenings; but when the same subject came on for discussion at the Electrical Engineers, to whom it should be of supreme importance, the discussion lasted practically only one evening, and those engineers who had equipped and worked electric railways did not take part in the same. Unless such keen interest can be excited, the main object of such institutions and congresses will never be attained.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TRAMWAYS.

SIR,—In a note in one of your contemporaries com laint is made that a well-known electrical engineer, who took a prominent part in the deputation to Mr. Balfour, had a few days before given evidence against an electrical tramway in the House of Commons, and apparently favoured omnibuses.

As this probably refers to me, who gave evidence on behalf of the Roads Improvement Association against laying electrical tramrails across the existing Hammersmith Suspension Bridge, but not in the least on the grounds given by your contemporary's correspondent, and as the matter is of considerable interest to the electrical profession, I shall be glad if you will give me space to bring my views before your readers. Some of them may have read my last year's address to Section G of the British Association, in which I pointed out that one of the most important problems in modern locomotion is that caused by the congestion of street traffic in our towns, and by the undoubted difficulties which exist in carrying our workers to and from their homes in the country to their places of employment in our towns. I then pointed out that a great deal of mischief might accrue from an ill-considered occupation of our streets by tramways, and gave as one of my reasons that the carrying capacity of a street is not increased, but rather diminished, by laying tramrails on it, and that this is due to the want of overtaking power of vehicles running on rails.

Your readers will see that there are several solutions of this problem of street traffic, but not the least interesting one to them is that of the development of electrically-driven cars or omnibuses to take the place of our present horse-drawn vehicles. Thanks to the efforts of a few electrical engineers, who have in the face of great discouragement persevered with their work, we already see considerable numbers of these vehicles running satisfactorily in the streets, and I learn that the next year will see an enormous development of this use of electrical power. It is needless for me to point out how important it is to the electrical industry that this development should have full scope and every possible chance of success given to it. Our electrical supply undertakings will benefit by the charging of these accumulator cars, which can be carried out at fixed hours of light load. The construction and simplification of the cars themselves, in the means for charging them and maintaining them at the lowest possible cost, will give a field of employment for electrical engineers, so that even if we take the narrow and selfish view that an electrical engineer should consider his profession first and the public afterwards—a view with which I personally disagree—I think it can be shown that the electrical profession as a whole, and certainly the public generally, is likely to benefit to a greater extent by the wide development of electrically-driven vehicles to take the place of our present horse-drawn vehicles than for electrical tramways to be developed on certain lines of road in such a manner as to hinder the progress of these smaller electrical cars; for no one, not even Mr. Clifton Robinson himself, imagines that electrical tramways can be laid in every street in our towns, and unless this were done it is always necessary to encourage the development of mechanically-propelled vehicles to take the place of the horse-drawn traffic. If the encouraging progress which has already taken place in the development of all classes of mechanically-propelled vehicles continues at anything like the rate attained during the present year, we shall soon find a notable decrease in the number of horses. Our streets will rapidly become cleaner; the surface of the roadway will not suffer so much from the impact of the horses' feet; the reduced cost of cleansing and upkeep which will follow on this will make it economical year by year to increase the number of streets and roads laid with perfected surfaces. Every street which at that time has been laid with tramrails will be dangerous and difficult for use by vehicles having smooth tyres, and all such thoroughfares will then be a hindrance instead of assistance to the flow of traffic.

I know that I am not alone in holding these views, but all who agree with me must from time to time find themselves compelled to oppose the indiscriminate laying of tramrails, especially on the old lines of road leading out of London, which are in most cases the only means by which the Londoner can obtain access to the country, or on which garden or other country produce can be brought in. The promoters of these electrical tramlines laid on our lines of road out of London know well that their future profits depend not on carrying the omnibus traffic which already exists, but on stimulating a greatly increased traffic by encouraging new building estates along their line. Thus London is rapidly extended along these lines of road, the traffic on them, other than that carried by the tramcars themselves, is more and more congested, and those living in London thus find themselves further removed from the country scenery and country air. These lines are really railways, and ought to be constructed on land purchased for the purpose.—Yours, etc., R. E. CROMPTON.

[We cordially agree with every word Mr. Crompton says—indeed, are quite ready to go much further in condemnation of the indiscriminate construction of tramways, especially in London streets. Let the promoters buy the land over which the lines run, and not interfere with the birthright of every unit of the population.—ED., *E. E.*]

WANTED IDENTIFICATION.

SIR,—Last evening, when just escorting three ladies to the door at the close of the conversazione of the Institution of Electrical Engineers, I was accosted by a gentleman, unknown to me, in evening dress, who appeared to be under the influence of liquor. He addressed me by name and said that he wished to tell me that I was a cheeky young cad, whose letters were not worth answering, and that I must take care. He was repeating his insult, when I remarked, "I do not know you," and turned on my heel. He was of a medium height, with fair hair, and apparently about 30 years old. Would any member who may have witnessed the incident kindly help me to identify the individual and ascertain who is responsible for his admission?—Yours, etc., SILVANUS P. THOMPSON.

West Hampstead, N.W., July 2, 1902.

Caerphilly.—The District Council have decided to apply for a provisional order empowering them to erect and maintain plant to light the district by electricity.

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"THE POISONED ARROW."*

It is not in my nature to refuse a challenge, but of all the things journalistic I abhor, it is personality. The circumstances, however, which necessitate this statement are not only of personal, but of public interest, and will probably end in a legal decision. This I shall eagerly welcome in order to place a few gentlemen under cross-examination, and to obtain information which can be obtained in no other way. It is generally known that I am editorially responsible for this paper, and for another, entitled the *Contract Journal*. During a somewhat long experience I have carefully refrained from mixing the editorial with the business part—that is, with the advertisements of these papers—and I do not believe there exists two opinions as to the impropriety of an editor mixing himself up with advertising matters. In my opinion, only an archangel could do the two things and remain honest. The dual character, in my opinion, leads to everything that can be characterised as dishonest when found existing in metropolitan papers of a general, political, or of a technical character. It leads, in my opinion, to illicit commissions, to blackmail, to the leaving unsaid what ought to be said, and generally to a legalised state of blackguardly journalism. The aim of a newspaper is to tell the truth, the whole truth, and nothing but the truth; its responsible editor should be free from all business trammels and bias; and if by chance an erroneous statement is made, the correction of such statement should be frankly and fully acknowledged. Such is my opinion of newspaper work.

A short time since an editor of a specialising paper sent an advertisement to this office—or, rather, sent to ask if it would be inserted if sent by him. All information relating to the town from whence the advertisement came was refused—in fact, it was "Accept, or you don't get it." The advertisement manager's refusal was emphatic, if not polite. By a process of elimination well known to mathematicians it was thought the business came from a certain town, and in order to back up the "no" of the manager, I wrote to the clerk of the town. Within a few days a second advertisement was sent to this paper, and was similarly refused by the manager, with this difference—the town from whence the advertisement emanated was known, and also the consulting engineer. A telegram was sent to the consulting engineer, and, in reply, the manager was referred to the town clerk. A telegram was sent to the said clerk, who refused to transact business direct, and the matter was then brought to my notice. Again I supported my manager. A third case of the kind occurred, with a similar result.

My instruction to the manager of each paper is that we will not acknowledge newspaper editors as advertising agents. Of course, I am not referring to local papers, but to the technical and high-class metropolitan papers. Can we fancy the editors of the *Times*, the *Telegraph*, the *Engineer*, *Engineering*, the *Builder*, the *Electrician*, the *Electrical Review*, etc., acting as advertising agents and claiming commission?

I have further to define the position of a true advertising agent and these editor-agents. The former fulfil a useful function. They advise large advertising firms as to the position and advertising value of papers the world over. Their advice is not restricted to English papers, nor do they advise much as to the advertisements of the kind sent out by town clerks.

Now take the particular class of advertisements to which this article has reference. A consulting or resident engineer to a local authority prepares a specification, and suggests certain papers in which an advertisement shall be inserted in order to obtain tenders for the work Ninety-nine per cent. or more—probably the exceptions are not one in 5,000—of the officials transact this small business direct. Their adviser is the engineer, and they need no advice from an advertising agent; and *if they get any advice, it is not expert advice, but is given from a prevailing desire to increase the amount of the agent's commission.* If, at the instigation of the advertising agent, they decline to put the advertisement into the papers suggested by the engineer, they are not doing their duty to their employers, and are encouraging blackmail by the worst class of agents, whose sole aim is *the largest commission.*

I have been challenged to say in print what I have said in private letters, and I think the above remarks are stronger than any I have privately written. If not, the following extracts from the letters themselves will suffice; and if the three clerks referred to and their agent (the editor-advertising-agent) care to take legal action, combined or separately, I shall be delighted Throughout I contend my attack has been upon a system, not an individual; but if the editor-advertising-agent's agency suffers, that is his fault for adopting a business not consonant with his position. He tells me: "If I am not greatly mistaken, the grave injury you have tried to inflict upon me, and the unwarrantable insults which you have offered to council clerks, will recoil upon your own head." To this I say, *Nous verrons.*

The following are extracts from my letters:

No. 1. Feb. 25, 1902. From *Contract Journal*—

> "I have given strict instructions that neither will this paper itself have truck in this manner with other papers, nor will it accept advertisements bearing commission from other papers. . . .
>
> "To put it bluntly, this kind of business savours very much of blackmail."

No. 2. March, 3, 1902. From same to same—

> "As a matter of some little importance, I assumed you to be in ignorance that we would not do business through third parties who assumed to be agents merely because they were newspaper proprietors."

In neither of these letters did the editor-agent's name appear

No. 3. June 5, 1902. From *Electrical Engineer*—

> "We refuse to accept advertisements from that source because it leads to illicit commissions, and you scratch my back, I'll scratch yours.
>
> "It is a disgrace that town clerks, if they understand the position, should permit themselves to work into the hands of any newspaper."

No. 4. June 7, 1902. Same to same—

> "You know the 'agent' either gets from 10 per cent. to 20 per cent. from you or from the newspaper. If from the latter, their charges are necessarily increased by that amount, and your employers pay that much more."

No. 5. June 13, 1902. Same to same—

> "I have never met the man who looked upon one of these editors or proprietors as a *bonâ fide* advertising agent . . .
>
> "Many agents insert advertisements in those papers which give greatest commission.
>
> "I do not mean to infer that Mr. —— does this, as I gather he sends the advertisements where he is told to send them. . . ."

No. 6. June 12, 1902. From *Contract Journal*—

> "I am sorry to say I absolutely refuse to have any business transactions with that gentleman or any person connected with other newspapers. We are pleased to transact business direct with you or any recognised agent of long standing not connected with newspapers. No one on principle has any right to arrange business matters so that people connected with other papers are made acquainted with the inner working of papers of older and better standing."

It will be gathered from these extracts that the editor-agent was only named or referred to in order to explain that on principle I decline to transact business on the lines discussed.

Now, Mr. Editor-Agent, I leave you to carry out your threat. I have condemned a principle; if you put on the cap, I cannot help it. You and your agency have been referred to simply as offering a sample of the business transactions I detest and mean to try to abolish. The

* The title of the article to which this explanation refers.

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whole system I object to leads to prevarication, to illicit commissions, to blackmail, to impudence, and everything contrary to honest, straightforward business transactions. There is no real work done or advice given in these transactions, and their sole object is to put money into a middleman's pocket. C. H. W. BIGGS.

THE UNION INTERNATIONALE PERMANENTE DE TRAMWAYS.

The twelfth annual meeting of the above Tramways Union was opened in the Berners Hall on Monday last by the Right Hon. Gerald Balfour, M.P., President of the Board of Trade. The meeting was presided over by Sir Charles Rivers Wilson, and a very large gathering of Continental and English engineers assembled at the hour appointed. After a few words of introduction from the chairman, the Right Hon. GERALD BALFOUR offered a cordial welcome to the members present. He referred in fitting language to the illness of the King, which had clouded the expectations of all present. He trusted, however, that the good news as to the King's health would continue, and that the congress meeting in London would be a pleasant one and full of interest and usefulness. He offered a most hearty welcome to London to all present.

Mr. LEON JANSSEN, the president of the congress and head of the Brussels tramways, proposed a vote of thanks to Mr. Balfour, which vote was seconded by Mr. R. H. SCOTTER, and supported by Mr. ZIFFER, of Vienna.

Mr. BALFOUR, in reply, said he was extremely grateful for the very kind words which had been addressed to him. It was a real pleasure and pride to be able to attend the gathering on behalf of his Majesty's Government.

FIRST SESSION OF CONGRESS.

The first session of the congress of the Union Internationale Permanente de Tramways was held on Tuesday, July 1, the proceedings commencing at 9.30 a.m. There was a good attendance, and its international character was in full evidence, the discussions being carried on in three languages—namely, English, French, and German. An opportunity was thus provided for linguists to display their attainments, and it was not missed. We noticed, in fact, that at least one of the visitors ventured to make his contribution to the discussion in the three languages successively, while many of those present used two. French and German predominated, and for the benefit of the Englishmen present the most important suggestions made in these languages were translated by Mr. L. Robinson.

In opening the meeting, the PRESIDENT of the union (Mr. L. Janssen) said he wished to thank the various Governments who had honoured them by sending representatives. They were particularly honoured to see amongst them so many men distinguished in the industry in which they were interested. He trusted that, as the result of the deliberations of the congress, those who had gathered together would carry away a maximum amount of useful information and data. Their aim was to make the union of the greatest possible service to its members. There were branches in each country, and they were making arrangements for the collection of accurate and complete information from these branches. Each one of them had something to learn from his neighbour, and they were fortunate enough to be engaged in an industry in which they could all furnish one another with useful information. The union had instituted an office from which all members would be enabled to obtain the information—technical or otherwise—which was collated, and which might be of use to them in the working of tramways and light railways. It was important, however, that any service of this kind should be reciprocated, and he would urge those present to co-operate in giving all the assistance possible to the office in the way of information required, so that the undertaking might be made a success.

The chair was then taken by Sir Charles Rivers Wilson, G.C.M.G., C.B., who addressed a few words of welcome to the foreign members present.

The general business of the meeting was subsequently proceeded with, but, owing to the necessity of translating, progress was rather slow, with the result that the programme of work which had been arranged for the morning had to be curtailed somewhat. Of the papers read, that by Dr. M G. Rasch, instructor of the Polytechnical School of Aix-la-Chapelle, on "The Power of Motors and Generators" evoked the most interest. It took the form of a report on the question commencing the following abstract:

PROPOSED BASIS FOR ESTIMATING POWER OF MOTORS.

"What basis should one adopt in estimating the power of motors and generators, taking into account the different elements which may enter into this calculation, such as output, speed, torque, heating, etc.?" Dr. Rasch gives his interpretation of the sense of the question as follows: "In the case of a contract for the construction or the enlargement of an electric plant, what are the conditions which should be required in the specifications for the good construction of the electric machines, and what are the means on the completion of the work which should be used in order to ascertain that these conditions have been really fulfilled?" Continuing, the author points out that the conditions laid down in the specification may be of two descriptions: "(1) conditions of which the fulfilment can be ascertained by trials—that is, in an objective manner; (2) conditions for which this manner of proceeding is not possible, and which the engineer charged with the acceptance of the work can only judge by relying on his technical sense and on the confidence, more or less, great with which the manufacturer inspires him; in other words, it is only in a subjective manner that he can convince himself that these last conditions fulfil the requirements of the specification." Further, it is important, even in the interest of the manufacturer, that on the reception of the goods the different qualities required on delivery which can be ascertained by tests should be tested. In this case it will be necessary to define in a precise manner certain of these qualities and to specify according to circumstances the methods of trial which will be used on reception; the results of trials being liable to vary according to the different methods by which they are obtained. It was this consideration which led the Verband Deutscher Elektrotechniker to establish standard regulations for the trials of generators and motors. Passing on to the examination of the different qualities which cannot be ascertained by means of trials, or at least only imperfectly by them, the author gives security of the service, accessibility to the different working parts, and small bulk as the essential conditions for a good traction motor. It is only, however, in specifying more explicitly these requirements that they become important in a specification, he observes. The author then goes on to consider the requirements already specified by some companies, and subsequently proceeds to state what is to be understood by the "power" of a motor. In his opinion the indication of power alone is not sufficient, because it does not allow of the determination of the torque of the motor. Moreover, he considers a distinction should be made between the power received by the motor and that given out by it. But rather than that the power of a motor should be exclusively expressed in watts, he would prefer to see the German terminology adopted, according to which mechanical power is given in horse-power and electric power in watts, whence it follows that a motor of 25 h.p. is always a motor which gives out and not one that receives 25 h.p. But this, the author continues, is not alone sufficient, since two motors of different sizes may both be of 25 h.p., the temperature of one remaining very low during the run, while that of the other rises above the limits admissible. Paragraphs 18 and 19 of the German regulations define what is to be understood by the admissible limits of heating. The same regulations distinguish the three kinds of service as follows: (1) intermittent service; (2) momentary service; (3) continuous service. In giving the power of a motor, there should always be added to it the indication of the kind of service required from it, and when dealing with a momentary or intermittent service there should also be given the number of hours corresponding to the length of the service. It is, in fact, evident that the same machine may for each of the three categories of service yield quite different powers.

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This is why the indication of a motor without the explicit designation of the nature of the service to which it will be subjected remains valueless. The German regulations determine as the normal power of a traction motor that which in the test-room can be yielded during one hour without causing the temperature to rise above the admissible, but the author regards this trial as insufficient for general application, and suggests that in determining the length of trial it would be advisable to take into consideration the special conditions of the car service for which the motor is designed. It is pointed out, however, that the acceptance of a trial of the duration of a hour gives a basis for determining in an exact manner that which should be meant by the normal power of a motor. Without this exact definition, no clear signification could be given to the word "overload." The author then goes on to consider the proper ratio between the overload permissible and the ordinary load, pointing out that these two factors depend in effect on local conditions, and are consequently liable to differ. Permissible rise of temperature is next dealt with, the German regulations on this point being again quoted. The fallacy of insisting upon a high efficiency as the prime quality of a good motor is pointed out. In the author's opinion, this question of efficiency should become secondary to other more important considerations. But if a lowering of the rate of efficiency brought no compensating advantages with it, it would evidently be necessary to weigh the importance of the two factors, efficiency and weight of motor, more especially if the necessity of paying a high price for electric energy existed. In other words, it is not always rational to admit the very highest limits of elevation of temperature. In concluding, Dr. Rasch says: "In addition to the normal power of the motor, the purchaser has equal interest in being informed as to the torque of the motor and its speed. Many companies require that the motor should not only be specified by its torque, but also by its traction power at the periphery of the motor wheel; while as to the speed, they require that the designation of the number of revolutions should be replaced by that of the speed of the car. The tractive effort at the periphery of the motor wheel is obtained when the four following particulars are known: (1) the torque of the motor; (2) the gearing efficiency; (3) the ratio of gearing; (4) the diameter of the motor wheel. Of the four foregoing particulars, it is only the first which is special to the motor. When a change is brought about in one of the three others, the force of traction at the periphery of the motor wheel will accordingly vary even if the torque of the motor remains the same. It will be similar when referring to the speed of the car. This depends not only on the speed of the motor, but also on the gearing and the diameter of the motor wheel. We are of the opinion that it would be convenient to characterise a motor by the two following factors: M = torque in kilogrammes and N = turns per minute of the axle of the motor. Those two factors are related in the following manner to the power, W, of the motor given in watts:

$$w = \frac{2\pi 9{\cdot}81}{60} \text{ M N} = 1{\cdot}028 \text{ M N}.$$

"We must nevertheless remark that in this formula the power does not represent the total energy (volt-ampere) delivered to the motor, but only the electrical energy received exclusive of electric losses, or, then, 92 to 97 per cent. of the total electric energy delivered. Admitting, then, an average efficiency of 95 per cent., the above formula could be reduced as follows:

$$W = \frac{w}{0{\cdot}95} = 1{\cdot}08 \text{ M N}.$$

"This formula gives, consequently, the energy really received to within 5 per cent., which is sufficiently accurate. In adding, for example, 20/550 in determining a motor, it would be necessary to understand by that a motor which under a normal load produces a torque of 20 kilogrammetres and attains a speed of 550 revolutions per minute. The energy received by the motor would be then $1{\cdot}08 \times 20 \times 550 = 11{,}900$ watts, which at a pressure of 600 volts will represent a current of 200 amperes. It is further to be remarked that in the preceding formula the torque represents, not the *useful torque*, but rather a torque somewhat higher than that. The torque indicated above would be sufficient, nevertheless, to rate the motor, and if guarantees can be asked from the contractor, nothing prevents these referring to efficiency. M. Mackloskie was right in saying in the report which he presented to the Paris congress in 1900, that motors cannot be rated by the two factors tractive effort and strength of current; nevertheless, we doubt if it is useful to recommend the general use of the two constants, A and B. The manufacturer must, indeed, begin by calculating these two factors by test trials of the motor; afterwards the buyer must calculate anew that what he wants to know, by means of the factors A and B. The procedure would in such a case be the same as in one of communication made by someone to another person in a strange language which should be translated on the fresh by the second person into his mother tongue. We prefer to make the following suggestion: the determination of the expression "normal power" shall remain fixed by the rules of the German Association of Electrical Engineers These comprehend without ambiguity what it is necessary to understand by half-load and by overload of 50 per cent. Concerning efficiency, it will be necessary to specify in every case if the efficiency of the motor alone is required, or that of the whole car. This latter information will naturally be asked for when the motors and car trucks are ordered from the same factory. It hardly appears necessary to us to specify the special basis to adopt for the rating of generators. We strongly recommend adhesion to the principles laid down by the German Association for Electrical Engineers."

Discussion.

In the course of the discussion which followed the above paper several of the speakers recommended that the meeting should accept the report of Dr. Rasch, and adopt the standard regulations for testing which had been already formulated by the Verband Deutscher Elektrotechniker. It was, however, pointed out by the author of the paper that the German specifications as they now stand are not sufficiently detailed for tramway work, and suggested by him that the question should be further considered and the clauses relating to traction motors added to. The greater experience of the Americans with regard to traction work was suggested by another speaker as a reason why the meeting should adopt the American methods of testing, etc., rather than the German.

Mr. SCOTTER, chairman of the Congress Committee. the only Englishman who took part in the discussion, referred to the Standardisation Committee now sitting under Sir William Preece. He felt, speaking unofficially, that the committee would be happy to assist the members of the union, and he would undertake, on behalf of his association, if it met with the approval of the congress, to see that the paper just read, and the discussion thereon, should be placed before Sir William Preece's committee. He hoped that the assistance of the union would help them in England to arrive at something approaching a universal standard in these matters.

This course was agreed to, the meeting being evidently impressed with the necessity for quick action in the matter in view of the enormous amount of tramway work now going on in different countries. At the same time, the difficulty, having regard to the different conditions prevailing for different systems of electric traction, of framing a set of rules on which general standardisation could be based was admitted.

TRANSFER TICKETS ON TRAMWAYS.

A report by M. Lavalard, manager, Paris Omnibus Company, on transfer tickets on tramways also provoked a good discussion, in the course of which the disadvantages of the transfer system and abuses to which it lent itself were touched upon. In view, however, of the success of the system in the United States, with which the report in question largely dealt, the question was considered by the meeting of sufficient importance to refer to a special commission of the union for further consideration, the report of this commission to be submitted to the next meeting of the congress.

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The day's proceedings further included a lunch, by invitation of the Mayor of the borough of Islington, in the Welcome Hall; visits to the Islington power station and the City and Great Northern underground (tube) works in construction respectively; and attendance at the conversazione given by the Institution of Electrical Engineers at the Natural History Museum, Cromwell-road.

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, JULY 4.

Incorporated Municipal Electrical Association.—At 8 p.m., smoking concert in Banqueting Hall, St. James's Restaurant, Regent-street, W.

THURSDAY, JULY 10.

Association of Municipal and County Engineers.—Annual meeting opens at Bristol. The meeting closes on July 12.

The following fixtures for meetings have also been made:

Sanitary Institute.—Sept. 9-13, congress, Manchester. Sept. 9-27, health exhibition.

Sanitary Inspectors' Association.—Aug. 7-9, autumn meeting, Middlesbrough.

Waterworks Engineers.—July 22-25, annual meeting, Leicester. December, London.

Iron and Steel Institute.—Sept. 2-6, Dusseldorf.

Institution of Civil Engineers.—Birmingham students' visits: July 19-26, Paris; Sept. 25, Crewe.

Institution of Junior Engineers.—Aug. 9 to 16, summer meeting.

Municipal Officers' Association. — July 14, district meeting, Hampstead.

British Association.—Meeting at Belfast commences Sept. 10.

BURY ELECTRICITY ACCOUNTS.

From the accounts of the Bury Corporation electricity department, just issued, the total expenditure on capital account to March 31, 1902, is stated as £511,127. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,282	13	8
Repairs and maintenance of buildings and plant	289	7	3
Management expenses	635	6	8
Distribution	125	9	4
Public lamps	123	13	4
Miscellaneous	424	10	5
Amount carried down to net revenue account	2,356	15	6
	£5,237	16	2

Cr. Income.	£	s.	d.
Sale of current for private and public lighting	4,939	5	8
Rental of meters, etc.	186	17	7
Ditto motors	102	3	6
Private construction	9	9	5
	£5,237	16	2

BALANCE-SHEET.

Liabilities.	£	s.	d.
Loans on mortgage	45,229	0	0
Sundry creditors	1,942	15	10
Cash owing bank	1,689	4	0
Sinking fund, less loans paid off	1,208	14	4
Debt extinguished	3,246	0	0
	£53,315	14	2

Assets.	£	s.	d.
Amount expended on capital account	50,649	12	5
Sundry debtors for current, etc., supplied	2,027	5	3
Stock of stores	480	4	3
General rate account	158	12	3
	£53,315	14	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			349,030
Quantity sold	Public lamps	53,264	
	By contract	7,990	323,337
	Private consumers by meter	262,083	
Quantity used on works			10,122
Total quantity accounted for			333,459
Quantity not accounted for			15,671
Total maximum supply demanded (kilowatts)			272·9

Number of public lamps, 31 arcs, 17 incandescents.

SHEFFIELD ELECTRICITY ACCOUNTS.

From the accounts of the Sheffield Corporation electricity department to March 25, 1902, it appears that a total expenditure of £538,501. 17s. 7d. has been incurred. Abstracts of the revenue account and balance-sheet are appended:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	7,425	19	1
Repairs and maintenance of buildings and plant	1,984	15	1
Distribution of electricity	934	18	7
Rents, rates, and taxes	1,722	17	10
Management expenses, salaries, etc.	1,517	4	3
Balance carried to profit and loss account	26,245	5	8
	£39,831	0	6

Cr. Income.	£	s.	d.
General receipts for supply of electrical energy, etc.	38,639	17	0
Meter rents	1,005	0	5
Revenue from service connections	71	18	7
Revenue from other sources	44	4	6
Rents receivable	70	0	0
	£39,831	0	6

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans account—mortgages	296,899	10	0
Redeemable stock	76,097	4	4
Instalments to sinking fund	16,265	5	9
Motors (provided out of revenue)	2,200	0	0
Cash balances	150,913	7	1
Present available surplus	33,644	6	1
	£576,019	13	3

Cr. Assets.	£	s.	d.
Capital expenditure	538,508	17	7
Stock of motors	3,873	9	7
Sundry debtors for amounts owing	18,750	7	8
Stores on hand	5,329	18	6
Work in progress	2,580	13	2
Cash balances	6,983	6	9
	£576,019	13	3

EALING ELECTRICITY ACCOUNTS.

The accounts of the Ealing electricity department show a total expenditure on capital account to March 31, 1902, of £116,311. Appended are abstracts of the revenue account and general balance-sheet:

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	6,441	0	0
Distribution of electricity	67	2	8
Public lamps	333	13	4
Rents, rates, taxes, etc.	352	1	5
Management expenses	989	10	0
	8,183	7	5
Balance carried to net revenue account	6,557	16	0
	£14,741	3	5

Cr.	£	s.	d.
Sales of current supplied by meter	10,603	11	0
Rental of meters	431	19	6
252,399 units supplied for public lighting	3,213	12	10
Attending and repairs as *per contra*	333	13	4
Special charges	129	10	9
Fees for testing consumers' installations, repairs, etc.	28	16	0
	£14,741	3	5

BALANCE SHEET.

Liabilities.	£	s.	d
Value of land appropriated for electrical purposes	1,000	0	0
Mortgage debt, less amount repaid	90,929	16	2
Treasurer's overdraft	19,415	13	7
Sundry creditors	2,345	16	11
Reserve for instalments of principal accrued	195	4	7
Reserve for bad debts, less written off	76	0	6
Loans paid out of revenue, less balance of profit and loss	6,576	16	4
	£120,539	8	1

Assets.	£	s.	d.
Amount expended for works	116,311	4	5
Stores on hand	265	1	2
Sundry debtors for current supplied	3,348	6	4
Other debtors	611	8	1
Cash in hand	3	8	1
	£120,539	8	1

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers.

[The correspondent, "A. C.," who sent us an answer to No. 486, writes that the lettering in his answer should read A C B, not A B C.—ED. *E. E.*]

QUESTIONS.

495. Is there any meter similar to a gasmeter for measuring directly the quantity of steam in cubic feet, at a certain specified pressure, passing through a pipe? In the case of a consumer having his own supply of steam, but also being supplied with steam from an outside source, what would be the best means of measuring the quantity of steam supplied by the outside source at the same time as using own steam? A separate steam-ring not to be considered.—STEAM.

496. At a sub-station 10,000 yards distant from the main generating station there is a 500-kw. synchronous motor-generator, the motor being three-phase star-wound at 5,500 volts, this being the line voltage, the generator direct current at 500 volts. The high-tension motor is run up to synchronism by means of a 75-kw. induction motor-generator. It is found impossible to synchronise the high-tension motor without getting a "kick" on the ammeter unless its volts are at least 200 less than the 'bus-bar volts. After the motor has been switched on to the 'bus bars, the machine volts rise to the same as the 'bus-bar volts. All the voltmeters and voltmeter transformers have been tested and found correct. Please explain fully the reason of this.—H. B. S.

ANSWERS.

Question No. 489.—What is the best system of guarding against explosions in gaseous coal-mines where it is necessary to use electric signals in a main haulage road, which is also the return airway?

Answer to No. 489 (*awarded* 7*s.* 6*d.*).—The ordinary mining engine plane signal is usually made up of a battery of from 8 to 16 Leclanché or Fuller's cells according to the length of the circuit, an electric bell (a 6in. trembler as a rule) and a pair of naked iron telegraph wires running side by side for the whole length of the engine plane, and supported by reel insulators nailed to the timber supporting the roof. In this way a signal can be sent from any part of the road by simply bringing the naked wires into contact. The drawback to this system in fiery mines is the sparking both at the point of contact and at the clapper of the bell. The writer has got over this difficulty by transmitting the signals through a relay and using single-stroke bells. Get a 100-ohm relay with very sensitive armature. This will work with one Fuller's cell for any practicable distance underground. Thus, owing to the low E.M.F. and the comparatively high resistance of the relay, the spark on making contact is so small as to be almost imperceptible, and is certainly not intense enough to ignite any gaseous mixture. The relay should have base and cover of cast iron, the cover screwing down on rubber joints. So that with a single-stroke bell the only dangerous spark will be at the circuit closer of the relay, which is properly enclosed.

Of course, increased attention must be given to the wires, as the conductivity and insulation must be kept especially good. The wires should be of No. 8 galvanised iron, and as soldering is out of the question, the joints should be made by twisting the ends together and then bridging over with a piece of No. 16 binding wire, the latter being well tightened down with the pliers.—T. L. JONES.

Answer to No. 489 (*awarded* 7*s.* 6*d.*).—"P." asks what is best to guard against explosions in coal-mines by electric signals. From a fair experience of both coal-mining and electric signals in haulage roads, which is the return airway, I believe there is much room for very serious consideration on this question. It is simply a question of the danger arising by sparking which takes place when the bare wires are brought in contact to give the signal.

To keep the sparking down, the system must be worked with the potential difference of the positive and negative wires as low as possible. To do this (irrespective of cost), I believe it best to let each bell have its own local battery and relay, as the relays connected up in parallel from the line wire would be worked with a much feebler current than would the bells if connected on the line wire. Therefore, the line wires, which are the chief source of danger, would have a lower potential difference, thus the risk of sparking is reduced. In general mining bells and pushes are now well enclosed, and the danger arising from sparking on this point is very much minimised. The chief danger, as before stated, I believe is in the bare line wire contact. And the only way to reduce this as much as possible is to keep the line wires clean, so as to be able to make good contacts. Adopt

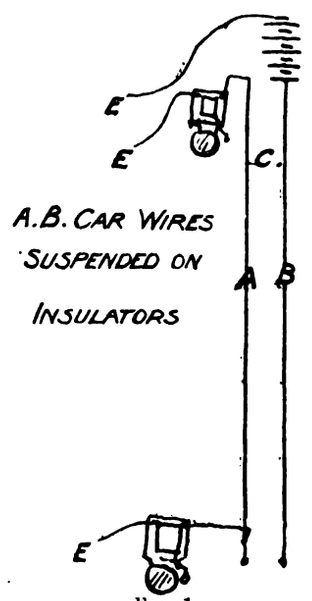

FIG. 1.

the system of local batteries and relays to each bell, thus keeping the main battery voltage low. This system of local battery and relay is not, I know, very generally adopted; yet for signalling in (fiery) mines I consider it worth some consideration, irrespective of the first cost of

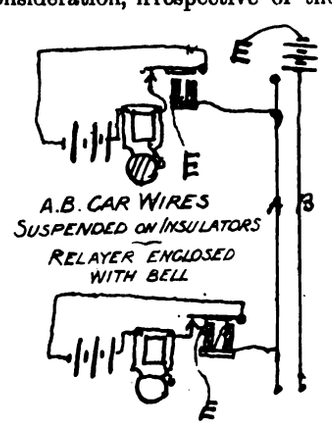

FIG. 2.

plant. In Fig. 1, which is the largely adopted system and if contact is made, say, at C, possibly a heavy spark is the result. Hence I would advise, if "P" wishes to avoid this, Fig. 2 as a means of reducing it.—B. J.

Answer to No. 489 (*awarded* 5*s.*).—As the electric current is only wanted for signalling purposes, its quantity would not be very large, and the whole circuit should be arranged so as to produce as little self-induction as possible—*e.g.*, an earth return could be used, or if that should be undesirable, the two line wires should be kept well apart. Again, all coils such as on magnet bobbins should be as short as possible, so that the spark on breaking the circuit should be very small. The parts of the switch where the spark occurs should be fairly massive and solid, so that the heat of the spark may be kept very low, and the whole of the switch should be thoroughly immersed in oil (rosin or

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mineral oil would be about the best). Of course, the handle of the switch or key could be above the surface of the oil for convenience and cleanliness. If the spark is at all large, then the switch should be arranged in steps, with a resistance between each so that the current may be greatly reduced before being actually broken. But this is hardly necessary if the switch is immersed in oil, because any gas in the mine could not possibly get in contact with the spark, and so no explosion could be caused by it. Still another arrangement is possible—viz., never actually break the circuit at all, but by means of resistances reduce it to a minimum, which will not hurt the battery.—F. G. A.

Question No. 490.—I have seen on a high-tension alternating switchboard of the receiving end of a power transmission plant an instrument indicating the number of cycles. I should like to have the theory of this instrument?

Best Answer to No. 490 (*awarded* 10*s.*).—An instrument which will readily measure and indicate the frequency of alternation of an alternating-current circuit is sometimes very convenient. Such instruments are usually based on one or other of the two following principles. The first is the use of a little synchronous motor, which is accelerated by hand until it falls into synchronism with the circuit to be tested. This little motor is usually of the two-pole type, and hence the number of revolutions affected by it in an interval of time, observed with the aid of a chronograph, or a small tachometer, gives the frequency of alternation, or at least its average, during the interval. The second method is to vary the dimensions of an elastic vibrating body until its natural period of vibration coincides with that of the alternations in the circuit to be tested, and then to determine the mechanical vibration period of the body. An instrument of the latter type is made in Germany, and consists of a number of tuned steel ribbons, each of which has a known definite vibration period of its own and intermediate between that of its neighbours. The ribbons are presented in succession to the poles of an alternating electromagnet, which is excited from the circuit to be tested, until some one particular ribbon responds powerfully. The figure representing the frequency required is usually stamped on the ribbon. Variations in the frequency can also be tested by observers where the amplitude of vibration in the adjacent ribbons, which are, of course, slightly out of tune, appreciably varies. With a steady and stationary frequency no such variation should be perceptible.

Another and yet simpler apparatus of similar type consists merely of a straight steel spring of adjustable length, supported in a clamp and varied in length until it apparently ceases to vibrate when viewed by an arc lamp fed from the circuit to be tested. When the frequencies of the vibrating spring and of the circuit coincide, the spring appears as though motionless. The length of the spring, of course, is calibrated to read off the frequency from.

Another and rather more complicated type of frequency meter, which does not depend on either of the above principles, is "Manzetti's frequency meter." This instrument has a moving system consisting of a copper disc and a parallelopiped of laminated iron rigidly connected together, one above the other, and suspended by a silk fibre. Each is acted upon by an independent pair of coils. The two pairs of coils are connected in parallel across the circuit to be tested, with an adjustable resistance in series with one of the pairs. The torque exerted on the iron is independent of the frequency, while that on the copper being due to Foucault currents is a function of it. If, then, the two pairs of coils be so adjusted that for any given standard frequency the torques excited by them are equal and opposite, there will be no deflection. If, however, the frequency changes, a deflection will be at once produced—*i.e.*, the tendency to rotation produced by the difference between the two torques will be balanced by the torsion of the silk fibre suspension—which can be annulled by adjusting the resistance in series with the one pair of coils. The measurement of frequency is thus reduced to a zero adjustment of the instrument, and a measurement of a resistance ratio. The alteration of the resistance from the standard can, of course, be calibrated to read the frequency from directly. This instrument gives fairly reliable readings over the usual range of working frequencies. It can measure very low frequencies well, but its readings might be falsified by self-induction at high frequencies. A description of the above instrument will be found in vol. xxxviii. of the *Electrical World* of New York.—T. SQUARE.

Answer to No. 490 (*awarded* 7*s.* 6*d.*)—Though numerous optical and acoustic methods of measuring frequency have been suggested, they have generally been quite unfitted for use on a switchboard—the care and time necessary to obtain a reading rendering them only suitable for laboratory use. The nearest approach to a direct-reading frequency meter in use at the present time, and the one probably referred to in the question, is that made by Messrs. Hartmann and Braun, and shown in Fig. 1. It consists of 20 or 30 steel strips, Z, arranged in a circle. They are fixed at the back end, and free to vibrate through a maximum arc of about 1in. at the front end. The strips are of graduated sizes, and are calibrated to have natural periods of vibration, increasing from strip to strip in a uniform manner by steps of, say, half a period per second, from a minimum to a maximum value, the number of such steps determining the range of the instrument. A single instrument can easily be arranged to cover such a range as from 40 periods to 60 periods, which is ample for station requirements. The base to which all the strips are attached can be rotated by means of the knob, G, so as to bring any desired strip opposite the small horseshoe magnets, M_1 M_2. These magnets are made up of laminated soft iron, and are usually kept close together by moving

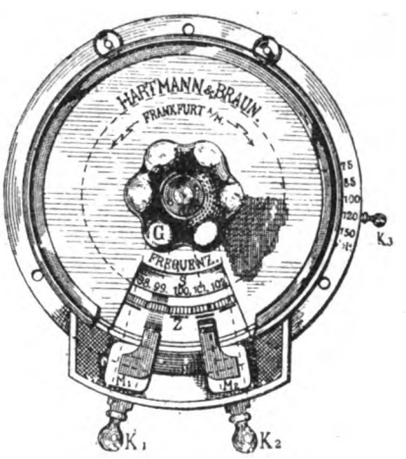

FIG. 1

the levers, K_1 and K_2, so as to act as a single magnet. They are excited by coils connected to the supply circuit (through step-down transformers if necessary).

To determine the frequency of a circuit, it is only necessary to connect the exciting coils to the circuit and turn the knob, G, by hand until the strip which is most strongly vibrated when opposite the magnet is found. This strip will be the one whose natural period approximates most closely to the periodicity of the circuit. The frequency of this strip (clearly marked above it) is then the frequency of the circuit, with a possible error equal to the difference in frequency between two strips. By further noticing whether the strips on both sides of the most strongly vibrated one are equally affected or not, it is easy to determine the frequency with even greater accuracy. The object of the levers, K_1 and K_2, by which the magnet can be opened out into two parts with a varying gap between them, is to enable the instrument to be set so that should the frequency of the circuit fall below a predetermined value or rise above another predetermined value, it will at once give notice of the fact. Thus, in Fig. 1, the one magnet is shown under the 99 strip and the other under the 101 strip, so that as soon as either of these values is reached one or the other strips will begin to vibrate strongly. This vibration is easily noticeable by ear as well as by eye, for a loud humming noise is given out when in action. The lever K_3 is simply for the purpose of inserting more or less external resistance in series with the exciting coils, and so enabling the instrument to be employed on circuits of different voltage without fear of overheating.

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The sensitiveness of the instrument is remarkable. If the correct strip for a given periodicity is found, and the periodicity of the circuit is then altered by as little as ½ per cent., the arc of vibration of the strip will be at once reduced to from one-half to one-third its former value, thus making the readings quite definite.—Q.

Answer to No. 490 (*awarded* 5*s.*).—As the question says, these instruments are only used when the number of cycles are required to be known some distance away from the generating plant, as the ordinary rule would suffice there—*i.e.*, counting the number of revolutions of the engine, etc. They are called frequency tellers, and the following is a description of two of the best—I daresay the one seen in the question is one of them.

The frequency teller of Campbell consists of a soft-iron strip, and so held in a frame that it can be caused to protrude more or less from a holding block. The end of this iron strip projects over an electromagnet with a laminated core, through the coils of which passes the A. C. to be examined. Now, this iron strip has a natural free period of vibration, and if the attractive impulses which act upon it agree in frequency, the amplitude of the vibration (of the strip) becomes pretty great. This instrument includes, also, a slow-motion arrangement for pushing the iron strip more or less in and out of the clip which holds it at one end, and an indicating needle which magnifies the motion. The operator then makes the movement until the sounds, or visible movement, or oscillations of the vibrating iron strip is a maximum, and then he reads off the scale the frequency of the current passing through the coils of the electromagnet. This instrument is graduated by applying to it current of various frequencies, and is accurate to about 0·2. There is a modification of this instrument by C. Kinsley, in which the free portion of the strip is altered, not by varying its length, but by sliding along it a non-magnetic rider or weight.

The other instrument is an arrangement by Profs. Ayrton and Perry, in which a stretched wire is placed between or over the poles of an electromagnet. The wire is of iron and the magnet is reversed by the current to be examined. In this case periodic attractive impulses set the wire in vibration if its free period is in agreement with the current or is some harmonic of it. The free period of the wire is determined by its length, diameter, density, and tension, and is expressed by the equation

$$t = 2\,l\sqrt{\frac{\pi\,r^2\,\delta}{T}},$$

in which t = periodic time;
l = length of wire;
r = half the diameter;
δ = density of the wire;
T = tension in dynes.

So that if T is varied by using different stretching weights, the free period of vibration of the wire may be equal to that of the exciting current of the magnet, and when this happens the vibration of the wire becomes a maximum. Another way of doing this is to send the periodic current along the wire and use a permanent magnet, but owing to the rise in temperature of the wire by the current it is rather difficult to determine the frequency, so that it is better to pass the current to be examined through the magnet coil and use an iron wire or a wire with a small iron armature attached to it, varying the tension on the wire until it is in unison between its free period of vibration and that of the current through the coil.—A. H. E.

Answer to No. 490 (*awarded* 5*s.*).—There are a variety of instruments that indicate the frequency of alternating currents in the market. The most accurate are those that depend on the resonance of steel springs placed in front of an alternating-current magnet. Those that depend on the increased voltage across the terminals of a choking coil in series with a resistance when the frequency increases are only accurate when the wave form of the applied alternating-current pressure is always the same, and hence they cannot be recommended. In the Hartmann and Braun frequency indicator a series of steel tongues can by means of a milled head be brought within the range of the electromagnet in succession until a pair of tongues is reached whose vibration amplitudes are greater than any other pair. Suppose that one of the tongues is under the mark 101, and the next is under the 102, and that the vibration of 101 is about three times the vibration of 102, then the frequency is about 101·25, and so on. They are made for various ranges of frequency; for example, the 100 frequency one is calibrated from 79 to 110, etc. Each instrument can also be used on a 75, 85, 100, 125, and 150 volt circuit, depending on the position of a stop on the side of the instrument. We have not seen any instrument of this kind that could be directly connected to the high-tension lines of a power transmission plant, but as the frequency of the current is the same on the high and low tension sides, nothing would be gained by making an expensive instrument for use on the high-tension side. The instrument seen was probably connected to the low-tension side.

Another instrument made by Messrs. Nalder Bros., which is considerably used in this country, is the Campbell frequency "teller." The principle is the same as the Hartmann and Braun instrument, but there is only one tongue, whose length can be varied by means of a ratchet and pinion. It is calibrated by putting it on circuits of different frequencies, and has a very wide range, sometimes from 40 to 150. In using it we turn the pointer by means of a milled head either on front or by the side of the instrument to 40, and then gradually turn it round until the instrument gives out a loud note, say, at 83·5; then this would be the frequency. If the pointer be turned backwards, the readings are quite incorrect, and so it is absolutely necessary that the pointer be always turned slowly upwards from its bottom reading on making an observation. Used in this way its indications are quite accurate. It was probably one or other of these instruments that "E. E. C. P." saw.—J. C. R.

APPOINTMENTS VACANT.

Distribution Engineer, London County Council Tramways Department, £350 per annum, July 14. For particulars see advertisement.

Assistant Superintendent of Mains, Edinburgh Corporation, £150 per annum, July 7. See advertisement.

Foremen Linesmen (3), Manchester Corporation Tramways, £2. 10s. per week, July 5. See advertisement.

Electrical Engineer and Tramway Manager, Swindon Corporation, £250 per annum, July 9. Full particulars from Mr. R. Hilton, town clerk, Town Hall, Swindon.

Telegraph Linesmen (3), for eight months, Northern Nigeria, £210 and local allowance of 5s. per day, July 7. Full particulars can be obtained from the Crown Agents for the Colonies, Downing-street, S.W.

Station Superintendent, Hammersmith Borough Council Electricity Department, £200, July 11. See advertisement.

Chief Clerk, Bournemouth Town Council Tramways Department, July 9. See advertisement.

Assistant Clerk, Bournemouth Town Council Tramways Department, 32s. 6d. per week, July 9. See advertisement.

Chief Inspector, Bournemouth Town Council Tramways Department 35s. per week, July 9. See advertisement.

Shift Engineers (2), Bournemouth Town Council Tramways Department, 40s. per week, July 9. See advertisement.

Fitter-Drivers (2), Bournemouth Town Council Tramways Department, 38s. per week, July 9. See advertisement.

Car-Shed Foreman, Bournemouth Town Council Tramways Department, 40s. per week, July 9. See advertisement.

Engineer, dynamo works, to devote his whole time to methods of manufacture and piecework. See advertisement.

Switchboard Attendant, burgh of Motherwell Electricity Works, £65 per annum, July 14. Particulars from Mr. E. Britton, Electricity Works, Motherwell.

Meter Inspector, Colchester Town Council Electricity Department, 34s. per week, July 7. Particulars from the Borough Electrical Engineer.

Responsibility of Telegraphists.—They do things different on the Continent. Lately, two telegraphists in the employ of the Prussian Government were mulcted in what is there very heavy damages for errors committed by them individually in the transmission of telegrams, the new statute making the individual liable for his fault. One man who transmitted *kaufen* (buy) instead of *verkaufen* (sell) in a broker's error had to pay £100.

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LEGAL INTELLIGENCE.

IS AN "ELECTRICIAN" A WORKMAN?

In the Westminster County Court on Friday, the 20th ult., his Honour Judge Woodfall and a jury had before them the case of Isaacs v. the Grand Theatre, Clapham Junction, in which the plaintiffs, who are the parents of a young man who lost his life at the theatre whilst engaged as an "electrician," sought to recover compensation for his loss. It appeared that in July of last year the deceased man was employed on the electric lighting plant at the theatre in question, and in the course of his work fell into a tank of boiling water which had been left with the cover off. The result was that the unfortunate man was killed, and the plaintiffs were deprived of the partial support which he had rendered them. At the time of his death the deceased was earning two guineas a week, and this action, which was brought under the Employers' Liability Act, was to recover three years' salary.

His Honour, after hearing evidence at some length, said it was a most painful case and the plaintiffs were entitled to every sympathy, but he must hold that the deceased man was not a workman within the meaning of the Act, and therefore the plaintiffs must be non-suited.

Notice of appeal was given.

COMPANIES' MEETINGS AND REPORTS

EDMUNDSONS' ELECTRICITY.

The report of the directors for the year ended March 31 last states that, including the sum of £2,202 brought forward from last year, the net profit, after payment of debenture interest, amounts to £30,962, which, together with the premiums received on new issues of shares and debenture stock, amounting to £6,807, makes a total of £37,770 to be dealt with. After deducting a dividend on the preference shares, paid and accrued, amounting to £6,701, and an interim dividend at the rate of 5 per cent. per annum on the ordinary shares, amounting to £4,437, there remains a balance of £26,631, which the directors recommend should be appropriated as follows: a final dividend on the 37,500 ordinary shares at the rate of 9 per cent. per annum, making 7 per cent. for the year; dividend at the rate of 7 per cent. on 10,000 ordinary shares issued in October, 1901; dividend of 7 per cent. on the deferred shares; to be added to reserve fund, £10,000; leaving to be carried forward to next account, £6,179. Since the last report a central station at Newport, Isle of Wight, has been opened, and powers have been obtained for electric lighting at Ryde, Cowes, and Ilfracombe. The undertaking of the Woolwich (District) Electric Light Company, Limited, in which Edmundsons' Electricity Corporation has a considerable interest, has been sold to the Corporation of Woolwich upon terms which will allow of a return of upwards of £2 a share to the shareholders of that company. It is intended to complete the sale during the present year. During the year 10,000 preference shares, 10,000 ordinary shares, and £40,000 debenture stock have been issued.

RAND CENTRAL ELECTRIC WORKS.

The report of the directors for 1901 expresses regret that the war prevented the resumption of operations until Sept. 22, 1901, and that from Jan. 20 to that date the whole of the plant was lying idle and totally unremunerative, as the Board were of opinion that it would be highly dangerous to restart the works without having such military protection as would practically ensure immunity from further raids. The statement of accounts shows a loss of £9,570, and adding thereto the amount set apart for depreciation—viz., £8,710—and the balance brought forward from 1899 of £6,951, there is a total debit balance of £25,231. The revenue from all sources amounted to £8,529, as compared with £25,395 for 1900, and the working expenses, including depreciation, to £26,809, against £32,848 for the previous year. The revenue derived from the supply of power amounted to £7,870, as against the revenue for the previous year from the same source of £24,470. The contract with the Johannesburg Municipality alluded to in the last report has been duly completed, and is yielding a satisfactory return to the Company. The municipality have already given notice that they will require the full amount of power contracted for—viz., 600 kw. within about six months' time, and 700 kw. from Jan. 1 of next year until the expiration of the agreement. From the returns to hand for the present year, which show a large increase each month (the power supplied for April being more than double that supplied in January), the directors hope that when next they have the honour of calling the shareholders together they will be in a position to report that an increased and remunerative share of the business, which it is expected will accrue as a result of the cessation of hostilities in South Africa, has been secured by the Company.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The third ordinary general meeting of the shareholders in this Company was held last week at Winchester House, Old Broad-street, Mr. Roger W. Wallace, K.C., presiding.

The **Chairman**, in moving the adoption of the report, which appeared in our issue of the 20th ult., explained several of the items in the accounts. In connection with the item of £36,215, the amount of calls unpaid, he stated that the directors had decided to issue debentures for £50,000, of which the contractors would take up £10,000. They might ask why it was necessary to issue these debentures. Well, they found that it would be a very profitable thing for this Company to do other work than that which they had undertaken to do at Kalgoorlie under their contracts. They had found that in the early stages it was very beneficial for a company like theirs to supply certain plant to the mines (such as motors, hoists, pumps, meters, etc.), which were not originally estimated for. Therefore, this was additional work to what was originally contemplated, and the cost had to be added to the amount of the contracts. The Company had undertaken to supply power for the working of the Kalgoorlie tramways, which were their first customers. According to the contract the works of the Company were to be completed in July next, but they had already completed a large amount of the work, so much so that they were able to supply the tramways, which started on May 20.

Mr. G. P. Doolette seconded the motion.

In reply to questions, the **Chairman** explained that there were several reasons why the report and accounts could not be presented earlier. As far as the directors knew, the only contract that had been definitely signed was the one with the tramway company. Although they could have signed contracts for a very large amount of power, they had not done so, because they were selecting the most favourable. The shareholders need not have the slightest doubt that all the power they had would be taken up. What they were looking for was a good average load. There were enquirers at the present time for more than twice the power the Company had at its disposal. The plant they possessed was the best of its kind in Australia. With regard to the directors, he and his colleagues would seriously consider the advisability of reducing their number.

The motion was carried unanimously.

HARRINGTON ELECTRIC LIGHT.

The directors' report for the past year states that the cost of supplying power has been reduced from £405. 18s. 4d. to £335. 18s. 6d., but this item is still very heavy when compared with the accounts three years ago. The charges for repairs and replacements still remains very high—viz., £222. 16s. 3d., against £223. 19s. 8d. last year. This amount can only be reduced by the consumers themselves in adopting some system of supervision over their workpeople so as to prevent any rough usage in connection with the lamps and other fittings. The light consumed during the year is 88,414 units, against 87,283 last year. The profits during the year are £453, which, with the balance of £23 carried from last year, amounts to £476. This the directors recommend to be appropriated as follows: dividend at the rate of 8 per cent., £240; to write off plant and fittings (depreciation), £200; to carry forward, £36.

MEYRA ELECTRIC.

At Board of Trade offices, Lincoln's-inn, on Tuesday, the statutory meetings of creditors and shareholders were held under the failure of this Company.

Mr. Winearls, assistant receiver, presided, and reported that the Company was registered in September, 1900, with a nominal capital of £10,000, divided into shares of £1 each, and was formed to acquire and work an invention in galvanic batteries, and letters patent which were to be granted to a Mr Paul Meyer. An agreement dated Sept. 7, 1900, between Mr. Meyer and a trustee on behalf of the Company, was subsequently adopted by the Company, and provided for the purchase from Mr. Meyer of all his rights for an invention and improvements in galvanic batteries, and letters patent in connection with them. The Company was also to acquire a secret process for dry batteries and the trade mark "Meyra."

At both meetings a resolution was passed leaving the matter in the hands of the official receiver as liquidator.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Chester.—The Corporation invite tenders for accumulators and booster. Tenders by July 7.

Pontypridd.—The Urban District Council invite tenders for cables and dust destructors. Tenders by July 31. See advertisement.

Barking Town.—The Council invite tenders for construction of tramways in their district. Tenders by July 31. See advertisement.

Sunderland.—The Corporation invite tenders for the supply of permanent way, overhead equipment, and cables. Tenders by July 9. See advertisement.

West Ham.—The Council invite tenders for 50 double-deck electric tramcars, complete with electrical equipment. Tenders by July 8. See advertisement.

Wigan.—The Electric Light and Tramways Committee invite tenders for the supply of 1,500 yards of ·1 square inch lead-covered, paper-insulated cable. Tenders by July 14. See advertisement.

Medomsley.—The Parish Council invite tenders for the supply and erection of about 30 electric lamp-poles, etc. For particulars apply to Mr. M. T. Milburn, clerk, Jubilee Houses, Medomsley. Tenders by July 5.

Swansea.—The Electric Lighting and Tramways Committee invite tenders for the supply, delivery, fixing, and laying of earthenware conduits, cables, pilot wires, street boxes, etc. Tenders by July 10. See advertisement.

Leskovatz (Servia).—The Société d'électricité de Leskovatz require two turbines of 200 h.p. and two dynamos for three-phase current; also accessories for a power installation with a radius of 11 miles Tenders by July 14.

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Bexley.—The Urban District Council invite tenders for points and crossings and boilers. Specifications, etc., may be obtained from the engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders by July 7.

Lowestoft.—The Corporation invite tenders for the construction of tramways, rails, fishplates, and bolts, and permanent-way construction. Specification, etc., may be obtained from Mr. R. Beattie Nicholson, town clerk, Lowestoft. Tenders by July 12.

Newcastle-upon-Tyne.—The Corporation invite tenders for the supply of 2,000 tons of tramway rails and the necessary fishplates for same. Particulars may be obtained at the City Engineer's Office, Town Hall, Newcastle-upon-Tyne. Tenders by noon on July 10.

Italy.—The Government Railways require tenders for electric lighting of 100 carriages and for adapting another 175 carriages now lit by gas. The estimate for the whole work is about £12,000. Tenders may now be addressed to the Inspector-General of Government Railways, Rome.

Manchester.—The Electricity Committee invite tenders for supply and delivery of three electric locomotives at their Stuart-street works. Specifications, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by July 17.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1. The Government also propose to lay a cable between Punta-Arenas and Puerto-Montt.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Willington Quay.—The Willington Quay and Howdon Industrial Society, Limited, invite tenders for supplying and fixing electrical apparatus as required for power and light at their Bewick-road premises. Specification, etc., can be had on application. Tenders by noon on July 4.

Falkirk.—The Corporation invite tenders for storage batteries, generators, transformers, switchboard, cable work, crane, lamps, and fittings. Specifications can be inspected at Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster. Tenders by July 14. See advertisement

Budapest.—The Principal of the Machinery Department of the Hungarian Government Railways ask for tenders for the erection and equipment of a central station at Pressburg. Conditions (5s.) may be obtained from the Printing Department of the Royal Hungarian Railway at Budapest. Tenders by July 15.

Gillingham.—The Urban District Council invite tenders for the supply and erection of two water-tube boilers, steam and exhaust piping, condenser, cooling tower, high-speed engines, three triphase alternators (250 kw. each), switchboard, underground cables, arc lamps, crane, and well. Tenders by July 17. See advertisement.

Brighton.—The Town Council invite tenders for installing electric light in the new wholesale vegetable market, and the performance of other works in connection therewith. Specifications, etc., may be obtained on application at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton. Tenders by 10 a.m. on 9th inst.

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection at the generating station, Constantine-road, Ipswich, of engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains, and road work, permanent-way construction of tramways, and arc lamps. Tenders by July 5. See advertisement.

London, S.W.—The London County Council invite tenders for the supply, delivery, and erection at the Council's temporary generating station at Loughborough Junction of steam, exhaust, feed, and other piping, valves, etc. Specifications and other particulars may be obtained from the County Hall, Spring-gardens, S.W. Tenders by July 8.

London, S.W.—The London County Council invite tenders for the manufacture and delivery of 80 double-decked electric tramcars, complete with trucks, motors, controllers, ploughs, etc., for the service of the Council's conduit tramways. Specification and other particulars a the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on 15.

London, S.W.—The London County Council invite tenders for the manufacture and supply of two steel cables—one 30,000ft. and the other 9,400ft. in length—for use in connection with the Council's cable tramways at Streatham. Specification, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by July 10.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of a 30-ton electric overhead travelling crane, span 33ft. Specification, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by 12 noon on 7th inst.

Epsom.—The Urban District Council invite tenders for the supply and erection of semi-marine dry-back boiler, with fittings, etc.; ejector condensers, circulating pumps, and pipework; spray cooling pond; steam, feed, and drain pipes, etc.; and one 150-kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, etc. Tenders by July 18. See advertisement.

Devon.—The Visiting Committee of the Devon County Asylum, Exminster, invite tenders for wiring alterations and additions, 2,000 lamps, booster, dynamo, motors, switchboard, and replacing of a battery of 120 700-ampere-hour cells, etc. Specification, etc., can be obtained from Messrs. O'Gorman and Cozens-Hardy 82, Victoria-street, Westminster. Tenders by July 23.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of one electric power overhead travelling crane, to lift 25 tons, three hand-power overhead travelling cranes, to lift 10 tons each, at certain of the Council's depots in the south of London. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 15.

London, S.W.—The London County Council invite tenders for the trenchwork, concreting, bricklaying, repaving, etc., in connection with the laying of stoneware cable ducts for the Council's southern tramways, including the laying of the ducts provided by the Council. Specifications and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 15.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply, delivery, erection, and construction of three 500-kw. steam-driven, direct-coupled three-phase alternators, etc.; three 50-kw. steam-driven, direct-coupled continuous-current exciters, etc.; and permanent way, including copper bonding and conduits for cables. Tenders by July 7. See advertisement.

Teddington.—The Urban District Council having obtained a provisional order enabling them to supply electricity within the urban district of Teddington, invite tenders from persons and companies able to carry out electrical undertakings, stating terms upon which they would be willing to take over such provisional order, and to submit a scheme of electric lighting for the district, with particulars of cost. Tenders by July 12. See advertisement.

Chester.—The Corporation invite tenders for construction and reconstruction and electrical equipment of tramways, alteration, adaptation, and equipment of shed, tramway cars, and general equipment (preferably for the whole, or in sections)—viz.: permanent-way construction (length of route about 4,678 yards) and car-shed; bonds; overhead equipment; and cars. Specifications, etc., may be obtained from Mr. I. M. Jones, city surveyor, Town Hall, or Mr. F. Thursfield, city electrical engineer, New Crane-street. Tenders by July 7.

Norway.—The Board of Trade notify that tenders will be received at the Norwegian State Telegraph Department, not later than noon on July 7, for the supply of 256-pair and 204-pair telephone cable, and for Leclanché battery glass. Specifications and conditions can be seen in the Technical Department of the Board of Telegraphs, Christiania. Apart from the usual customs duties, a preference of from 10 to 15 per cent. is given to native manufactures. Particulars may be obtained at the Board of Trade Offices (Commercial Intelligence Branch), 50, Parliament-street, any day between the hours of 10 and 5.

RESULTS OF TENDERS.

Ilford.—The Urban District Council have accepted the tender of Rhodes and Webster, of Bradford, for the three motors for the pumping station.

Bournemouth.—The Town Council have accepted the tender of J. G. White and Co. for supplying certain machinery, shafting, cranes, and tools at £1,295. 2s.

Bristol.—The Electrical Committee have accepted the tender of Clark and Chapman, Gateshead-on-Tyne, for feed and general service pumps, and Doulton and Co. for water softener for the Temple Back works.

Cardiff.—The Town Council have accepted the tender of the Tudor Accumulator Company for supply of cells for meter test rooms at £25, and that of Messrs. Gould and Wheeler, Cardiff, for supply of three-core disconnecting boxes at £4 for the pattern and £1. 5s. for each box.

Stretford.—The Urban District Council have accepted the tender of E. Heaton and Sons for steam-raising plant, £3,095; British Westinghouse Company, steam generators, condensing plant, pipes, and accessories, £5,619 (subject to conformity with the specifications and requirements of the engineer); Anchor Cable Company, service mains, £9,682.

Bath.—The following tenders have been accepted by the Corporation for extension plant: Dick, Kerr, and Co., Limited, London, two 250-kw. steam dynamos with Belliss engines £4,246, 50-kw. motor-alternator £375, 30-kw. balancer £250; Ferranti Limited, Hollinwood, transformers, £674; Johnson and Phillips, Kent, arc lamps, £113. 9s. 6d.; Callender's Cable Company, London, cables, £1,081.

Tonbridge (Kent).—The Urban District Council have received the following tenders for the fitting-up of an electric light installation in their electricity works:

Strange and Sons, Tonbridge	£159 14 4
Searle and Austen, Tonbridge	177 2 11
Hayward and Co., Tunbridge Wells	180 15 9
Johnson and Phillips, Charlton	204 0 0
Dann, Maidstone	221 10 0
Jackson Bros., Tonbridge	272 17 6
Cross and Co., Tonbridge	322 17 0

London County Council.—The Council have received the following tenders for the erection of the engine-house for the temporary electricity generating station to be erected by the Council on land adjoining the station of the South London Electric Supply Corporation, near Loughborough Junction:

W. Jones and Sons, Magnet Wharf, Bow Bridge (accepted)	£4,176 9 11
J. McManus, 237, Hammersmith-road	4,184 3 11
J. Westwood and Co., Napier Yard, Millwall	4,692 4 9
Jones Ironfoundries, etc., Company, 156 and 158, Goswell-road	4,939 10 7
Peirson and Co., 17 and 18, St. Dunstan's-hill	5,015 1 11
W. Harbrow, Iron Building Works, South Bermondsey Station	5,142 14 8

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BUSINESS NOTES.

TRACTION.

Birkdale.—The Town Council have decided against the running of the tramcars on Sundays.

Warrington.—The Board of Trade have sanctioned the borrowing of a further sum of £27,000 for tramway purposes.

Poole.—A proposal is being considered to extend the tramways from Branksome Junction to the extreme end of the Sandbanks *viâ* Compton Acre.

Eccles.—The main streets in the town are to be widened in connection with the proposed electric tramways, the construction of which will shortly be commenced.

Shipley.—Major Pringle, R.E., on behalf of the Board of Trade, on Tuesday inspected the electrical equipment of the new tramways. The lines will shortly be opened for traffic.

Nelson.—The work of constructing the tramlines to the end of the Nelson borough boundaries on the Barrowford and Colne roads is about to be commenced by the Nelson Corporation.

Huddersfield.—The tramway receipts for the seven days ending Saturday last amounted to £1,662, and for the Saturday the amount was £456. Both amounts constitute records.

Stretford.—Official sanction to the borrowing of the sum of £54,680 for the reconstruction and equipment and electrical traction of the tramways of the district has been received.

Bath.—The result of the recent arbritration to decide upon the figure to be paid by the Corporation of the price of the tramway company's undertaking is daily expected to be made known.

Stoke-on-Trent.—Major E. Druitt, R.E., on behalf of the Board of Trade, has held an enquiry into the objections of the Corporation to the electric traction company making a double line between Stoke and Newcastle.

Financial.—The warrants for the interest to June 30 on the 4½ per cent. first mortgage debenture stock of the South Lancashire Electric Traction and Power Company, Limited, were posted on Monday last, the 30th ult.

Sunderland.—Close upon 100,000 persons travelled on the tramways on Thursday week, constituting a record in the history of the enterprise. The construction of the proposed new tramway along Pallion-road is to be proceeded with.

Devonport.—The tramways extensions will be opened on Aug. 1. During the year ended June 26 last the company's cars travelled a distance of 568,122 miles, and carried 5,834,025 passengers, or the population of Devonport 88 times over.

Brockley.—A committee of private gentlemen has been formed to take steps in the matter of tramways for Brockley. One of the duties of the committee will be to canvass the district and obtain the views of the residents and tradespeople on the subject.

Aberdeen.—The United Trade Council have passed a resolution protesting against the abolition of ½d. fares on the Woodside tramway route, and agreeing that the Town Council should inaugurate ½d. fares all over the system. The cars now run on Sundays.

North Staffordshire.—The Corporations of Stoke-upon-Trent and Hanley have lodged petitions at the Private Bill Office of the House of Commons intimating their intention of opposing the passage through committee of the North Staffordshire Tramways Bill.

West London Tramways.—Some record figures were obtained on the London United Tramway Company's system in West London last week. From June 21 to 27 inclusive the total number of passengers carried was 1,025,400, or at the rate of 55,000,000 a year.

Gravesend.—Owing to the inability of the Corporation to give a supply of electrical energy for working the new tramways in Gravesend and district, the opening of the lines has had to be deferred. Arrangements had been made to run the electric cars last Tuesday.

Pontypridd.—The preamble of the Bill to confirm a provisional order authorising the Pontypridd Urban District Council to lay additional tramways in their district has been proved before the Select Committee of the House of Lords of which Lord Newton is chairman.

Brighton Electric Railway.—It is stated that the survey for the London and Brighton electric railway is to be commenced at once. There will be no material change in the route originally proposed in the plans laid down before the Parliamentary Committee early this year.

Slough.—The majority of the people have welcomed the proposal of the London United Tramway Company to extend their system to Slough, but the Parish Councils of both Langley and Datchet have passed resolutions against the suggested branches from the Bath-road line.

Penarth.—Information was received at the last meeting of the Town Council that a company is being formed to construct a tramway from Cardiff to Penarth. It was stated that a sub-committee had already been appointed to confer on the subject with the Glamorgan County Council.

Bilston.—A second and much more satisfactory trial trip over the whole of the Bilston section of the electric tramways was made last week. The car ran a great deal more evenly than on the previous occasion. This second trial was for the purpose of testing the cables, the crossings, etc.

Wrexham.—The work of laying the lines for the electric tramways has been commenced. The system will run from the racecourse, through the town, and up to Johnstown and Rhos. The Corporation has entered into an agreement with the electric tramways company to supply the electric power.

Halifax.—The Corporation electric tramway receipts on Friday, which was observed as a holiday, amounted to £528. 10s. 7d., compared with £449. 14s. 3d., the highest amount taken on any previous day. The receipts on Saturday amounted to £571. 6s. 6d., thus breaking the record of the previous day.

Stainland.—The District Council have applied to the Halifax Corporation to have the promised extension of tramways to their district commenced forthwith. The town clerk has, however, been instructed to reply that the Tramways Committee could not see their way to comply with the request at present.

Ayr.—The traffic on the Corporation electric tramways showed great expansion during last week. The number of passengers carried was 88,608, as compared with 65,854 in the previous week, which had been the highest. The drawings amounted to £455, which is £154 more than the highest previously recorded.

Dundee.—It is believed that when the tramway accounts for the financial year just closed are published they will show that the drawings have been about £10,000 better than those of the previous year This is only to be expected, seeing that in the past 12 months several new electric routes have been opened for traffic.

Bradford.—The whole of the Undercliffe section of the city tramways is now open for traffic. The electrical equipment of that part of the section between Peel Park and the Undercliffe terminus was completed on Friday night, and trial trips were run over the route. On Saturday morning a full service was started.

Doncaster.—Major Druitt, of the Board of Trade, on Tuesday inspected the Bennithorpe and the racecourse route of the electric tramway system, which was found to be satisfactory, and was at once opened to the public. The tramway runs from the station road to the Deaf and Dumb Institution near the racecourse. The Hyde Park section will be opened in a month.

Derby.—Notice of motion has been given for the next meeting of the Town Council: "That the Tramway Committee, in conjunction with the Electric Lighting Committee, be instructed to obtain a report from an electrical engineer of high standing as to the desirability or otherwise of having a combined generating station for providing current for electric lighting and traction purposes."

Darlaston.—With reference to the tramway difficulty on the line between Darlaston and Moxley through a portion of the line passing over the parish of Wednesbury, it was announced at the last meeting of the Council that a deputation had attended at Wednesbury, and the Mayor had given them an assurance that it was thought in a short time matters would be settled and everything in order.

Leeds.—The Street-lane extension of the Chapeltown route of the electric car service has been opened for traffic. It makes possible a circular tour by a connection with the Roundhay Park line, but the whole question of circular tours is yet under consideration, and, except on special occasions, it is the intention to treat the Canal Gardens as a terminus, and to return the Chapeltown cars by the way they arrive.

Barrow.—The tramways depôt owned by the British Electric Traction Company was found to be on fire on Saturday morning. The roof of the building fell in before the brigade arrived. When the fire broke out there were 12 steam tram engines and eight large tramcars in the building. Of these, 10 engines and four tramcars were completely destroyed, and the rest were considerably damaged. The loss is estimated at £5,000.

Broadstairs.—With reference to the Council's complaint as to the low rate of speed at which the tramcars travelled, it was stated at their last meeting that this was caused through the Board of Trade regulations, which only allowed a maximum speed of 10 miles an hour on any part of the line. If the Council would appeal to the Board of Trade to increase the rate of speed, the company would be only too delighted to fall in with their views.

Middlesex.—The proposals of the County Council for new light railways are to be embodied in two orders. The lengths and estimated cost of the two schemes are respectively: 6 miles 1 furlong 8·0 chains, £248,376; and 2 miles 3 furlongs 6·0 chains, £86,649. 10s. The total net estimate of the cost of the proposed new railways and of the additional lands required for the railways already authorised and sanctioned is £779,312. 12s.

Bournemouth.—The new Corporation electric tramways will be opened early next month. It was resolved by the Council this week to establish on the first section of 1½ miles a uniform 2d. fare per passenger for any distance. This is only provisional, it being the hope of the Council to have 1d. fares for certain stages, with 2d. from the centre to any part of the borough. The Tramways Committee have been authorised to engage drivers and conductors.

Rhondda.—The enquiry by the Select Committee of the House of Commons presided over by the Hon. de Tatton Egerton into the Rhondda Urban District Tramways Bill was continued this week. Mr. R. Hammond expressed the opinion that the tramways would be a great success. Mr. George E. Waller said there was absolutely no room for doubt that the tramways would be a paying concern. A drive through the valleys was sufficient to confirm that. The committee adjourned.

Exeter.—The City Council have decided to petition against the Bill promoted by the Exeter and District Tramways Company, as amended by the House of Lords. The Council have also reaffirmed the resolution of Oct. 25, 1899, in so far as it relates to the desirability of purchasing the existing tramway undertaking, with a view of reconstructing the lines for electric traction. A special meeting is to be convened to consider an application to the Board of Trade for permission to serve upon the Exeter Tramways Company notice of the intention of the Council to purchase their undertaking under the powers of Section 43 of the General Tramways Act of 1870.

London United Tramways.—The committee of the House of Commons presided over by Mr. Compton Rickett, revised the clauses

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of this Bill on Wednesday week. In certain cases agreements have been made under which, where the promoters take part of the property of frontagers, they shall, if required, take the whole of the property. It was urged on behalf of a number of property owners who had not petitioned against the Bill that a provision in the Bill should supply this agreement to all property affected. The committee, after hearing arguments, rejected the proposals. Amendments having been made in clauses to bring the Bill into conformity with the decision of the committee, the Bill was ordered to be reported for third reading.

Light Railways.—Recently the Board of Trade, on appeal, heard the objections which had been lodged against the confirmation of the Canterbury and Herne Bay Light Railway Order by the South-Eastern and Chatham Railway Companies' Managing Committee, under Section 9 (3) of the Light Railways Act, 1896 (the local enquiry having been held in Canterbury on April 16, 1902). The Board of Trade now state that, after careful consideration of the facts and arguments put forward at the appeal, they have arrived at the decision that the case is not one in which, on the objections of the railway companies' committee, the proposals of the promoters ought to be submitted to Parliament. The engineers to the scheme are Messrs. Pritchard, Green, and Co., of Westminster and Birmingham.

Bishopsgate.—The parishioners of St. Botolph, Bishopsgate, are much concerned about the safety of their interesting old church, in consequence of the proposed construction of three tube railways. At a vestry meeting at which the Bishop of Kensington presided, it was reported that owing to the opposition which had been raised by the parish officers, two out of the three Bills which were presented to Parliament had been dropped. The North-East London Railway will, however, run a tube railway through Bishopsgate-street, and it is feared that the church tower may be in danger. Clauses have been added to the Bill providing that 20ft. of London clay must be left between the lowest part of the tower of the church and the top of the railway, and the parish has been protected against any expense which may be caused by disturbances.

Lewisham.—At the last meeting of the Borough Council the Works Committee reported that they had considered the application to the Light Railway Commissioners by the Crystal Palace Light Railways and Tramways Company, Limited, for an order under the Light Railways Act to authorise the promoters to construct a light railway from a point in Lordship-lane near its junction with Crystal Palace-road, along Lordship-lane to Sydenham-hill, thence along Sydenham-hill and Crystal Palace-parade to the junction with Anerley-hill. The committee were of opinion that it was not intended that the Light Railways Acts should be used to facilitate the construction of what were properly tramways; and, apart from this, there were questions on this application affecting the interests of the Council, for the protection of which ample provision should be made if the scheme is proceeded with, and the committee recommended that the necessary steps be taken for opposing the application before the Light Railway Commissioners.

Glasgow.—The annual accounts of the Corporation tramways have now been published. They show a phenomenally successful result, which, subject to audit, is as follows: revenue, £614,413; working expenses, £405,042; gross balance, £209,371; which has been applied as under—interest and sinking fund on cost of Govan tramway. £5,057; interest on capital, £54,282; sinking fund, £36,974; payment to common good fund, £12,500; £108,815 net balance; added to general reserve fund, £100,566. The sums set aside as provision for renewal of permanent way and depreciation of plant, amounting to £111,758, are included in the working expenses of £405,042. Last year's gross balance amounted to £87,630. It is proposed to apply the whole of the general reserve fund in writing off the old horse traction plant and equipment. The traffic returns of the Corporation tramways for the week ending June 28, 1902, are interesting if compared with the corresponding week last year, the figures of which are shown in brackets: mileage of line open for traffic, double track, 53 (44½); car miles run, 249,991 (225,699); passengers carried, 3,612,277 (3,195,086); receipts, £13,217. 9s. 11d. (£11,988. 11s. 7d.).

Accidents.—A serious accident, resulting in the death of three persons and injury to eight others, occurred on the tramway system last Saturday night in the midst of the Coronation festivities. A well-laden car was descending Somerset-road, on the new route to Almondbury, when it left the metals on taking the curve into a busy thoroughfare. The car crashed into a grocery stores, completely smashing up the shop front. Part of the stonework was displaced, and some damage was done to a public-house next door, which the car first caught. The upper portion of the car was badly damaged, but the lower part was not much the worse beyond the breaking of the windows. The reason for the car leaving the metals is stated to be that the driver lost control, and the vehicle was precipitated down the hill at a great rate of speed, failing to round the curve in the line. The car was one of the newest in service at Huddersfield, and was fitted with three electric brakes, each independent of the other.—An accident at Bradford to an electric car is also reported. This occurred on Sunday. About half-past seven a car was standing at Thornton terminus, four miles out, when, in the absence of the driver, through an unaccountable cause it started down towards Bradford full of people. In their endeavours to jump off the car, a woman, the wife of a farmer, was killed, and seven others injured.

Halesowen.—The Worcestershire County Council appealed to the Board of Trade on Tuesday against the confirmation of an order made by the Light Railway Commissioners, on the ground that certain sections of the proposed line should be widened at once to 35ft., whereas the promoters of the scheme contended that they were allowed seven years for giving that width of road under the order. The promoters are the Halesowen District Council. Mr. Lees, for the District Council, said that a compromise had been agreed to between the promoters and the County Council, whereby the former were allowed seven years to widen the road. The land in question was being set out as a building estate, and as soon as the people began to build they could compel them to allow for the 35ft. of roadway; but if these people knew that the promoters were compelled to widen the road at once, they would hold back building operations in order to get the promoters to buy at a forced sale value. Evidence having been tendered by both sides as to what took place before the Light Railway Commissioners, about which there was a great conflict, Sir Herbert Jekyll said he understood that the proviso which was now sought to be put upon the promoters was not before the Light Railway Commissioners, and he should hardly be prepared to advise the Board of Trade to do what the County Council desired.

Aston.—The Urban District Council on Monday took over the tramways in their area. At the Council meeting on Tuesday a report was presented stating that the local Tramways and Electric Light Committee had effected an arrangement with the tramways company, under which the latter would assign and transfer to the Council the residue of the existing term of the lease granted to the company by the Corporation of Birmingham, which expires on Dec. 30, 1903, and under which they become lessees of the line of tramways extending from the boundry of the city of Birmingham into the Old-square. The price for the transfer is to be fixed by Sir Frederick Bramwell. Further, the committee intimate that they have negotiated the purchase of the line of tramway authorised by the order of 1884, commencing at or near the Vine Inn, running along the Lichfield-road to Gravelly Hill, with the leasehold land and buildings used as a depôt, and the horses and other effects belonging to the company, and used by them for the purpose of working such line of tramway. The sale and purchase of the whole of the undertakings of the company is to take effect as from June 30, 1902. After that date, until the actual completion of the purchase, the company are to carry on the undertaking as agents for and on behalf of and for the benefit of the Council, the Council paying interest at the rate of 4 per cent. per annum from June 30 until the actual date of completion.

Cardiff.—Some interesting figures bearing on the cost of reconstructing the tramways have been submitted to the Tramways Committee by the borough engineer, Mr. W. Harpur. He estimated at £70,700 the total cost of reconstructing the tramways purchased from the tramway company, and this amount included the cost of tools and plant of all kinds still in the possession of the Corporation, the making good of the roads at the sides of the tramways, and other contingencies. For the purpose of comparing this cost with the offer of the tramway company of October, 1901, he has made all requisite deductions and additions for placing the two estimates on an equal basis. He finds that had the offer of the company been accepted there would have been extras on their proposed terms amounting to at least £12,700, which, added to their offer of £90,841, makes a total of £103,541, showing a saving to the Corporation upon the transaction of £32,841. In addition to this the Corporation would probably have had to pay for the supervision of the work, for clerks of works, and additional surveyors, for measuring up extras, etc., at least £1,000, or, putting it in another way, had the Corporation carried out the works only stipulated for and included in the terms set out by the company in their letter of October, 1901, the cost of the work carried out by the Corporation would have been £58,000 only, instead of £70,700. In reply to statements recently made in one of the local papers alleging that there will be a loss of £50,000 on the first year's working of the electric tramways, the chairman of the Tramways Committee stated at the last meeting that he has had an offer from a strong syndicate in the town, who were prepared to take over the tramlines and pay the Corporation 5 per cent. on the Corporation's outlay. That was the reply of the Tramway Committee to those who wanted to say that they would lose by the undertaking. The total receipts from the tramways for the week ending June 28 amounted to about £2,300, which constitutes a record, the nearest approach to this figure being during Whit week, when the takings were not quite £1,800.

London County Council.—The recent action of the House of Lords in striking out Clause 5 of the London County Council Tramways Bill, thereby prohibiting the construction of any tramway south of the Strand, was the subject of a short report from the Highways Committee at Tuesday's meeting of the Council. The committee herein point out that the effect of the decision of the House of Lords, if acted upon, will be that should the Bill as proposed to be altered become law, the Council will be empowered to construct a costly subway for tramways, but the scheme will necessarily be very incomplete owing to the tramways terminus being underground at the Strand, and no facilities being afforded for taking the tramways to the surface at and along the Victoria-embankment. The committee have thought it right to call the attention of the Council to the course taken by the House of Lords with regard to the matter. As will be seen from our "Tenders" columns, the Council on Tuesday accepted the tender of Messrs. W. Jones and Sons for the erection of the engine-house for the temporary electricity generating station to be erected at Loughborough in connection with the tramways conversion. The total cost of the work will be about £4,500. The Council also agreed to enter into a contract with the Sanitary Block and Tile Pavement Company for the paving with the company's sanitary blocks of such portions of the tramway track as are in front of places of worship and some other public buildings. A special recommendation from the Highways Committee was also received by the Council to the effect that application be made in the next session of Parliament for powers to enable the Council to enter into arrangements with the company concerned, when any bridge carrying, or over, any thoroughfare in London which is already, or may probably be selected by the Council as, a route for tramways, is about to be reconstructed, or altered, under powers conferred upon the company by special Act of Parliament, for the work to be carried out in such manner as to permit of the placing of electrical conduits in the carriageway of the bridge, or of the laying of a

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double line of tramways in the road beneath the bridge; and also to enable the Council to contribute the whole, or a part, of the extra cost to be incurred in respect of the work necessary to adapt the bridge for the purpose.

Croydon Festivities.—Taking first advantage of the official announcement that the King is now happily out of any immediate danger, the management of the electric tramway system at Croydon on Monday night last ran a magnificently-decorated and illuminated car through the town and out to Purley. The original intention was to have the demonstration on Thursday, June 26, but owing to the general abandonment of the Coronation festivities for a time all over the kingdom on account of his Majesty's illness, this was also postponed to a more favourable occasion. As the car turned out of the Thornton Heath depôt at about a quarter to ten on Monday night it was loudly cheered by the crowd which had assembled to view the beautiful illuminations adorning the walls of the tramway offices, and extending a considerable way over the network of wires immediately in front. The car itself presented a magnificent picture, blazing with hundreds of incandescent electric multi-coloured lights, with an illuminated image of the King at the one end and that of the Queen at the other. It was at once boarded by a large party of invited guests, among whom were Mr. J. G. Scott, the newly-appointed borough electrical engineer of Croydon, and Mr. F. S. Grogan, the representative electrical engineer of the British Thomson-Houston Company, the contractors. A sharp run was first made to the southern extremity of the line at Purley. Notwithstanding the comparative lateness of the hour there were lots of people abroad, and the car was enthusiastically cheered on its triumphant passage through the town. On the return journey similar demonstrations were made, and the warm welcome which the appearance of the car at every turn of the road received may be taken as an evidence of the popularity of the electric service at Croydon. The system is being worked by the British Electric Traction Company under a lease from the Corporation, with Mr. T. B. Goodyer as general manager, and to this gentleman and Mr. Spurway, the electrical engineer for the tramways system, is due the credit of organising the above trip in celebration of the unavoidably postponed Coronation. We understand that the tramcars have been exceptionally busy during the past week, many visitors from a distance having taken advantage of the electric service to view the local decorations.

Lancashire Light Railways.—We have received from Mr. A. Tracey, the secretary of the Lancashire Light Railways Company, a few interesting facts respecting the extension of the Liverpool tramway service to Prescot and St. Helens, which was inaugurated on Wednesday last week. The Liverpool Corporation have extended the city tramways from the present terminus at Old Swan to the city boundary at Knotty Ash, where this company's line—the Liverpool and Prescot light railway—commences and continues along the main road to the boundary of Prescot, where it forms a physical junction with the existing tramways of St. Helens, which go through Prescot, Rainhill, and Eccleston Park to St. Helens, and then on to Haydock. The Liverpool and Prescot light railway was authorised under the Light Railways Act of 1896, and the line has been fully constructed and equipped for some months, but owing to the connection with the city tramway service being incomplete, it was not considered desirable for it to be opened for public traffic until this was done. Thus, the lines were not brought into public use until last week. The Liverpool and Prescot light railway is nearly 3½ miles in length, and is of the tramway type, there being practically no difference between the construction of the track, overhead equipment, and cars of this line and the ordinary tramways, the same gauge—namely, 4ft. 8½in.—being used. The rails are laid in precisely the same manner as by the Liverpool Corporation tramways. It is a single line, with passing places within sight of each other. The cars are of the double-deck type, with seating capacity for 55 passengers—22 inside and 33 outside—and are fitted with all modern improvements, including up-to-date life-saving guards, brakes, electric light, etc. The Lancashire Light Railways Company is one of the companies controlled by the South Lancashire Electric Traction and Power Company, who also control the South Lancashire Tramways Company. To this latter company powers were given under the South Lancashire Tramways Acts of 1900 and 1901 for the construction of over 105 miles of tramways in the districts between St. Helens, Manchester, Bolton, and Warrington, embracing the populous towns and districts of Leigh, Atherton, Hindley, Newton-in-Makerfield, and other places. The company have now in hand the first constructional scheme, including nearly 20 miles of tramways, which it is expected will be completed in six or seven weeks' time; also a large generating station at Atherton, which is approaching completion. There is every prospect of these tramways being opened for public traffic early in August, after which important developments in the carriage of goods (for which the company have powers) may be expected.

Tube Railways.—Mr. Campion, one of the examiners of Standing Order Proofs, sat at the House of Commons on Tuesday to consider various allegations of non-compliance with the rules of Parliament in connection with the London United Electric Railways Bill, the Brompton and Piccadilly-circus Railway Bill, and the Piccadilly, City, and North-East London Railway Bill. Mr. Cripps, on behalf of H. L. Florence (chairman of a residents' committee) and others alleged non-compliance with Standing Orders in the case of the London United Electric Railway Bill, which contemplated the construction of a tube railway under Knightsbridge-road, and another similar tube railway. He alleged non-compliance in respect of Clause 107, which confirmed an agreement between the London United Electric Railways Company and the Piccadilly and City Railway Company for through fares, and through traffic facilities over the respective lines. He contended that this was an agreement exactly of the nature required by the Standing Orders to be expressly stated in the notices of the Bill; and the promoters had failed to include it in any of their notices. Mr. Greg said that when the notices were issued there was absolutely no connection between the two companies, and that, therefore, it was impossible to cite the Piccadilly and City Railway Company by name. He held also that the notices given were sufficiently wide to cover this particular agreement. Mr. Cripps then proceeded with a similar allegation against the promoters of the Piccadilly and City Railway Company. The Examiner said it seemed to him that this allegation went to the root of the whole matter. The agreement undoubtedly came within the requirements of the Standing Orders, and there could be no question that the notices did not comply with the Standing Orders in so far as they failed to specify the agreement in the terms required, or to mention the persons with whom it was proposed to make the agreement. He should support the allegation, and report both Bills as having failed to comply with the Standing Orders in regard to this matter. The remaining allegations of non-compliance made against the promoters of the Piccadilly and City Railway was considered and over-ruled. The same decision was given on the objection of insufficient notice urged against the Brompton and Piccadilly-circus Railway Company in regard to the confirmation of an agreement between the promoters of that undertaking and the District Railway Company. Mr. Geo. Drew writes to the daily Press on behalf of the National Association for the Extension of Workmen's Trains and Trams, complaining that the provision made in several of the Tube Bills before Parliament this session with regard to workmen's trains is absolutely inadequate, and fail to carry out the recommendation of the Joint Committee of last year. Sir John Dickson-Poynder, the letter states, has given notice after the second reading of each Bill which does not make sufficient provision for workmen's trains, to move that it be an instruction to the Committee to whom it is referred to insert as far as practicable in the Bill provisions to carry out the recommendations as to workmen's trains and fares contained in the report of the Joint Committee of Session 1901 on Underground Railways, and to deal with different companies, but forming continuous through routes as one railway for these purposes.

LIGHTING AND GENERAL.

Faversham.—It is proposed to borrow £24,000 for electric lighting.

Fraserburgh.—Sufficient subscribers have been obtained to start a Post Office telephone exchange.

Leicestershire and Warwickshire Electric Power Bill.—This Bill has been read a third time and passed.

Worksop.—The Urban District Council have reduced the price of electricity for motive power from 2d. to 1½d. per unit.

Carburet of Calcium.—The price of this material has advanced during the last half of June from £9. 10s. to £17. 18s.

Chesterfield.—The Town Council propose to borrow £3,000 to cover further capital expenditure on the electric lighting undertaking.

Share Market.—There were few changes in electric supply shares during the week, though there were a few small investment orders about.

St. Pancras.—The Council has decided to extend the electric light to Bartholomew-road, Brownlow-mews, Charlotte-street, and Seaton-street.

Newton.—The Urban Electric Supply Company are about to lay down main cables and the boxes for connecting up the same in a number of streets.

Stourbridge.—The Council have decided to retain the electric lighting order, and that powers to carry out the order be transferred to the Gas Committee.

East Cowes.—The Urban District Council Council are considering an offer from the Isle of Wight Electric Lighting Company with regard to the lighting of the district.

Charing Cross and Strand Electricity Supply Co.—Warrants for the interest on the 4 per cent. debenture stock of this Corporation were posted to the stockholders on July 1.

Greenwich.—The Blackheath and Greenwich Electric Lighting and the Lewisham and District Supply Company propose to apply for a joint order in the next session of Parliament.

E.E.I. Journal.—Full list of contents of Part No. 157, edited by W. G. McMillan, secretary, and published by E. and F. N. Spon, Limited, 125, Strand, W.C., appear in another column.

York.—The Electric Lighting Committee have appointed Mr. F. B. Walker, of Bradford, clerk accountant at their works, and Mr. G. H. B. Holmes, of York, as junior assistant engineer.

Removal.—Messrs. Dick, Kerr, and Co., Limited, have removed their office in Manchester from the Prudential-buildings, 78, King-street, to the Northern Assurance-buildings, Albert-square.

Maidstone.—The Electric Light Committee are advertising for tenders for constructing the coal store and railway at the electric light works. The tenders are to be limited to Maidstone builders only.

Lowestoft.—The Town Council are about to apply for a license from the Board of Trade to supply current for private and public lighting in certain rural parishes more or less contiguous to the borough.

Aberdeen.—At the last meeting of the Gas and Electric Lighting Committee it was agreed, on the report of Mr. Bell, to extend the electric mains along Holburn-road to Great Western-road, and along Fonthill-road to Albury-road.

Derby.—The last report of the Electric Lighting Committee states that the sanction of the Local Government Board has been received to the raising of a loan of £7,955 for the purpose of meeting expenses. Extensions of the mains to Overdale-road have been ordered.

Stock Exchange.—Applications have been made to the committee to allow the following securities to be quoted in the official list:

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Callender's Cable and Construction Company's further issue of 5,000 ordinary shares of £5 each fully paid, Nos. 40,001 to 45,000.

City of London Electric Lighting Co.—The directors have declared the following dividend upon the preference shares on account of the distribution for the year ending Dec. 31, 1902: 6s. per share, or at the full rate of 6 per cent. per annum for the six months ending 30th prox.

Malton.—The Urban District Council have received a letter from the Postmaster-General stating that the erection of the trunk line for the telephone to connect Malton with the general system would be proceeded with, and if 40 subscribers can be obtained the usual local facilities will be given.

Bexhill.—The Urban District Council have been discussing a resolution to the effect that the electrical engineer should be requested to consider the question of averaging the price of the unit to the consumer. The proposal did not meet with the favour of the Council, and after a short discussion it was negatived.

Glasgow.—In connection with the Central Station extension, the Caledonian Railway Company have decided to put down new electric lighting plant in their greatly enlarged premises. The site is at present being prepared on the Union-street side of the station, and a high chimney stalk has now been almost completed.

Bilston.—At the last meeting of the Urban District Council a complaint regarding the smoke nuisance from the market electric light engine was referred to, and the hope was expressed that the Council would soon get their supply of electricity from a company, and would, therefore, be able to do away with the boilers.

Cardiff.—A number of lamps have been purchased for the police, and before another stock will be required Mr. McKenzie is to report upon the question of the utility of electric lamps for the purpose. The electric main cable is to be extended down Corporation-road at a cost of £96; a net profit of 6 per cent. is assured.

Ormskirk.—With regard to the circulars recently posted in the town with a view of ascertaining the probable number of consumers of the electric light in the event of the Council putting down an installation, we understand that the replies so far have been very satisfactory. They will be considered by a sub-committee this week.

West Hartlepool.—The Hartlepool Corporation having entered into negotiations with the Northern Counties Electricity Supply Company, have informed the Town Council that there is now no need for them to appoint a sub-committee to confer with the West Hartlepool committee upon the recent negotiations respecting the supply of current at Hartlepool.

Barnstaple.—In order to avoid the breaking-up of the wood paving in High-street, Cross-street, and Joy-street, the cables are to be laid on both sides at an extra cost of £327. The engineer, after reporting upon the cost of wiring and fitting-up intending consumers' premises, has received directions to order stock fittings for 300 lights at a gross cost of £220.

Swansea.—The Swansea Gas Company has given the Swansea Corporation formal notice of its intention to terminate at Michaelmas the agreement existing between the two bodies, and that in any future agreement the same charge for public lighting will be made as that to private consumers. The Corporation will meet this challenge by taking steps towards having the town lit by electricity.

Wimbledon.—Mr. F. Barnes Spencer has submitted a report to the Urban District Council recommending that from Oct. 1 current for lighting be supplied at 7d. per unit; after the first 120 hours per quarter in the winter and 60 hours in the summer, 2d. per unit is to be charged. Twopence is also the price for power, but during the winter, if power is used between 5 and 8, lighting rate is to be charged.

French E. L. B.—We are informed that several of the visitors to our naval review—as for instance, the French cruiser "Montcalm" and Baron Rothschild's splendid yacht—were fitted with the E. L. B. system by the French company, who are now busily occupied with preparations for the Government and municipal celebrations of the 14th inst., having only recently completed the arrangements of the great fête at Neuilly.

Malaga.—We understand that the Malaga electricity works are about to lay down a complete installation of direct-current plant in addition to their high-tension system, which will in future serve only for the outskirts of the town, the cables to be of English make, but the engines and dynamos to be American. The orders are not yet given out, and we hope that English works will at least have an opportunity to tender.

Uxbridge.—The contractors are busily engaged at the electric light generating station, at Waterloo-road, in carrying out the work they have undertaken, and it is expected that in the course of another month or so the entire scheme will be completed. The date of the opening ceremony of the works of the Uxbridge and District Electric Supply Company, Limited, has been postponed for consideration at the directors' meeting in August.

Kent House Improvement Association.—The question of the arc lighting was discussed at last week's meeting, and the following resolution was passed: "That this meeting desires to express its confidence in the chairman, and its thanks to the three members of the Kent House Ward for the efforts they have made, and it is hoped that they will continue their endeavours to secure the improvement of arc lighting for Beckenham at as early a date as possible."

Accident.—An accident happened at Shipley on Wednesday last, when the heavy cover of a connection box over the electric lighting cable was blown off, inflicting slight injuries upon two young girls who were passing at the time. It is supposed that the cable had become affected by the damp, which caused fusing, leading to the explosion of coal gas accumulated under the pavement. The current was soon switched off the fused cable, and no further trouble arose.

Stepney.—Partly owing to the dislocation due to change of local government, and partly to the date of the Local Government Board audit, the accounts of the electric light undertaking covering the whole period since the commencement of supply—viz., two years and three months—have only just been published. From the accounts for the year ending March 31, 1902, we note that the revenue exceeds the total charges to the revenue accounts by over £2,000, and although the undertaking during the period referred to was only in its second year, over 1,000,000 units have been sold in what until recently was considered a most unpromising field for profitable electric supply. These results are specially interesting, in view of the fact that the average price obtained from private consumers is under 2¾d. per unit, and is the lowest in the United Kingdom for undertakings showing a balance on the right side of the net revenue account, and not having the advantage of a traction supply, while the initial price charged is the highest—viz., 8d.

Photography by Electrical Transmission.—Two years ago Mr. Sczepanik promised to transmit moving pictures at a distance by means of electricity. Those who knew had more than their doubts as to his ability to transmit effects which are succeeding each other rapidly while that process is still going on. However, this much-trumpeted invention has apparently joined the ranks of the submerged. A step in the right direction has been taken by Dr. Arthur Korn, of Munich, who has invented a receiver which, according to a preliminary account published by him, will allow of the transmission of an image graduated in light and shade, thus marking a progress from the line drawings which have hitherto been obtained. This, of course, only refers to the reproduction of pictures after the movement of drawing has ceased. A description by Mr. A. W. Isenthal of this process, which is based upon the selenium principle, appears in this month's issue of the *Photogram*, a number, which besides other excellent matter, contains a directory of public dark-rooms all over the world—a list which has now become almost indispensable to every tourist or traveller.

Kingston-on-Thames.—The Council have resolved that the price to be charged to private consumers for electric current be modified as follows—namely, the charge to be at the rate of 8d. per unit, subject to a reduction to 3d. per unit for current consumed after the first hour per day on the demand indicator system. A main is to be laid in Wood-street from Vicarage-road to Ceres-road. Arrangements have been made for a visit to the Ealing electric works on July 8. Application is to be made to the president of the Institution of Electrical Engineers to name three experts. The points to be submitted are: (1) Whether it is desirable to adopt a charge of 8d. per unit, subject to a reduction of 3d. per unit for current consumed after the first hour per day on the demand indicator system. (2) (*a*) The relative advantages of electric incandescent and arc lighting for street purposes, and (*b*) the correct principle of allocating the cost of current supplied for street-lighting purposes. (3) The necessity of providing additional plant, and plant requisite in the course of the next three or five years. He is also to indicate what plant would be most economical in regard to (*a*) first cost, and (*b*) working cost. (4) The expert is desired to express his opinion as to the desirability of modifying the system of generation and distribution, the present system being (except for street arc lighting) the high-tension alternating-current system with transformer sub-stations. (5) Lastly, the expert is requested to indicate whether there are any items of cost of production which can in his opinion be reduced or modified, such, for instance, as coal, oil, stores, or labour; also what means he would suggest for effecting economy in production.

London County Council.—The Council have sanctioned an application from the Council of Islington to the borrowing of £8,668 for the installation of electric light within the borough (to be repaid within 42 years). Notices of intention to lay mains, etc., under Electric Lighting Acts and orders were agreed to as follows: the Lewisham and District Electric Supply Company (High-street, Lewisham, Rushey-green and Catford-road, and to construct transformer boxes in High-street, Lewisham (two), Rushey-green, and Catford-road; Blackheath and Greenwich District Electric Light Company (along Royal-hill and Circus-street, and along Point-hill and The Grove, and along portions of Victoria-road, Wellington-road, and Church-lane, and to construct a transformer box at the junction of Wellington-road and Church-lane); the Charing Cross and Strand Electricity Supply Corporation (along Surrey-street and Howard-street; the County of London and Brush Provincial Electric Lighting Company (a transformer box in Greenhill-rents); and the Notting Hill Electric Lighting Company (Russell-gardens). The receipt of a notice from the Hammersmith Borough Council of intention to lay mains along Blythe-road was also reported. At Tuesday's meeting attention was drawn to the premises used as the Avenue exchange of the National Telephone Company in Lime-street, E.C., and Dr. Longstaff said that the company occupied part of the third floor and the whole of the fourth and fifth floors. On the fifth floor, used as a trunk-line exchange, nine males were employed; on the fourth floor, used as a central telephone exchange, 80 females; and on the third floor was a messroom and motor for supplying electricity. A 4ft. brick-enclosed stone staircase in the east angle of the premises connected the basement, ground, third, and fourth floors only. The doors to the staircase were ordinary deal doors. From the fourth floor there was a spiral iron staircase up to the fifth floor, and a similar staircase from the lighting area to the third floor. The windows on the third and fourth floors were fixed iron sashes, and would not be available for escape. The premises did not appear to come within the scope of Section 14 of the Factory Act, and could not, therefore, be dealt with by the Council. Dr. Longstaff added that the company had refused the Council's inspector facilities to examine the premises, but that official was rather smart, and had seen enough to enable him to make a sketch for the Building Act Committee. The committee would consider very carefully the course to be pursued.

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Gravesend.—Mr. McInnes has been appointed electrical engineer to the Council for a period of five years, the Corporation being at liberty to terminate the engagement at three months' notice. The salary is to be £250 per annum, subject to an understanding that in the event of his being able to show a reasonable profit he may ask for an increase in his salary not exceeding £52, and should the Corporation in that case not deem such increase advisable, Mr. McInnes shall have the right to terminate his engagement with the Corporation at a like period of three months.

Telegraph Manufacturing Co.—It is intended that the name "British Insulated Wire Company, Limited,' shall shortly be altered so as to embrace the characteristics also of the Telegraph Manufacturing Company, the amalgamation of the two companies having now been completed. We are informed that the Telegraph Manufacturing Company are now ordering goods in the name of the British Insulated Wire Company, Limited, but invoices for goods ordered from the Helsby or Liverpool works should be rendered to Helsby or Liverpool, as well as all statements of accounts in respect of the same.

Electric Cranes.—A striking illustration of the excellent work that can be accomplished with the electric cranes recently introduced by the North-Eastern Railway Company at the West Hartlepool Docks is afforded by the discharge of the steamer "Westmanland." This vessel docked at 3 p.m. on Saturday, the 21st ult., with a cargo of about 650 standards of pulpwood props. She was berthed alongside the electric cranes and commenced discharging at midnight on Sunday. By 9 p.m. on Monday the whole cargo was entirely discharged. The actual working time was 16 hours, or an average of over 40 standards per hour.

Wireless Telegraphy. — It is reported that the Cunarder "Campania," which arrived in Liverpool from New York on Saturday, was in wireless communication with passing steamers practically from the time she left the United States until she was off the Irish coast, the communicating vessels including the "Minneapolis" on the 22nd, the "Lucania" on the 25th, the "Minnehaha" on the evening of the same day, the "Saxonia" on the 26th, and the Irish coast on Friday afternoon.—Mr. J. D. Spreckels, the Californian sugar magnate, has arranged for an installation of a system of wireless telegraphy between California and Hawaii.

Islington.— From the accounts of the electricity undertaking for the year ending March 31, 1902, it appears that a further capital outlay of £43,508. 4s. 7d. was incurred during that period, and that the total capital invested now stands at £365,842. 12s. 10d. The total expenditure on revenue account amounted to £24,639. 17s. 8d., and the income for the year to £41,308. 8s. 3d., leaving a gross profit of £16,668. 10s. 7d. After payment of interest and redemption of debt there remained a net profit on the year's working of £1,402. 6s. 6d. Since the Borough Council has been in existence an equivulent of 26,512 8-c.p. lamps has been connected for private consumers.

Prevention of Accidents.—Some time ago we mentioned a time-saving white-washing machine put on the market by Messrs. Wallach Bros. The same firm are showing at the Wolverhampton Exhibition various safety appliances for the prevention of accidents in industrial concerns, amongst which are fire, heat, and acid proof garments, face and hand protectors, aluminium respirators (weighing 1oz.), eye protectors, guards for machinery, etc., electric miners' safety lamps, fire extinguishers, etc. A very efficient safety appliance is the wire-embedded glass protectors for boiler-gauge glasses. These glasses have a wire netting embedded in their centre, and it is claimed that they will stand a pressure up to 400lb. per square inch.

Ealing.—The Electric Lighting Committee have resolved that prepayment meters should not be fitted in offices or shops or in houses under a ratable value of £30 a year, and that the minimum charge charge of 7s. 6d. per quarter should not be enforced where prepayment meters were installed. No sanction having been received from the Local Government Board for over 12 months for general electric extensions, the Council will now ask for sanction to a sum of £10,000 for such extensions. An enquiry will be held into the £7,881 loan required for feeder mains. Photometric tests were made recently which showed that, irrespective of age of lamp or mantle, the best results at 10ft. were given equally by the 12-c.p. silvered and the two 8-c.p. electric lamps; at 20ft. the best results were given by the 12-c.p. silvered-back lamps; at 40ft. the best results were given by the Welsbach Kern burners.

Bath.—The question of the future of the electric light works was again before the Council last week, and the reports of the joint sub-committee were adopted. With respect to the application of the authority to borrow £25,000 for new works, the Local Government Board sanctioned the borrowing of £11,196 required to defray excess expenditure on works in respect of which loans had been sanctioned by the Board, and the cost of other works already executed. The Board deferred decision with regard to the remainder of the application until they had been furnished with further particulars and specifications as to new works. The committee considered the matter pressing, having regard to the possibility of another breakdown next winter if the heavy load came upon the works without additional plant, and they recommended that tenders for new machinery amounting to £7,304 be accepted.

Madras.—An estimate of Rs.40,036 for providing an electric installation in the Government Press at Madras has been sanctioned for execution when funds are available. The superintendent of the Press when in England visited a number of firms and saw the several descriptions of lighting power used, and of motive power for driving machinery, and he obtained two estimates from well-known firms for the electric lighting of the Press. After his return he obtained estimates from four firms in Madras, but two of them were for acetylene and one for oil gas. The local tender for electric lighting is the lowest as compared with the two English tenders, one of which is considered "indefinite and not binding." The sanction for the purchase and use of the electric light is, however, equally vague. No details are given as to how the estimated figure is arrived at, nor is it made known which firm will get the order.—*Indian Engineering.*

Coventry.—The preparations for electrical illuminations for the Coronation festivities were very extensive. The Opera House had about 300 lamps distributed over the frontage; the Hen and Chickens had 60 lamps; Sydenham Palace, 90; Drapers' Hall, 90; Co-operative Society, Smithford-street, 150; Dyers' Arms, 50; Mr. Icke, Broadgate, 40. In all cases the arrangements of the lamps were most effective. In various streets the authorities placed chains of electric lamps hanging in festoons. In the absence of Mr. Jeckell, the electric engineer of the city, the supervision of the illuminations was carried on by Mr. William J. A. Sowter, A.M.I.E.E., chief assistant engineer. Mr. Sowter anticipated that about an extra 100 h.p. would be needed on the occasion.

Watford.—At the last meeting of the Urban District Council a letter from the Board of Trade was read, stating that they were not disposed to entertain applications for licenses under the Electric Lighting Acts in regard to proposed extensions of the area of supply under an existing provisional order, and that procedure by provisional order should be adopted. The Council are urging the Board to move in the matter, as the delay incident to obtaining a provisional order will seriously interfere with the development of the work. The electrical engineer estimates the cost of the outstanding works which have been sanctioned at £590, and has been directed to prepare specification and estimate, and to state what variations have been made from the original intention, as the previous estimate was £350. A low-tension main is to be laid to supply current for motor power to premises in Liverpool-road at a cost of £130 provided the applicants pay half the cost.

Dundee.—The managers of the Royal Lunatic Asylum some years ago introduced, on the initiation of the late Dr. Howden, a very complete installation of electric light, and Dr. Havelock, Dr. Howden's successor, has still farther developed that installation. In his last report, the manager says: "With the recent additions now completed, the whole installation is of the most modern type, and of the highest efficiency. It consists of two large Belliss engines, coupled direct to Crompton dynamos in duplicate, each capable of running 700 16-c.p. lights, and a smaller combined set capable of running 120 lights. This smaller set is used during the night, when few lights are required, and can also be used for storing accumulators should they be introduced at any future time. It is calculated that the light is produced at 3d. per Board of Trade unit, which compares very favourably with the cost of electricity even in the large corporations. Gas has almost been dispensed with entirely, except for cooking purposes. The introduction of a number of standard lamps in the grounds about the building has been of great convenience on dark nights."

Royal Cornwall Polytechnic Society.—Electricity is to be the feature of the sixty-eighth exhibition of the Royal Cornwall Polytechnic Society, which will open at Falmouth on Aug. 26. The president, Sir Wm. Preece, K.C.B., F.R.S., will be an exhibitor, and hopes to procure from the General Post Office a loan collection of electrical appliances. Mr. F. H. Hedley, electrical engineer, of St. Austell, will exhibit, and is taking an active interest in the exhibition. Messrs. Tangye, Limited, of Birmingham, are co operating with the society, and will provide one of their 5 B dynamos and a 22 b.h p. gas-engine for generating the electric current that will be required for exhibition purposes. It would appear that the present is a most opportune time for holding such an exhibition, in that Cornwall is awaking to the sense of the possibilities which lie in the application of electrical science in the development of the industries of the county. The Urban Electric Supply Company are at present constructing an electric tramway between Redruth and Camborne, whilst the Cornwall Electric Power Company have already obtained parliamentary powers, and have secured sites at Hayle and Par for transmitting currents all over the county. It will thus be seen that a field is being opened up for the introduction into Cornwall of electrical machinery and appliances for both industrial and domestic purposes.

Electricity at Earl's Court.—The illuminations at Earl's Court have to be seen in order to realise the magnificent effect they produce. The bandstands and the four different sections of the exhibition are each decorated on a different scheme, and each court literally outshines the other. Besides the already well-known electrical amusements, such as the electrophone, the electric launches on the lake, and the red dragon, an important addition is made by token of the Palais des Illusions. Here, by means of 3,500 incandescent lamps and a gamut of a number of well-blended colours, a symphony of light and colour is played, to witness which alone repays a visit to "Paris in London." The hall has many corners, and these, as well as the sides, are covered with mirrors reflecting endless garlands of lights. The pilasters around these are hollow and transparent, and also conceal lamps. Direct current taken from the ordinary supply is employed in producing the illusion. Another item on the bill is the Reno circular moving stair, on the principle of the ordinary Reno moving stair. When finished the travellers will pass through the pleasant scenery of valleys, where waterfalls are rustling, up into the rugged mountains. The air will get cooler as the ascent is made, which ends in a heavy fall of snow. This show is to be opened in about three or four weeks. The electrical arrangements are by Messrs. Vicor and Co., Grosvenor-road, Westminster; the timber construction is by the Reno Elevated Stairways Company, Limited, Finsbury-pavement; and the steel and iron construction by Messrs. Garton and Son, of New North-road, N.E.

Peru.—A Foreign Office report states that telephonic networks exist in the departments of Lima, Piura, La Libertad, Arequipa, and Ica. The total length of the wires is probably over 3,000 miles. Moreover, a number of applications for further authorisations to put up new installations have been made lately. Most of the telephonic appliances now come from Sweden. Only very small orders have been

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placed in the United Kingdom, on the ground that the instruments and appliances made by British manufacturers are quite unsuitable for use in this country. Inasmuch as the demand for telephonic apparatus must in the near future become very large in South America, this branch of industry may be deserving more attention than it appears to receive at present in the United Kingdom. In his report H.M. Consul-General at Callao says that the use of electricity for purposes of illumination is increasing rapidly in Peru. The town of Lima is now entirely lighted by electricity. This illuminant is also extensively used in private houses in Lima, and supplied by three companies. The town of Arequipa is also lighted to a considerable extent by electricity, and companies are being formed for lighting Callao, Trujillo, and Chiclayo in the same manner. The electrical plant chiefly comes from the United States. Notwithstanding the initial advantages possessed by the United States in the matter of electrical plant, it would seem that this is a branch of industry which fully deserves close attention on the part of British manufacturers, as the demand for electrical plant throughout South America must eventually become enormous. British machinery of this class is barely mentioned in this country. German dynamos and motors have been tried, but, although well finished, they are looked upon as being too complicated. It is also highly probable that a demand for power transmission lines for various purposes must arise sooner or later, as the natural configuration of the ground in this country can be turned to account for the development of immense power at comparatively little cost.

Chichester.—The City Council have adopted the following report of the Electric Lighting Committee: "This committee reported that the County of Sussex Electrical Power Distribution Company (who had recently laid down plant at Lewes) were prepared to offer terms for the transfer to them of the Corporation's electric lighting order, and as the committee were of opinion that the terms were as reasonable as could be got from any company, they recommended the Corporation to take such steps as might be necessary, and to transfer the order to the company, subject to a satisfactory agreement. The terms—which thus commended themselves to the approval of the committee—were, briefly stated, as under: (1) the company to repay the Corporation the costs (£300) incurred by the Corporation in obtaining the order. (2) The company forthwith to take steps, on the transfer of the order to them, to carry out works of electricity in the city, the execution of which will occupy about 12 months. (3) The company to have the right of purchasing the works from the company by valuation as a going concern at the end of 14, or 21, or subsequent years, in the usual way. (4) The capital expenditure to be taken as shown in the annual statements submitted to the Board of Trade, in either the fourteenth, twenty-first, or subsequent years. (5) As regards public lighting the Corporation were not bound to be customers of the company, but the latter would be prepared to supply energy by meter for public lighting or for all Corporation buildings and public places at the rate of 3d. per unit or the following fixed rates: for arc lamps burning up to 11 p.m., £15 each per annum, if fitted with two incandescent lamps to burn from 11 p.m. till dawn, an additional £2 per annum; for incandescent lamps each fitted with two 8-c.p. lights, and lit from sunset till dawn, 70s. per lamp per annum. For these fixed rates the company would provide, fix, and maintain the columns, and light and extinguish, while if the light be supplied by meter, the columns, etc., would have to be provided and maintained by the Corporation. (6) With regard to the cost of light to private customers the company would adopt the Brighton system of charging—*i.e.*, the charge would be 2½d. per unit for all current used by a consumer over and above a certain quantity in each quarter."

Bootle.—In his last annual report the electrical engineer (Mr. Dawson Clothier) gives a tabulated statement showing the operations of the department for the year ending March 31, 1902. We notice very satisfactory increases in all branches of the undertaking, with the exception of "work costs per unit," which have been slightly reduced. A clear profit of £1,483 has been made for the year's working after paying all charges. It is pointed out that the first instalments of capital required in payment are greater than should be made, having in view the nature of the undertaking, and that an endeavour is being made to get the present loan conditions altered. The following figures are given: first year—profit on working £480, interest £903, deficit £423, repayment £1,340, deficit £1,340; second year—profit on working £1,395, interest £1,259, balance £136, repayment £1,918, deficit £1,783; third year—profit on working £4,633, interest £1,232, balance £3,401, repayment £1,918, net balance £1,493. There is thus on the three years of working a credit balance of £3,114 after all interest charges have been paid, without taking into consideration the £5,176 debited on repayment account. The next feature in these statistics of most importance is the exceedingly low price received per unit sold on which this profit has been made. The average rate received from private consumers for electricity supplied was 3·4d. per unit. Of the 35 companies which supply electricity in provincial towns of which details are available, there is apparently only one which receives a lower average rate. Of the 91 corporations coming under the same heading there are nine which, with two exceptions, are amongst the largest cities and boroughs in the kingdom (Bradford, Brighton, Edinburgh, Glasgow, Manchester, Nottingham, Salford, St. Helens, and Stafford), so that it is obvious that the price of current charged to private consumers in Bootle compares very favourably with that charged in even the largest cities. In 1899 a scheme was sanctioned to lay mains in certain streets, at an estimated cost of £15,393. Part of this work only was carried out, and mains have been laid in streets not included in the scheme. Certain auxiliary machinery is required in the generating station, as the existing arrangements will be insufficient for next winter. The principal requirements are one boiler feed pump, one circulating pump, one settling tank, pipes, valves, etc., and increased coal storage. I estimate the cost of these at £1,000. The installation of coal-conveying gear is also recommended. Capital is required to meet the £2,006 over-expended on service charges, and a further sum of £1,000 is required to meet present and future service charges.

PROVISIONAL PATENTS, 1902.

JUNE 16.

13572. A new or improved electrically-operated hammer. Harry Benwell Stocks and Thomas McClelland De Bingham, 1, Princess-street, Manchester.

13593. Improvements in electric commutators. Carl Heinrich Prott, 221, Alleestrasse, Barmen, Germany. (Complete specification.)

13604. Electric incandescent lamp. Giovanni Bellina, 9, Dartmouth-road, Brondesbury, London.

13612. Improvements in and relating to electric fire-alarms. Harold Hawthorn, 322, High Holborn, London.

13626. Improved manufacture of hydroxylamine and chlorine by electrolysis. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Farbwerke vormals Meister, Lucius, und Brüning, ——.)

13658. Improvements in and relating to electric switches. William Sevenoakes, 70, Chancery-lane, London.

13663. Improvements in differential thermometers adapted for use as maximum electric demand indicators. Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

JUNE 17.

13713. Improvements in electric lampholders. Thomas Chalmers, 18, Cowdor-road, Fallowfield, Manchester.

13727. Improvements in electric snap switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank L. Fenn, United States.)

13728. Improvements in electric push-button switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin G. Kastenhuber, United States.)

13729. Improvements in trip coils for electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John D. Hilliard, jun., United States.)

13730. Improvements in perforating glass bulbs. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William R. Burrows, United States.)

13731. Improvements in globeholders for electric arc and other lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.)

13732. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Harthan, United States.)

13733. Improvements in train-signal systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis, United States.)

13734. Improvements in electric transformers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter S. Moody, United States.)

13737. Improvements relating to systems for electrical distribution. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

13738. Improvements in electric hoisting apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

13739. Improvements in and relating to insulating material. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

13740. Improvements relating to electric traction. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

13741. Improvements in and relating to electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

13742. Improvements in systems of electrical distribution. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

13743. Improvements in motor-controlling devices. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

13749. Improvements in galvanic batteries. Charles Henry Graham and George Dickson Bouton, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13759. Improvements in electric current-taking devices. Cipriano Portillo, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 14, 1902, being date of application in Spain.) (Complete specification.)

13787. Improvements in electric railways. Ed. Wilson Farnham, 18, Buckingham-street, Strand, London. (Complete specification.)

13789. An improved connecting rod for connecting telephones and telegraphic instruments to overhead conductors. Christian Dietz, 18, Buckingham-street, Strand, London.

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13776. Thurston's magic electric fountains. Howord Thurston, 17, Passage, Saulnier, Paris.

JUNE 18.

13792. A new or improved fault indicator for electric circuits. Michael Birt Field, 94, Hyndland-road, Kelvinside, Glasgow.

13795. The free wheel magneto fire-alarm. Julian Thomas Mill, 37, Lynette-avenue, Clapham Common, London.

13797. Improvements in connection with enclosed spring swivelling trolley standards and trolley heads for electric locomotives, cars, or trucks. Thomas Ernest Raymond Phillips and Frederick Alexander Moore Allingham, Finsbury-pavement House, London.

13802. A speed indicator for electric tramcars, trains, and locomotives. John Robert Crisp and James Foster Moore, 11, Beatrice-street, Sunderland.

13814. Improvements in travelling electric lighting devices. William George Inglefield, 55, Market-street, Manchester.

13851. Improvements in electric motor controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John B. Sinn, United States.)

13852. Improvements in electric switches or circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Robert H. Read, United States.)

13853. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett and Theodore E. Button, United States.)

13853. Improvements in electric switches worked by electromagnets or solenoids. Siemens Bros. and Co., Limited, Luiz Moraes Gomez Ferreira, and Robert Wilkie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13858. An electric light carrier ring adjuster and ring. John William Kirk, 32, Countess-road, Kentish Town, London.

13868. Improvements relating to electric current-taking devices. Henri Beau and Cipriano Portillo, 45, Southampton-buildings, Chancery-lane, London.

13877. Improvements in or relating to electric railways. Alfred Julius Boult, 111, Hatton-garden, London. (Luigi Negro, Italy.)

JUNE 19.

13882. The generation of electric, pneumatic, hydraulic, hydrostatic, and mechanical power by gravity and momentum. Charles Thornton, 2, Grove-hill-road, Camberwell, London.

13914. Improvements in and connected with telephone connections on the party-line system. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellshaft Mix und Genest, Germany.)

13922. Improvements in electric signalling apparatus for use on and in connection with railway locomotive engines and the like. Alexander Joseph Bounevialle and Alexander Charles Bounevialle, 4, Danes-inn, Strand, London.

13933. Improvements in variable-speed, direct-current shunt motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.)

13934. Improvements in electric current transformers for high-voltage circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Augustine R. Everest, United States.)

13945. Improvements in electric arc lamps. Hugo Bremer, 38, Neuenweg, Barmen, Germany. (Complete specification.)

13950. Electromagnetic machine. Adolph M. Ponti, 29, Cranbury-road, Eastleigh, Hants.

13956. Improved thermo-electric indicator. Lionel William Winship, 322, High Holborn, London. (The Firm of Antoine Heinz et Cie., Belgium.) (Complete specification.)

13961. Improvements in and relating to means or apparatus for measuring or indicating alternate currents. Arthur Francis Berry and the British Electric Transformer Manufacturing Company, Limited, 46, Lincoln's-inn-fields, London.

JUNE 20.

14001. Improvements in electromagnetic brakes. Joseph Gershom Childs, 145, Farringdon-road, London.

14002. Improvements in or relating to telephotographic or tele-autographic apparatus. Alfret Julius Boult, 111, Hatton-garden, London. (Laurent Sémat, Egypt.)

JUNE 21.

14109. Improvements in electromagnets. Illius Augustus Timmis and Edgar William Timmis, 2, Great George-street, Westminster, London.

14112. An improvement in miners' electric lamps. Henry George Prested, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14133. Improvements in connecting carbon electrodes with electric leads. Harry Baker and the Castner-Kellner Alkali Company, Limited, 55, Chancery-lane, London.

14134. Improvements in and connected with carbon electrodes. Andrew Thomas Smith, Harry Baker, and the Castner-Kellner Alkali Company, Limited, 55, Chancery-lane, London.

14129. Improvements in relating to printing by electricity in colours. William Friese-Greene, Millbrook, Dovercourt.

14135. Improvements in electrolytic cells. Harry Baker, Andrew Thomas Smith, and the Castner-Kellner Alkali Company, Limited, 55, Chancery-lane, London.

14136. Improvements in telephones for diving and like purposes. William Augustus Gorman and Alfred Graham, 4, South-street, Finsbury, London. (Complete specification.)

14138. Improvements relating to apparatus for controlling electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, U.S.A.)

14139. Improvements in apparatus for regulating electric currents. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, U.S.A.)

14140. Improvements in electrical indicators. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, U.S.A.)

14141. Improvements in or relating to electric switches and motor-starting devices. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, U.S.A.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 10.

1901.

7617. Electric meters. John Vaughan-Sherrin.

12023. Mechanically-operated and electrically-controlled alarm apparatus. Kielpinski.

12350. Revolving electric igniters for internal-combustion engines. Ronan.

13662. Electrolytic cells. Raschen and United Alkali Company, Limited.

13738. Means for preventing sparking at the collector of dynamo-electric machines. Heyland.

14551. Suspension gas lamps, chandeliers, brackets, electric light fittings, and the like. Barwell, Barwell, Kimberley, and Smith.

15460. Electric clocks. Wise. (Actiengesellschaft "Magneta" (elektrische Uhren ohne Batterie und ohne Contacte.)

15463. Secondary battery plates. Kuettner.

15475A. Synchronising dynamo-electric machines or motors. Justice. (Rowland Telegraphic Company.) (Date claimed under Patents Rule 19, July 30, 1901.)

15659. Lighting of railway tunnels by electricity. Westinghouse.

16629. Internal-combustion engines. British Westinghouse Electric and Manufacturing Company, Limited. (Arnold and Kasley.)

16911. Plug and socket detachable switch for electrical connections. Heaton and Smith.

17381. Electric lighting of railway carriages. Mawson and Mirza.

23294. Earth conductors for lightning conductors. Immisch.

1902.

1402. Means for operating the "points" of the overhead wires and of the rails on electric tramways. Collins and Collins.

4445. Automatic telephone system. Faller. (Date applied for under International Convention, Aug. 22, 1901.)

4865. Automatic circuit breakers of induction apparatus. Barreto.

5468. Trolley heads for electric tramcars. Willenbücher.

5982. Electric telegraph systems and relating more particularly to wireless systems. Shoemaker.

7689. Electric signalling on railways. Struble.

8190. Controlling means for electric motors, the invention being applicable to electric elevators. Otis Elevator Company. (Otis Elevator Company.)

8653. Holders for electric lamp shades, reflectors, and the like. McIntyre.

9325. Insulating tubes for the windings of electric machines, such as motors and the like, and the process of making same. Meirowsky.

9800. Switch or ringing keys for telephone switchboards. Ericsson.

9812. Electrolytic production of a bleaching liquor and caustic alkali lye and apparatus employed therein. Boult. (Seibert and Tempel.)

10532. Portable secondary or other electric batteries, accumulator plates, and the like. Bristol.

10538. Trolleys for use with overhead conductors in electric traction. Stoll.

11072. Switches for electric circuits. British Thomson-Houston Company, Limited. (Wood.)

11290. Electric switches and regulating sockets chiefly designed for use in connection with incandescent electric lamps. Lake. (Pinckard.)

11340. Dry or semi-dry cells of primary or secondary electric batteries. Heys. (Hutchison Acoustic Company.)

11342. Charging switches for secondary electric batteries. Heys. (Hutchison Acoustic Company.)

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	June28	5,878	4,727	+ 1,151	124,040	112,830
Blackburn Corporation	,, 27	1,195	621	+ 574	18,497	15,551
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 28	946	940	+ 6	9,261	9,956
Bolton Corporation	,, 29	2,519	1,575	+ 944	38,224	36,318
Bradford Corporation	,, 22	3,288	927	+ 2,361	60,738	21,722
Bristol Tramways Company	,, 27	5,480	4,743	+ 737	—	—
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 28	10,011	6,145	+ 3,896	179,437	161,183
City and South London Railway	,, 29	2,880	1,875	+ 1,005	77,345	51,014
Cork E. T. and L. Company	,, 26	660	558	+ 101	11,427	10,949
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 28	294	239	+ 55	5,051	4,853
Dublin & Lucan Electric Railway	,, 30	179	120	+ 59	2,611	2,491
Dublin U. T., electric cars	,, 27	4,503	3,965	+ 538	—	—
Dublin S. District, Electric	,, 27	1,254	943	+ 311	—	—
Dundee Tramways Company	May 14	647	678	- 31	—	—
Glasgow Corporation	June28	13,217	11,988	+ 1,229	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 25	2,181	1,645	+ 536	22,331	21,495
Liverpool Corporation	,, 14	9,277	9,125	+ 152	218,811	202,839
Liverpool Overhead Railway	,, 29	1,693	1,696	- 6	37,488	40,981
Newcastle-on-Tyne Corporation	,, 28	4,238	—	—	—	—
Portsmouth Corporation	,, 14	1,450	652	+ 798	—	—
Sheffield Corporation	,, 29	4,965	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Sunderland Corporation	,, 29	1,871	1,251	+ 620	14,889	13,201

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £169 increase.
Barcelona Ensanche y Gracia, £93 decrease. Barcelona £199 increase.
Brisbane, £479 increase (month of May, £10,832; decrease, £573).
Buenos Ayres and Belgrano Electric (month of May, receipts £12,454; increase £322), £273 increase.
Calcutta, £246 increase.
Cape Town (month of May), receipts, £16,330; expenditure, £7,205.
Isle of Thanet Electric, £145 decrease
Mexico Electric (month of May), receipts, £20,390; expenditure, £11,400.
Perth Electric, £28 increase.
Port Elizabeth (month of May), receipts, £3,796; expenditure, £1,872.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Insulated Wire, Ord., 1-70,000	5 ..	7½-8½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6
—— 5 per cent. Mortgage Debentures	100 ..	100-103 xd
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5⅞-6¼
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2 ..	1⅞-2¼
—— 4½ per cent. 1st Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99 xd
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	16-17
—— 5 per cent. Pref.	5 ..	5¼-6 xd
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	100 ..	101-106 p.c. xd
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	1½-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	73-77 xd
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼ xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	16 17 xd
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22 xd
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15¼-16¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	101-104 xd
Telegraph Manufacturing, Ordinary	5 ..	—
—— 5 per cent. Cum. Pref.	5 ..	—
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	105-107
Electric Railways.—		
Central London, Ordinary	100 ..	105-108
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	117-120
City and South London, Consolidated Ordinary	100 ..	72-75
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	128-131
—— ,, ,, ,, '01	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	93-96

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	101-104 xd
Brompton and Kensington, Ordinary	5 ..	9-9½
—— 7 per cent. Preference	5 ..	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8½-9½
—— Nos. 20,001-30,000	5 ..	8½-9¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, £10 Ord.	6 ..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-107
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5½-5⅝
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107 xd
Chelsea Electricity Supply	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12½
—— 5 per cent. Debenture Stock	100 ..	123-128 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	7⅞-8¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	108-111 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6½
—— 6 per cent. Cum. Pref.	5 ..	5⅞-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	108-111
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	99-102 xd
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5⅞-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	94-99
Metropolitan, Ordinary	10 ..	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113 xd
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100 xd
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅞-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2⅜-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8½-9½
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3¼-3½ xd
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4¼-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130 xd
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	104-107 xd
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¾-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	12-12½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105 xd
—— Prov. Cert., all paid	100 ..	95-98 xd
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	4¾-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	10¼-11 xd
—— ,, ,, ,, ,,	5 ..	8-8¼ xd
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	105-107 xd
—— ,, ,, Prov. Crts.	50 ..	79-81 xd
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98 xd
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅞
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102 xd
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	107-110
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	12s. ..	⅜
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	60 p.c.	60 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Preferred, 590,001-790,000	3½ ..	4⅛-4¼
—— Deferred Stock	100 ..	53-57
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅛-5¼
—— 3½ per cent. Deb. Stock, Red.	100	93-96
—— 4 per cent. Deb. Stock, Red.	100	102-106
Oriental Telephone and Electric Company	1	15/16-1 1/16

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NOTES.

Staff Dinner.—The annual staff dinner of the British Electric Traction Company and associated companies has been fixed for Friday, the 25th inst., at the Criterion Restaurant, Piccadilly-circus.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 7th inst, the Duke of Northumberland in the chair. Mrs. Baily, Miss L. M. Burnett, Sir Ernest Cassel, K.C.M.G., Lady Kelvin, Miss F. A. Musgrave, Mrs. E. Otter, and Mr. E. Schweich were elected members.

Books Received.—We have to acknowledge the receipt of vol. xxvii. of the "Encyclopædia Britannica," published by Messrs. Adam and Charles Black for the *Times*. We hope to give an extended notice of this latest issue in a future number of the *Electrical Engineer*. We have also received this week the "Record of Transactions" of the twentieth session (1900-1901) of the Institution of Junior Engineers.

University College, Liverpool.—The Walker engineering laboratories at the above college have lately undergone some important extensions to meet the demand caused by the greatly increased number of advanced students. These extensions, the cost of which has been borne by Sir John Brunner and Messrs. E. K. Muspratt, Chas. W. Jones, and R. Rathbone, were opened by the Lady Mayoress of Liverpool the other day, and are now in constant use by the students at the college.

Electrical Patents in Germany.—The following figures, which we take from the *Elektrotechnische Anzeiger*, give a good idea of the growth of patents taken out for electrical inventions during the last decade in Germany: 1891, 567; 1892, 563; 1893, 575; 1894, 603; 1895, 666; 1896, 724; 1897, 931; 1898, 1,213; 1899, 1,410; 1900, 1,565. It will be noticed that the increase during the first five years was but small, while from 1896 to 1899 the number has doubled, and the year 1900 shows three times the amount of 1891. The details for 1900 are as follows: telegraphs and telephones, 283; primary batteries and accumulators, 208; thermopiles, cables, and distributing system, 368; motors and distribution accessories, 199; meters, etc., 149; lighting, 250; auxiliary apparatus, 58; heating and cooking, 50.

Fothergill Prize.—The council of the Society of Arts offer the Fothergill prize of £50 and a silver medal for a paper on "Existing Laws, By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions." The paper should consist of about eight to ten thousand words, and be written with a view to its being read and discussed at an ordinary meeting of the society. Papers submitted for the prize must be sent to the secretary on or before Oct. 1, 1902. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto. The judges will be appointed by the council. The council reserve the right of withholding the prize, or of awarding a smaller prize or smaller prizes if in the opinion of the judges no paper deserving the full award is sent in.

Exhibitions in Science.—The Technical Education Board for the county of London has awarded 161 evening exhibitions in science and technology on the result of the recent competitions. It is satisfactory to note that the number of candidates this year is considerably in excess of those who entered last year, being 574, as compared with 491. The Board offers for competition each year 100 exhibitions (Class A) to candidates who have been pupils at evening continuation schools for two years and are under 17 years of age on June 1, and 100 exhibitions (Class B) to other candidates, mostly students of polytechnics and technical institutes. Of the 161 exhibitions awarded 21 come under Class A and 140 under Class B. In the competition candidates are examined both in the general subject of electrical engineering and electrical instrument making.

Power Transmission in India.—The Cauvery Falls electrical power transmission works, which have taken just under two years to construct, will, we learn, be brought into operation this month. The plant is designed to generate 4,500 h.p. for transmission over a distance of more than 90 miles to the heart of the Kolar goldfields, where it will be distributed among 10 gold mines, the best known of which are the Mysore, Ooregum, Nundydroog, and Champion Reef. The transmission line, consisting of telegraph posts carrying six strands of copper wire, runs through extremely hilly jungles infested by the tiger, panther, and bear, from which may be gathered some idea of the difficult nature of the work which had to be accomplished. The fact that the nearest railway station to the power station is some 30 miles distant also led to considerable trouble in getting supplies, and tame elephants were requisitioned to help to convey the machinery from the railway to the centre of operations. With the completion of the work this month it is hoped that the greater part of the mining machinery on the Kolar goldfields will be worked by electric motors, the necessary power being generated at the falls 92 miles away.

The World's Copper Output.—Recent statistics show that the total production of copper in all parts of the world in 1901 was 512,131 tons, as compared with 486,039 tons in the previous year. America produced the largest quantity of any other country, being responsible for an output of no less than 262,206 tons, a decrease, however, of about 6,000 tons on the previous year's figures. Next in order of production come Spain and Portugal, with an output of 53,621 tons, and Australasia third, with 30,785 tons, as compared with 23,000 in 1900. This large increase is mainly accounted for by the flotation of many new mining companies in Australasia and the high price of copper in the year 1900-1. Fourth on the list is Chili, with an output of 30,000 tons; Japan fifth, with 27,475 tons; Mexico sixth, with 23,795 tons; and Germany seventh, with a production of 21,720, showing a slight increase over last year. Canada, with an output of 18,800 tons last year, ranks eighth in order of production, showing a striking advance upon the total for 1900, which only amounted to 8,500 tons. Peru occupies ninth place, having produced 9,520 tons in 1901, and Russia is tenth, with an output of 8,000 tons. The eleventh place is filled by South Africa, which yielded an output of 6,400 tons, a decrease of 320 tons on the previous year's production. Each of the remaining countries produced less than 5,000 tons, the output of the United Kingdom being estimated at 600 tons.

The Storage Battery.—At the annual convention of the Canadian Electrical Association held in Quebec last month, a paper was read by Mr. A. A. Dion on the use of storage batteries in electric distribution systems. From the abstract of the paper before us we gather that the author offered some explanation of the bad reputation which the electric storage battery has gained in many quarters. Nothing, he said, had contributed so much to their bad reputation as the failures which followed their adaptation to city traction systems in the storage battery car. This service had been found too severe for the batteries, as they were then made, just as the first electric

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motors employed in electric traction work were found to be inadequate for good and reliable service. After many types had been brought out the range of application had been narrowed, and the battery not allowed to be sold for purposes to which it was not adapted, and the electrical engineer could not now afford to ignore the storage battery as a factor in the design of electrical plants for railway, light, or power supply. Storage batteries, he concluded, might be used in connection with direct-current generation and distribution for light and power service, for railway service, alternating-current generation and transmission, and direct-current distribution for railway service; alternating-current generation and transmission and direct-current distribution for light and power service; and for alternating-current generation and distribution for light and power service.

Coronation Illuminations.—In reply to enquiries sent out by us a week or two ago, we have received some interesting statistics from several of the electric lighting undertakings in London as to the equivalent number of 8-c.p. lamps which would have been brought into use for decoration purposes in addition to those already on the mains in connection with the Coronation celebrations, had they taken place as arranged. From the figures supplied us we gather that the number of lamps either connected or for which arrangements had been made for connecting, was close upon 75,000. These were distributed in the following districts: Notting Hill, Chelsea, Woolwich, Islington, Kensington, Knightsbridge, and Shoreditch, and the areas served by the City of London Electric Lighting Company and the London Electric Supply Company. The former of these two companies was responsible for some 30,000 lamps, while next in numerical order is the London Electric Supply Company with 20,000 lamps. In Shoreditch, Notting Hill, and Woolwich very little was done in the way of electrical illuminations, the total number of 8-c.p. lamps for these three places being only about 3,700. Chelsea, however, had 5,000, Islington 5,400, and Kensington and Knightsbridge 8,500 lamps. It will be seen from the above that the total of 75,000 does not by any means cover all the principal areas in London where arrangements had been made to illuminate in Coronation week, but the figures given will serve to show the extent to which electricity would have been employed in London for illumination purposes but for the unhappy postponement of the Coronation.

Society of Arts.—The council have awarded the society's silver medal for the following papers read before the society during the session 1901-2: to J. Gordon Parker, Ph.D., for his paper on "Leather for Bookbinding"; to Herbert Stone for his paper on "The Identification of Wood, and its Application to Scientific and Commercial Purposes"; to Prof. George Forbes, F.R.S., for his paper on "Range Finders"; to Prof. Roberts Beaumont, M.I.Mech.E, for his paper on "Recent Inventions in Weaving Machinery"; to E. Price-Edwards, for his paper on "Sound Signals"; to J. Clifton Robinson, A.I.C.E., M.I.E.E., for his paper on "Electric Traction: London's Tubes, Trams, and Trains"; to Major-General Sir John F. Crease, K.C.B., for his paper on "Ceuta and Gibraltar"; to Edward T. Scammell, for his paper on "The Timber Resources of the Australian Commonwealth"; to H. Warington Smyth, for his paper on "Boats and Boat Building in the Malay Peninsula"; to Prof Wyndham R. Dunstan, F.R.S., for his paper on "The Coal Resources of India"; to Thomas William Holderness, C.S.I., for his paper on "The Indian Famine of 1899, and the Measures taken to meet it"; to Thomas Jewell Bennett, for his paper on "The Past and Present Connection of England with the Persian Gulf"; to Commander B. Whitehouse, R.N., for his paper "To the Victoria Nyanza by the Uganda Railway": to W. T. Preston, for his paper on "The French-Canadian Relationship to the Crown"; to Halsey Ricardo, for his paper on "The Architect's Use of Enamelled Tiles"; and to Rev. Henry Thurston, S.J., for his paper on "The History of the Rosary in all Countries."

Heyland Induction Motor.—In a paper presented to the Electrical Society of Vienna Mr. Bresslauer discusses the merits of the Heyland induction motor. After describing the principles of the motor for three-phase currents, he remarks that he has found Heyland's theory fully confirmed by tests with an experimental motor, and points out the following advantages for the construction: it is no longer necessary to be as careful concerning the diminution of leakage and air-gap; the number of slots, which had to be made very high on account of leakage, can be essentially diminished; the motor becomes cheaper. He thinks, however, that Heyland's principle will be of still greater practical importance for the construction of generators. In the generator, however, a compound winding is to be added; this is the ideal method of compounding. The author further states that Heyland has informed him that a 500-kw generator designed according to this principle has been tested, and found to be very satisfactory; compounding was successful for a power factor equal to unity as well as for one equal to zero; he emphasises this point because this has never before been accomplished in alternating-current generators. Heyland generators can easily be operated in parallel. In the discussion which followed the reading of the paper, some questions brought out the fact that the no-load current in the experimental motor dropped from 15 amperes to 3 amperes, when the Heyland compensator was set into service; the current in the leads to the brushes was 250 amperes; the part of the stator winding which has to carry this current is made a bar winding with a few turns; the other part of the stator winding is made of wire of smaller cross-section.

A Post Office Retirement.—We understand that the retirement has recently taken place from the Post Office of Mr. C. T. Fleetwood, the superintending engineer of the metropolitan district. Mr. Fleetwood's first connection with the telegraph was on his entering the service of the Electric and International Telegraph Company in 1854 When, in January, 1870, the transfer of the telegraph undertakings to the Government took place, Mr. Fleetwood was responsible for concentrating the systems of the companies and making provision for the large increase of circuits attending the transfer. Three years later, on the special recommendation of Dr. Lyon Playfair, then Postmaster-General, he was appointed to supervise the wiring and transferring of the whole of the circuits from the central station in Telegraph-street to the present station in Newgate-street, commonly known as the General Post Office West. Mr. Fleetwood also rendered excellent service to his department at the time of the Diamond Jubilee, receiving the thanks of the Postmaster General for the successful way in which he provided a large number of circuits at very short notice. In connection with this part of his work an interesting anecdote is related in the *Times*. On the occasion of the Diamond Jubilee Queen Victoria wished to send a message to the Colonies on setting out from Buckingham Palace, and to meet this requirement five circuits were provided from the central station to five submarine cable offices. Mr. Fleetwood happened to have in his possession pieces of the original five wires laid underground by Messrs. Cooke and Wheatstone in 1837 between Euston and Camden Town. One

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of these wires was inserted in each of the five circuits, and thus the Queen's message of 1897 passed through the original telegraph wires laid in 1837.

Electric Lighting by Traction Companies.—In the course of an article in the *Street Railway Review*, Mr. Adams discusses the growing tendency of traction companies to try to obtain a lighting load. The author is of opinion that such a load would often be of great advantage, as it would afford a source of large income at a comparatively small increase of fixed charges. Taking the present generating equipment of traction systems, general demands for electric light and power may be safely supplied in either of the following two ways: If the terminals of each 500-volt direct-current dynamo are brought to a double-pole switch, trolley feeders and track may be connected to one side of this switch and an entirely independent set of circuits for general light and power service to the other. A single throw of the switch for any dynamo connects it to either the traction or the lighting system, so that any of the station dynamos may be operated singly or in multiple on either the lighting or the traction load. The 500-volt current would be at once suitable for motors and for enclosed arc lamps, connected four or five in series. For incandescent lamps a three-wire system would be most suitable, a motor-generator being used for balancing; such a system with 500 volts between the outers could economically distribute energy for lighting and power to a distance of at least three miles from the station. This system, however, requires a separate set of conductors for the lighting service, which, in many cases, would mean a large increase of investment. To make use of existing 500-volt dynamos and of feeder circuits in traction systems for electric lighting at any points to which these circuits extend, small sub-stations are necessary, containing one or more motor-generators and a storage battery. In fact, Mr. Adams advises what is the usual practice in this country for combined lighting and traction stations.

Signal Apparatus.—In a paper recently presented before the Berlin Electrical Society, Mr. Heubach described a new electric signal apparatus, as used more especially on ships for transmitting rudder signals. The voltmeter principle is used, but for this purpose a strong damping effect must be provided. The arrangement is shown in a diagram, from which it seems that the transmitting device consists of a number of resistances bridged across two feeders, and a handle which can be turned round. It is evident from the diagram that the voltmeter measures the E.M F. between the fixed point and the variable point, to which the handle is connected. In practice a receiver and a transmitter are placed at both ends; the officer in charge gives a signal to the attendant, who in turn sends it back, so that the correct understanding of the transmitted signal is guaranteed. Two diagrams are given which show two different forms of connection for this purpose. To get a good damping effect, a short needle is used, and a large scale is obtained by a special arrangement of the pole-pieces. The instrument is practically free from errors due to insulation faults. When storage batteries or motor-generators are used for supplying the current to the signal apparatus, the errors due to variations of voltage are avoided, because motor-generators can be so designed that the dynamo delivers current at approximately constant voltage, while the voltage of the current which feeds the motor varies considerably. In cases in which the current for the signal apparatus is taken directly from the lighting circuit, they use either special iron rheostats or insert into the feeders a small series motor, the counter E.M.F. of which varies and counteracts the variations of the supply of voltage. In closing, the author discusses at some length telegraph apparatus to the boiler-rooms, and describes some special arrangements for this purpose.

An Electric Target.—An ingenious electric target, which is so devised that the hits are registered by an annunciator, is the invention of two Frenchmen, Chas. Chevallier, a captain in the army, and Mr. Eugene Cadet. A description of the target in the *Scientific American* shows that the structure itself consists of two sets of metal panels of segmental form, arranged in different vertical planes. One series of segments overlaps to a certain extent the next series of segments in order that an entirely full surface may be presented to the marksman. Behind each series of segments lies a fixed disc, serving as a guide and support for rods secured to the segments. Coiled springs are placed between the segments and the disc, in order to return the segments after they have been driven in by a projectile. Opposite each rod, secured to the segments, is the electric contact device, which consists of a screw mutilated for about $\frac{7}{16}$in. In its normal position an insulated plate, having threads of a corresponding pitch to those of the screw, lies opposite the neck thus formed in the screw, and is, therefore, out of contact with the screw. The vertical screw turns in a fixed nut or support. The upper part of the screw is fitted with a cross-piece, provided with counterweights at its ends, so as to form a balance member. The insulated plate constitutes one terminal of the circuit, the wires being secured to the other terminal. The wires are equal in number to the other segments of the target, and are assembled together in a cable leading to an annunciator of ordinary construction placed near the marksman. He can thus ascertain at a glance what his success has been without moving his position. When the projectile strikes one of the segments, one or more of the springs coiled about the rods are compressed, and the corresponding rod or rods are driven in through the perforations of the disc and strike the counterweights of the balance member. The impulse thus given to the balance member causes the screw to turn and rise. The lower threaded part of the screw is then engaged in the screw threads of the plate, and the circuit is completed. The target is often made in the shape of the human body, which lends more realism to the practice than if ordinary discs be employed.

Telephone Development in the West.—It is instructive to compare the state of the telephone industry in this country with that obtaining in other countries, and for this purpose it would be hard to find a more typical example of American practice than the State of Indiana, in the Middle West. Prior to 1895 the well-known Bell Company had the monopoly in this State, but when the basic patents expired numerous smaller telephone companies were formed, and this policy was continued until by 1897 they had grown to a considerable total. Since then this development has gone on, and at the present time the independent telephone companies of Indiana are doing business through 169 exchanges. In the 92 counties of the State the number of their telephones in use is about 55,000, and the amount of capital invested about 2½ millions sterling. In the meantime, however, the Bell Company have been excited to greater activity, and have increased their service, now having about 22.000 telephones in use throughout the State at about 60 exchanges. The result of this competition is that for a population of 2½ millions there are at the present time nearly 80,000 telephones, or about one to every 30 persons. The effect on the price has also been most marked. In the capital city, Indianapolis, the charge is £8 a year for unlimited use in business offices, and just under £5 a year for a similar service in residences. In the smaller exchanges the rate

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ranges from 4s. to 8s. per month, or from £2. 8s. to £4. 16s. a year. It is noteworthy that of the entire number of telephones, more than one-fifth are in farmhouses, and, of course, these are charged for at the lower rate. The long-distance charge has also been reduced by about 40 per cent. since the independent companies came into the field. With a minimum of 2½d., the average charge for longer distances is about ⅛d. per mile—*i.e.*, for any ordinary distance outside of the local exchange the rate would be 2½d., up to 30 miles 5d., up to 45 miles 7½d., and so on. It is interesting to read that so far there is no decided tendency towards making a combination or a trust, although in the future it is predicted that the independent companies will probably perfect an organisation on the same lines as those which have already been carried out in some 50 separate States and territories in America. At present, however, the telephone business in Indiana remains one of the best examples of the beneficial effects of active competition.

Repayment of Loans.—Although the report of the Select Committee of the House of Commons on the repayment of loans by local authorities, issued on Saturday last, does not directly refer to the electrical industry, it has an important bearing upon the subject of the repayment of loans raised by municipalities for the purposes of electrical enterprise in the United Kingdom. The committee was appointed to consider whether any relaxation of the conditions limiting the periods for repayment of loans was desirable, and whether uniformity of practice could be secured in this matter. The first important recommendation made by the committee in their report is that the maximum period for repayment of loans raised under either the Municipal Corporations Act, 1882, the Local Government Act, 1882, or the Municipal Corporations (Ireland) Act, 1843, should be extended to 60 years. Other recommendations of general importance are to the effect that some postponement of the payment of the first instalment should be allowed in the case of certain works; that the sanctioning authority should be empowered to fix the method of repayment in all cases, and to provide for the establishment of a repairs fund where necessary; that the Commissioners for Public Works for Ireland should be empowered to lend for a maximum period of 60 years; that Private Bill Committees should, except where they undertake detailed enquiry, leave the fixing of the exact periods for repayment to a Government department; and that five years should be the ordinary maximum period for repayment of loans for the cost of promotion of private Bills. It is further recommended that Standing Order 173 of the House of Commons should be amended with reference to the raising of loans by private Bill. The committee are aware that in many cases, where general statutes are not applicable, or the limits of the borrowing powers given by those statutes have been exhausted or are not sufficient to cover the desired new loan, local authorities must obtain permission to raise the loan by private Bill; but they recommend that the Standing Orders of the House should be so altered as to prohibit this method of obtaining borrowing powers being used in any case where legal necessity for it does not exist. The committee also make various recommendations in regard to loans under the Housing of the Working Classes Acts, one of which is that the maximum period for the repayment of loans for actual rehousing operations should be fixed at 80 years.

Physical Society.—At the ordinary meeting of the above society held on the 20th ult., a paper by Prof. R. W. Wood on "The Electrical Resonance of Metal Particles for Light Waves" was read by the secretary. This is the second communication that Prof. Wood has contributed on the subject to the meetings of the Physical Society. In his previous paper the author showed that granular deposits of the alkali metals exhibit brilliant colours by transmitted light. These colours were referred provisionally to the electrical resonance of the minute particles for light waves. The present paper gave an account of experiments made with gold and silver films to determine whether the reasonance is molecular, or whether it is an electrical vibration of metallic masses, smaller than the light waves, though of the same order of magnitude. Further investigations on the dispersion of the films and a more careful study with polarised light will doubtless throw light on the matter. At the same meeting Prof H. L. Callendar showed a "Simple Apparatus for Measuring the Mechanical Equivalent of Heat." A cylindrical brass calorimeter is rotated by hand about a horizontal axis at a moderate speed. Unequal weights are suspended from the ends of a belt slung over the cylinder. Stability of equilibrium is secured by making the two halves of the belt of different materials and connecting the side having the smaller coefficient of friction to the larger weight. The weights are adjusted by trial to suit the friction of the belt, and may be varied within wide limits, provided that the ratio is kept nearly the same. The advantages of the methods are: (1) the friction is very nearly independent of the speed; (2) the balance is automatic; the belt immediately adjusts itself to any change of load or friction; (3) there is no change in the thermal capacity of the calorimeter with change of speed or load; (4) there is no pull or bearing friction to introduce errors; (5) there are no forced vibrations, and no dashpot is required; (6) the actual torque may be measured statically if desired. The rise of temperature is observed by means of a bent platinum thermometer inserted through a hollow axle on one side. The external loss of heat can be eliminated by Rumford's compensation method, or by performing two experiments with different loads on the belt. The motion of the surface of the calorimeter eliminates the effect of draughts and convection currents, so that the heat loss is much more regular than if the surface were at rest. The society adjourned until Oct. 24 next.

Rating of Incandescent Lamps.—At the recent Cincinnati convention of the American National Electric Light Association a specially appointed committee presented a report, in which they made certain recommendations with regard to the basis of rating for incandescent lamps. With respect to the manner in which incandescent lamps shall be tested, the committee adhered to the opinion that, while in theory the mean spherical candle-power should be the final test for luminous radiation of incandescent or other lamps, until such candle-power can be determined by more correct and precise processes than are now commercially available, it is best to depend upon the mean horizontal candle-power, to be determined by rotating the lamp in the manner heretofore suggested and in general use. Obviously, such a measurement does not place lamps with all possible shapes of filament on a parity, but it does treat with substantial justice ordinary commercial incandescent lamps, and, moreover, it corresponds to the way in which other illuminants—competitors of the electric lamp—are habitually measured. Cases will undoubtedly arise in which candle-power in some specified direction may demand the consideration of the members of the association. In all cases where directed candle-power—as contra-distinguished from distributed candle-power—is to be considered, the only possible way of placing various illuminants on a parity is to measure their intensity in the direction in which a specialised radiation is wanted, including in such measure-

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ment the effect of all devices intended to produce directed illumination, such as reflectors, special globes, and special positioning of the light-giving parts of the lamp with reference to intensity in particular directions. The great bulk of all lighting done is distributed lighting, and for this purpose the committee believed that the mean horizontal candle-power rating should be adhered to, while for the special problems of directed lighting all means for securing unusual intensity of illumination in some particular direction of the lamp ought to be included and placed on a parity. For example, rating a Nernst lamp—which is deliberately intended to give a downward hemispherical distribution—on its mean horizontal candle-power would be manifestly unfair; while if a lower hemispherical distribution is for any particular purpose desired, it would be equally unfair to deny to incandescent lamps the privileges of using reflectors or similar means of turning downward the luminous energy, which would otherwise not be radiated in the direction contemplated. In other words, the committee thought that a logical distinction can be drawn and should be made between general and directed illumination. Lights designed for the former class of work can be conveniently measured in a single conventional zone, while in directed illumination the only fair programme is to compare lights on the basis of the directed beam which is desired for practical use.

Patent Law.—The Bill brought in by the Government for amending the law relating to patents passed its second reading in the House of Commons on Friday after considerable amendment. As originally framed the measure met with considerable opposition, and, as was recently noted in these columns, various representations were made to the President of the Board of Trade on behalf of chambers of commerce and others urging him to make modifications and alterations in certain of the more important clauses of the Bill. For instance, the patentee might be required, as the Bill originally stood, to grant licenses when the "reasonable requirements" of the public with reference to his invention had not been satisfied by reason of the neglect or refusal of the patentee to work the patent, or grant licenses on reasonable terms. It was thought that the phrase "reasonable requirements" was not explicit enough, and in particular that it did not especially include the reasonable requirements of the producing part of the public as opposed to those of the consumers. Accordingly, in the House of Commons on Friday, Mr. Balfour announced his intention of amending the clause so as to provide that if any existing industry or the establishment of any new industry were prejudiced by the failure of the patentee to work his patent or to grant licenses, the reasonable requirements of the public should not be held by the court to have been satisfied. Mr. Balfour also proposed to retain the principle of granting compulsory licenses as the basis of the amended clause, but to give the court in certain extreme cases the power to revoke the patent. Thus, the court would be empowered to revoke the patent if they were of opinion that the reasonable requirements of the public were not satisfied by the grant of licenses, subject to a proviso that no order should be made before the expiration of three years or if the patentee gave satisfactory reasons for his default. This is a most important provision, and one which will be welcomed in the electrical industry as making it impracticable for an inventor to take out a patent to prevent production in this country. Another amendment of the Bill as proposed by Mr. Balfour was that the tribunal for dealing with this matter should be the Judicial Committee of the Privy Council with no appeal, instead of the High Court, the objection to which was the length to which proceedings might be carried by appeals. The last point on which the President of the Board of Trade proposed to amend the measure was in regard to cases where there was *primâ facie* evidence that a patent was being used only to prevent manufacture in this country. In such a case he proposed that the onus of proving the public interests had been reasonably met should lie with the patentee. The House discussed these proposals of Mr. Balfour for more than two hours, but no serious opposition to them was taken. In the result the motion for the second reading was carried, and it was afterwards agreed to refer the Bill as amended to the Standing Committee on Trade.

Magnetostriction in Bismuth.—In the current number of the *Physical Review* Mr. A. P. Wills contributes a short article giving the results of some experiments he has recently carried out on the above subject. He first of all refers to a remarkable effect observed by Bidwell on magnetising a bismuth rod. With a magnetising force of 280 C.G.S. units an elongation was suspected, with 470 units it was quite perceptible, and upon increasing the field to 680 units the extension was roughly measurable and amounted to ·3 ten-millionths of the length of the rod, and with a field of 842 units the extension was 1·5 ten-millionths of the length. The experiments described by Mr. Wills in the article in question were begun at this point with a view to determining the behaviour of bismuth under the action of much higher fields. The bismuth cylinder used measured 1·1cm. in length and ·52cm. in diameter, and the arrangement for measuring any possible change in length consisted of a system of two levers and a high-power micrometer microscope. The support for the electromagnet used was upon a table of its own, so that there was no material contact between the electromagnet and the other apparatus. In the experiments tried the field was varied, reaching a maximum of 3,200 C.G.S. units, but neither with the maximum field nor with any of the various intermediate fields could any effect be detected which was not due to one of the following causes: (1) a heat effect, in which case time was required to produce it; (2) an effect due to the action of the magnet on the currents induced in the levers themselves; in this case a sudden jerk was observed when the magnet circuit was made or broken, and then the pointer would return to its zero position immediately. The experiment was repeated with a bismuth cylinder made of bismuth one buys in the market as chemically pure, but again negative results only were obtained. After working with levers for some time, it became evident that great care must be used if their action was to be relied on. Finally, with a new lever and what the author terms "the point, slot, plane arrangement" of the points, the action was improved considerably, adding to the stability of the system without interfering with its sensitiveness. But in order to have a check upon the sensitiveness of the levers, it was decided to measure the depression of a stiff steel spring under the action of small weights. The depression of the spring as actually measured was $6{\cdot}70 \times 10^{-6}$cm. The agreement, says the author, is quite satisfactory. Furthermore, the depression was found to be proportional to the load. This seems good evidence that the lever system finally worked as it should. Further evidence is afforded by the fact that when the bismuth cylinder was in position, and a lighted match held in its neighbourhood, the pointer in the microscope moved gradually and not jerkily. The field was measured ballistically by means of a d'Arsonval galvanometer, and the galvanometer was calibrated by means of a long standardising solenoid. It is intended to continue these experiments soon with a much more powerful electromagnet.

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TRAMWAYS AND LIGHT RAILWAYS EXHIBITION AT THE AGRICULTURAL HALL.

(Continued from page 8.)

Continuing our notices of the exhibits at the above exhibition in the order that we commenced—that is to say, in the order of visiting them, which was determined largely by the opportunity of interviews with the prominent engineers in charge—we now come to the Westinghouse exhibit, a truly attractive and enterprising one. One naturally expects something unusual in the way of enterprise from the BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, and there is certainly no cause for disappointment on this occasion. The machinery shown is practically all in operation, the pieces not in motion being, as a rule, duplicates of those in operation, and placed so as to facilitate inspection. All the apparatus exhibited is, needless to say, of the most modern type, and well calculated, therefore, to illustrate the most approved practice in traction installations. The exhibit can well be treated and described as a combined electric tramway and street-lighting system. The main generating plant (Fig. 6) consists of a 112-h.p. gas-engine coupled to a traction-type generator, the former receiving its supply of gas from the public mains. It may be mentioned that the engine of this set is of the Westinghouse three-cylinder type, and is the more remarkable because of its fundamental difference from the types of gas-engines with which we have hitherto been familiar. In the engine exhibited, which is similar to those installed at Walthamstow, the three vertical cylinders are placed close together side by side, and all are counterparts of each other, both as regards size and valve arrangements. Moreover, the cylinders are each single-acting, of 13in. diameter and 14in. stroke, working on the Otto cycle, whereby each piston receives one explosive impulse every other stroke. The three main cranks are set at angles of 120deg. relative to each other, whence it follows that the main shaft receives one propelling impulse every two-thirds of a revolution. A remarkably even rate of rotation is thus secured. Another important feature of the engine is the system of governing employed, by virtue of which it is enabled to successfully rival the highest grades of steam-engines. The air and the gas are always admitted to the cylinders ready mixed, and in the exact proportions for securing the maximum power from the gas The air and gas come together in a separate box or mixing chamber, from which the engine draws its supply into the cylinders through a valve, the orifice of which is regulated by a very sensitive revolving governor. It will be seen that the principle resembles somewhat the throttle governing of steam-engines Experience has established the efficiency of this system of governing, no further proof of its success being required than to know that in many cases the Westinghouse gas-engine is in constant use, direct and rigidly coupled to alternators running in parallel. Besides ensuring steady running, the system of governing in question effects the highest possible economy in gas consumption at all loads. Electric ignition is employed with the best of results, we are told. We were agreeably impressed by the steady running of the engine on exhibit. Vibration and noise are certainly not among its attributes, nor is any trouble experienced through back firing, we were assured. When the engine was called upon suddenly to respond to a heavy load, due to the starting up simultaneously of a heavily-laden four-motor tramcar and a motor truck, as occurred several times during our visit, it gave a slight wheeze, but there was no appreciable decrease in the speed.

The generator to which the above gas engine is direct coupled has an output of 75 kw. at a pressure of 500 to 550 volts. It is of the Westinghouse standard traction type. The armature, which is of the slotted-core type, is practically built direct on an extension of the engine shaft. The particular features of this generator are the excellent provisions for securing cool and economical running and an original arrangement of the armature winding, whereby perfect magnetic balance of the machine circuits is secured.

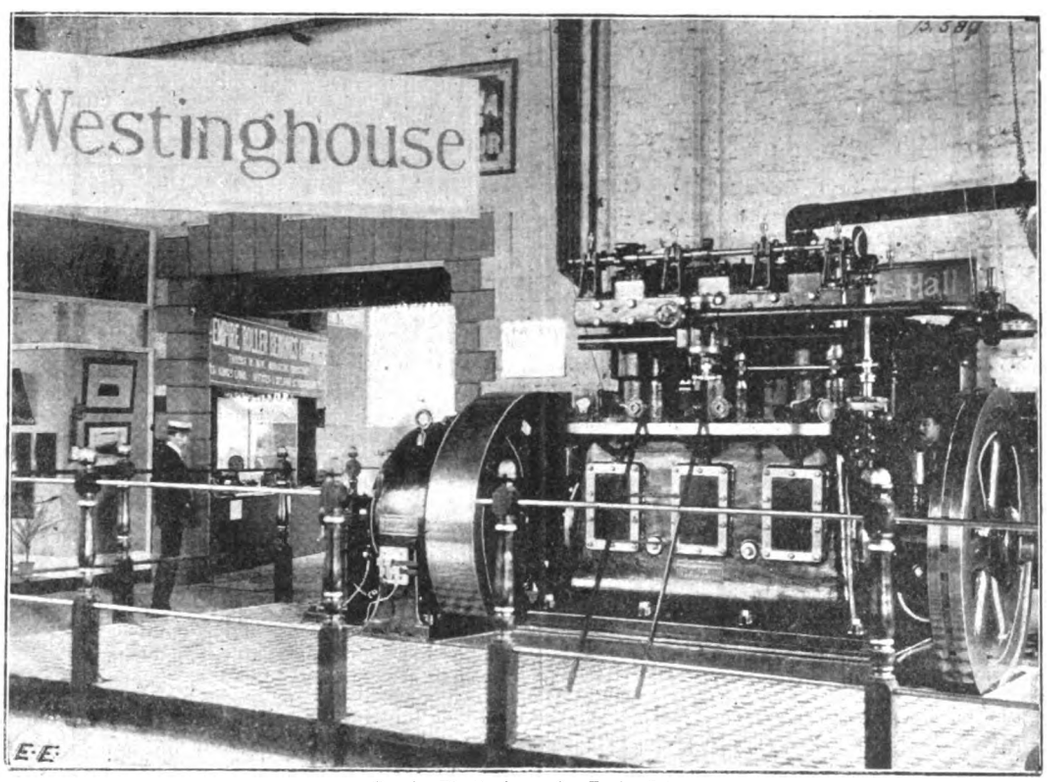

FIG. 6.—Westinghouse Gas-Engine Set.

The current generated passes to a switchboard carrying the necessary controlling switches and instruments, all of which are of the Westinghouse standard types of manufacture. The greater part of the output of the generator is utilised for the operation of a length of tramway. This tramway consists of a single track running the full length of the Agricultural Hall. It is fitted complete with an up-to-date system of overhead trolley wires. The total length of the track is 310ft. The car (Fig. 7), which makes regular journeys over the line, is of interest, owing to its extraordinary size and the unusually powerful electrical equipment consequently entailed. It may be mentioned, also, that the car body is of beautiful finish, and in every respect a credit to Messrs. Milnes, of Birkenhead, who were the builders. As regards the motor equipment of the car, this consists of four Westinghouse No. 49 B tramway motors, each axle being driven by a

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motor through single-reduction gearing in the usual manner. It is unusual to find cars in service with quadruple equipments. The car under notice is one of those recently ordered for the Tyneside tramways, and is indicative of the progress which is being made in electrical street traction. Speeds of transit and the size and power of rolling-stock are all rapidly increasing. A special feature of the Westinghouse No. 49 B traction motor is the small diameter of the armature, which, it is claimed, introduces many advantages, such as reducing the centrifugal force on the armature conductors and reducing the losses of the system owing to the small amount of momentum and

FIG. 7.—Westinghouse Exhibit, showing car built for Tyneside Tramways.

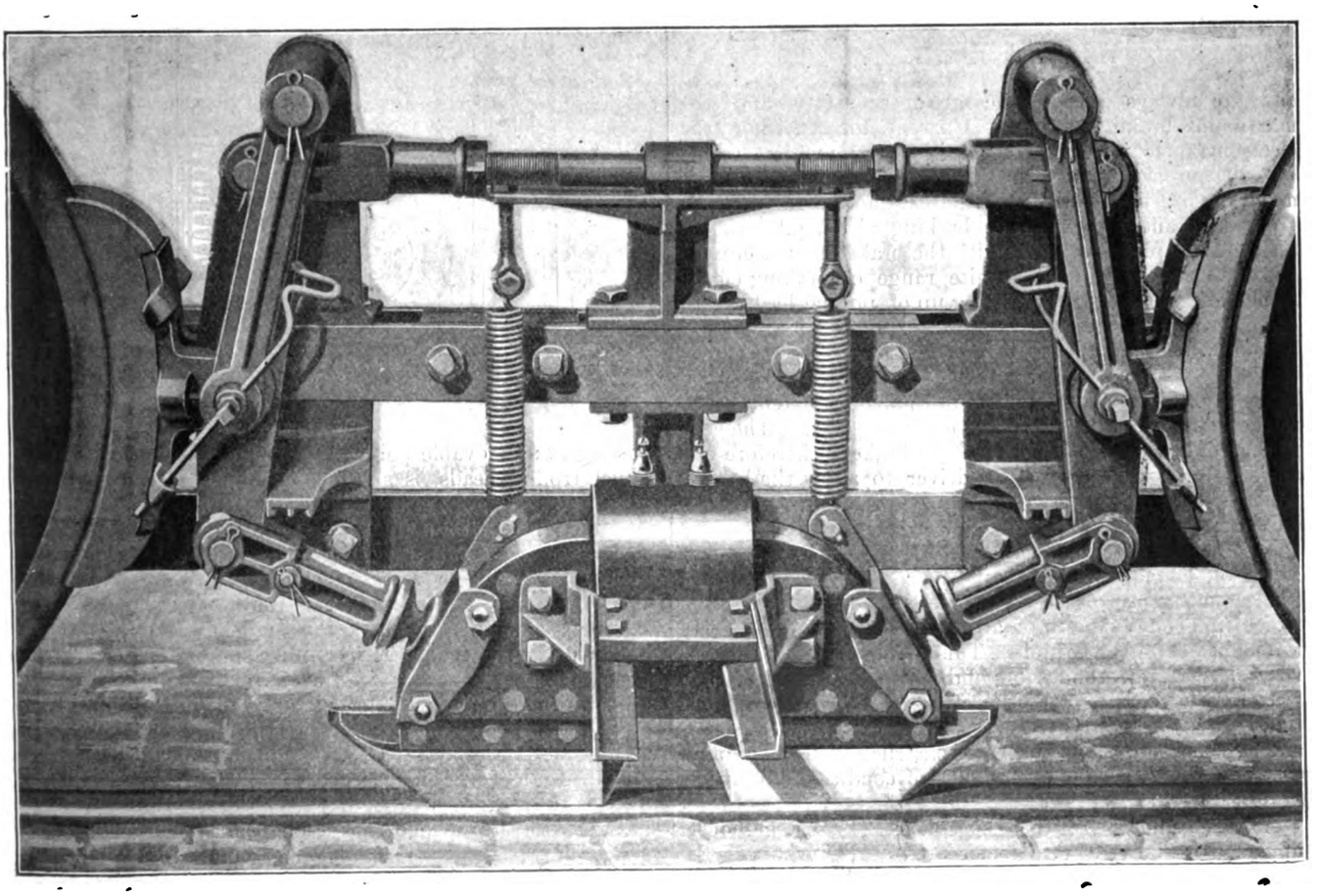

FIG. 8.—Arrangement of Westinghouse Magnetic Brake.

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inertia to be overcome in stopping and starting comparatively light rotating parts. A controller of the Westinghouse No. 412 type is provided at each end of the running car. This controller is a new adaptation of the well-known double-equipment Westinghouse type, compared with which it is said to be just as reliable in practice. Each serves to control by the one main lever all four motors of the car. The feature, however, which attracts the most attention in connection with the tramcar equipment is the Westinghouse magnetic brake, by means of which the car is stopped in its journeys backwards and forwards over the route. This brake is a recent invention, and is designed expressly for use on city and suburban electric tramways. Its essential feature consists of a horseshoe electromagnet suspended, poles downwards, by spiral springs immediately over the track-rail head, as shown in the accompanying illustration (Fig. 8).

The magnet poles are fitted with iron slippers. A flow of current round the coil of the electromagnet causes it to be drawn downwards, the slippers on the poles gripping the rail by virtue of their magnetism. A moving car is therefore braked by the drag of the magnet on the rail, the frictional resistance depending upon the strength of the magnet—*i.e.*, upon the strength of the current flowing round the magnet coil. The body of the magnet is coupled by a system of simple levers to the brake blocks of the car wheels on each side of the magnet, by which the drag of the slippers on the rail is made to apply lateral pressure to the brake shoes on the wheel rims. The proportional braking effect on track and wheels is definitely adjusted, so that whilst the wheel braking effect is maximum, the pressure on the wheels is never sufficient to cause skidding. Adjustments are provided whereby the proportional braking effects may be regulated once and for all to suit the weight of the car and the gradients of the track,

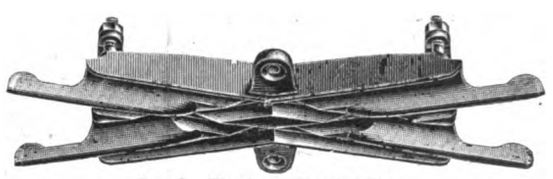

FIG. 9.—Wood's Patent Crossing.

and so always secure the greatest safety and the maximum braking effects. Current for exciting the electromagnet is drawn from the car motors, which are driven as generators by the momentum of the moving car; this loading of the car motors introducing a powerful and very effective braking alone. A series of resistances is placed in series with the brake magnet circuit, and these serve to give a definite range of braking effect, from the easy and gentle slowing up of normal braking to the most rapid of emergency stops. The brake is applied by moving the main lever of the tramcar controller beyond the "off" position, the lever moving over a series of stops corresponding to the resistances in the magnet circuit—*i.e.*, to the strength of the braking effect required. The cost of the power required to operate the brake is therefore nil, and it is impossible for the car driver to apply the brakes while the car motors are receiving driving current. The exhibition tramcar is fitted with four of these brake sets, this being the full complement for a double-truck car. The action of the magnetic brake and its construction can, however, be more clearly seen on the electrically-equipped truck which runs on a length of about 40ft. of track alongside the main line of the exhibit This truck also gives one a very clear idea of the motors and their suspensions. We were informed that the penetration of water to the electrical parts of the brake is rendered impossible under any circumstances by the waterproof construction adopted, and that no failure is liable under service conditions from this cause.

Among numerous other specimens of Westinghouse apparatus a number of Bremer arcs are shown. These serve to bring not only the Westinghouse exhibits, but all the neighbouring exhibits into great prominence at night. The light obtained is wonderfully effective, and coupled with the great economy of lamp, which has been discussed several times in these columns, this effectiveness should ensure its success. Briefly stated, it is a direct-current lamp with two carbons placed almost vertically side by side, the arc being formed at the two lower ends. Consequently no shadows are thrown on the globes, which appear as spheres of even luminosity. The abundance of orange rays, which give such beauty to the light, is due to the use of special electrodes.

It would be an omission on our part not to mention, in conclusion, the courtesy with which the several representatives of the Westinghouse Company at the exhibition helped to satisfy our thirst for information—no trouble seemed too much for them.

Another exhibit which cannot fail to be of interest to the electric tramway engineer is made by the GENERAL ELECTRIC COMPANY (1900), LIMITED, at Stand No. 34. It may be said to be truly representative of electric traction supplies, including overhead line material and car fittings for the same, car-lighting and signal fittings, traction telephones, traction generator panel and switches, and miscellaneous supplies. A large variety of Wood's patent frogs,

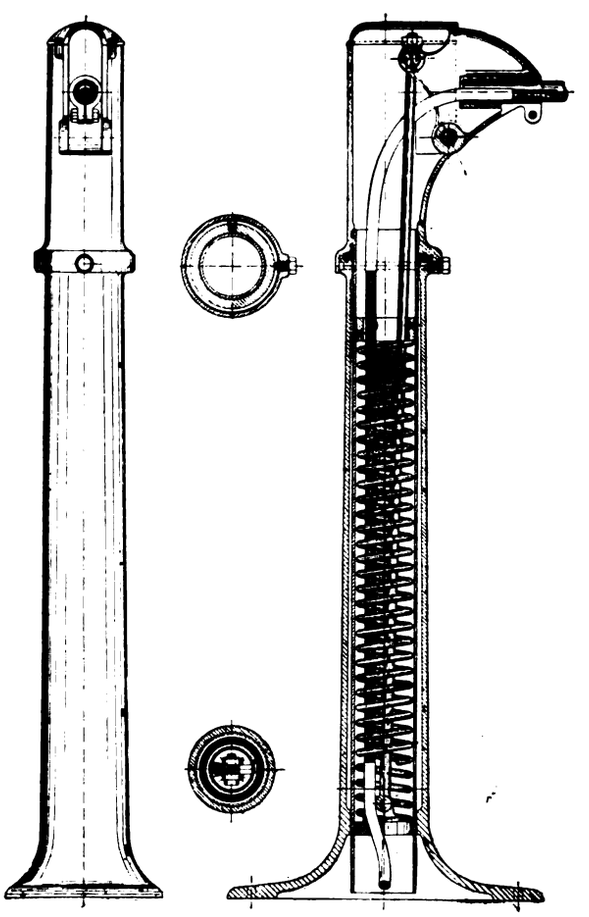

FIG. 10.—Wood's Patent Trolley Standard.

crossings, and movable points for use in connection with swivel trolley heads is shown. The special advantage claimed in regard to these fittings is that they provide a continuous path for the passage of the trolley wheel, thereby rendering it impossible for the latter to come off the line, while the movable points and shunt points are provided with suitable devices for throwing the trolley wheel on to any line at a junction with a minimum of trouble to the pointsman. The illustration (Fig. 9) shows how the continuous path referred to in the above is obtained at a crossing. In the centre of the stand there is erected one of Wood's patent trolley standards (Fig. 10), complete with mast, trolley head, and trolley. The top of this standard is shown with the cover off one side, so that the excellent design inside is fully exposed to view. It may be mentioned that the standard is provided with a compensating lever which carries the pole, and is so arranged in connection with the spring that when the pole is in a horizontal position the pressure on the wire is only 15lb., and when the height of the trolley wheel is 23ft. from the ground the pressure is 20lb. A tension nut is provided for adjusting the pressure and the angle which the pole makes with the

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wire. It is claimed that this invention effects a saving of 25 per cent. in trolley wheels, not an unimportant consideration where a number of cars are running. We have by no means exhausted the Wood's patents shown at the stand, but must limit ourselves to the mention of one other—namely, the latest—a section insulator (Figs. 11 and 12), which is without any wooden strip whatever. Instead of the usual wooden bridge piece, the ears are extended towards the centre, where a small gap is left, and above this an insulated centre piece is fixed with two sector-shaped extensions on its underside. These sectors are provided at their circumference with shoulders so adjusted that just before the trolley wheel leaves one ear its peripheries run on to the shoulders, and do not leave them until the trolley wheel makes contact again with the ear of the next section. It is claimed that in this manner absolutely smooth running is obtained over the gap and all arcing avoided. A good display is made of "Samsohm" insulation, another speciality of the General Electric Company, also of electric fittings for cars in connection with lighting and signalling. The excellence of the latter is indicated by their almost exclusive use in the tramcars shown by various exhibitors. Telephones for traction systems, of which the General Electric Company have a monopoly, are shown in working order, also an example of the firm's standardised traction generator panel. The switches on the latter are of the General Electric Company's knife pattern "Peel" type, in regard to which the special feature is the novel method of interlocking. The negative switch is so interlocked with the positive and equaliser switch that the latter cannot be closed until the former has been closed. In addition to this, the positive and equaliser switch cannot be closed until the shunt-making and regulating switch has been closed. Under ordinary conditions, therefore, it is possible for the attendant to close the negative switch at any time he likes without anything happening, but he has to make the shunt circuit before he can put the machine on to the 'bus bars, the final operation being, of course, to close the automatic circuit breaker. In conclusion, it may be said that the design and finish of the apparatus shown leave nothing to be desired.

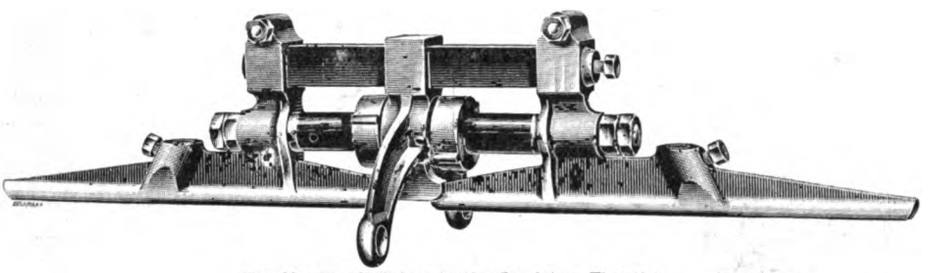

FIG. 11.—Wood's Patent Section Insulator—Elevation.

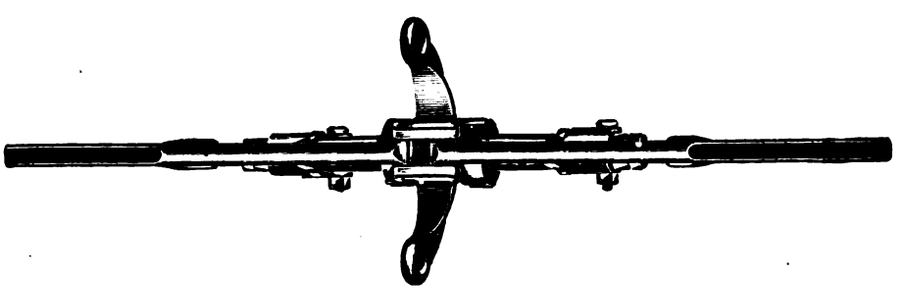

FIG. 12.—Wood's Patent Section Insulator—Plan.

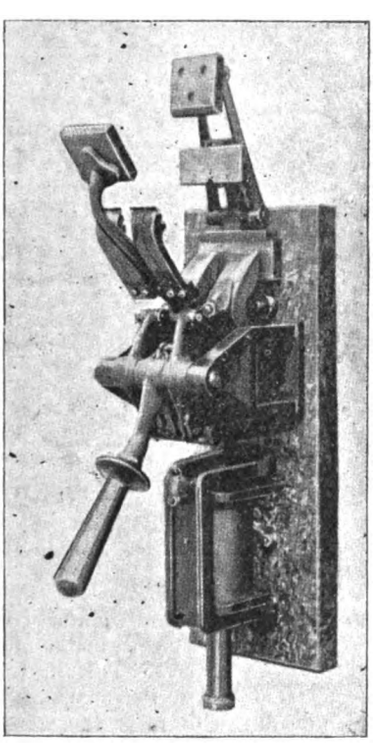

FIG. 13. Cowan's Circuit Breaker (J. M. Type).

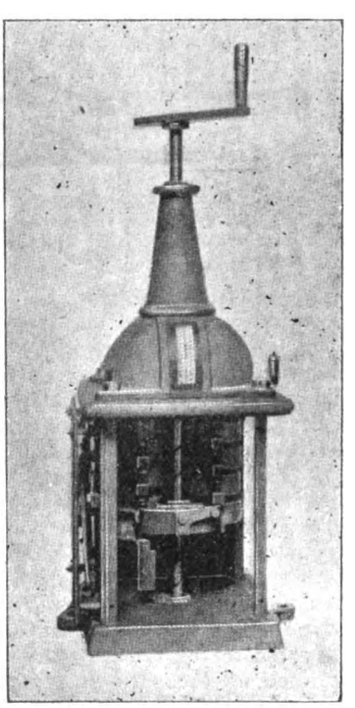

FIG. 14.—Cowan's Motor Starter (Pilla Type).

MESSRS. COWANS, LIMITED, of Salford, Manchester, make an excellent display of their well-known switchgears at Stand No. 74. Prominent in the exhibit are the two main switchboards for the Hornsey electric lighting scheme, made to the specification of Mr. Robert Hammond. One

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of the field switches on the generator board is coupled up to a circuit of high self-induction, and when operated demonstrates by the small spark at break its effectiveness in preventing a rise of pressure when the field is opened. On the feeder board Messrs. Cowans's special spring carbon-break switches are used throughout, and Andrews's return-current cut-outs are mounted on the generator panels. The heavy battery switches are separately mounted, and are operated from the main board by large concentric hand-wheels and chain gearing. A 15-kw. Cowan-Still patent regulating transformer is shown in operation. This type of regulating transformer gives a perfectly gradual change

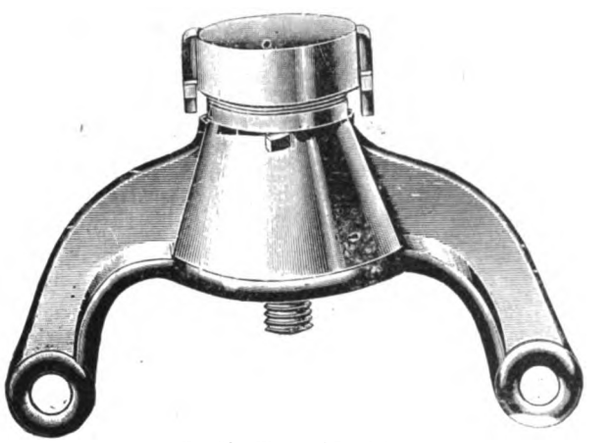

FIG. 15.—West end Insulator.

of secondary pressure from zero to maximum. It is worked by varying the magnetic induction through the secondary circuit, and is used for boosting feeders, testing, starting, and regulating polyphase motors, etc. Deserving of special notice is a new type of circuit breaker ("J. M." type) This circuit breaker is shown on the accompanying illustration (Fig. 13). The main brushes are not attached to the lever carrying the auxiliary contacts, and the consequent lightness of the moving parts ensures a very rapid break. The switch is free to operate when the handle is grasped by the attendant, and when it is required to open the switch, instead of pulling or pushing a separate stop, it is only necessary to pull down the handle when the catch is released, and the switch opens. All wearing parts, carbons, etc., are quickly renewable. Messrs. Cowans have arranged this switch to be worked by a relay coil when it is required that it shall operate with a return current, or with a return current and also with a maximum. The release gear is enclosed in a small cast-iron box, and it can be fixed at any distance from the switch which it controls. The adjustment for the maximum current is independent of the adjustment for the return or minimum current, and *vice versâ*. The switch in connection with separate release is shown in operation. Two other types of circuit breakers are shown. One—the Andrews type—has no winding of any kind, the necessary field to actuate the release gear being obtained by the configuration of the parts carrying the current. We noticed also a substantial form of motor starter of the pillar type (Fig. 14) fitted with C.S. patent resistance units. Nor must we forget to mention that a model of Andrews's new duplicate mains system for alternating currents is shown in operation. By means of this system not only is supply maintained without interruption at the feeding point if one of a pair of feeders fails, but any abnormal rush of current at the moment of failure is prevented, and the consequent rise of pressure avoided. It is very simple, and does not depend upon the action of return-current cut-outs, as with Andrews's duplicate mains system for continuous currents. Judged by the working of the model in question, the system would seem to offer splendid possibilities.

THE ELECTRIC TRAMWAY EQUIPMENT COMPANY show a full line of overhead fittings manufactured at their Birmingham works. Their speciality, "Verus" insulating compound, is given prominence. Being moulded under very heavy pressure, this compound is very hard, and can be freely handled without fear of chipping or cracking. As regards its insulating qualities, we were told by the firm's representative at the exhibition that their "Verus" insulated bolt, as used with the ordinary West-end insulator (Fig. 15), has successfully withstood a pressure of 20,000 volts, while at a recent independent test for water absorption, in which

FIG. 16.—Globe Strain.

the insulation was first broken in pieces, "Verus" absorbed a lower percentage than any other make. The insulation is also mechanically strong, and will bear an enormous crushing strain. In Fig. 16 we give an illustration of a Globe strain, which is guaranteed to stand a strain of three tons. The design of frogs and crossings has received the special attention of the firm, as evidenced by the examples shown. Their five-way car-shed frog (Fig. 17) is an ingenious yet simple piece of mechanism, by which the berthing of the cars in the shed is more readily accomplished. The movable tongue is operated by a lever on the top, which is connected by flexible wires with another lever on an indicator board, which may be placed in any convenient position, the tongue being automatically locked in the position to which it is moved. These frogs are made with either two, three, four, or five ways or points, and are now used in many of the large car-sheds in this country, notably at Liverpool, Manchester, Blackburn, Leeds, etc.

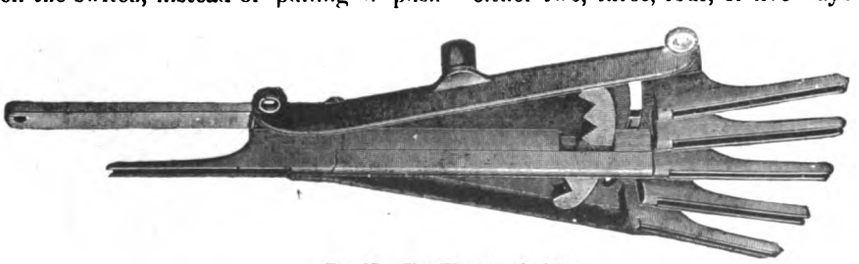

FIG. 17.—Five-Way Car-Shed Frog.

(To be continued.)

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

SECOND SESSION.

The second session of the seventh annual convention of the above association was held on Thursday afternoon last week in Berners Hall, Agricultural Hall, Islington, the president (Mr. J. H. Rider) in the chair. The morning had been spent by members in inspecting the exhibits at the Tramways and Light Railways Exhibition, at the invitation of the Exhibition Committee, who also entertained them at luncheon. The agenda for the afternoon meeting contained two papers to be read, and for convenience sake they were taken together and discussed as one paper. As the subjects dealt with by the respective authors are closely allied, this arrangement considerably shortened the proceedings, and rendered the discussion one of much wider interest. In the unavoidable absence of Mr. S. E. Fedden,

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the paper on "Steam-Turbines" was read by the hon. secretary, Mr. E. T. Ruthven-Murray.

Steam-Turbines.

BY S. E. FEDDEN, CITY ELECTRICAL ENGINEER, SHEFFIELD.

The technical details of the steam-turbine have been very promiently placed before engineers lately in numerous able papers, that the author does not consider it necessary to go over this ground again. Suffice it to say that the construction of the steam-turbine is simplicity itself, as it consists only of a hollow drum revolving in a stationary drum or cylinder, each with teeth or vanes attached, and so arranged that they clear each other. The two cylinders are steam packed, and, of course, the thrust guides require careful adjustment so that the vanes do not clash. Of late years this turbine engine has been meeting with signal success, and many engineers are now considering whether it is not destined to revolutionise the means of obtaining power from steam both by land and by sea. The author suggests, however, that engineers and inventors should turn their attention towards bringing to perfection gas-turbines, now that cheap gas is available, and the ideal engine, combined with the most economical way of obtaining electrical energy from coal, may then result.

The fundamental principle attending all methods of electrical working is implied by the word "velocity," a requirement eminently possessed by the dynamo, motor, and rotary converter, owing to the entire absence from these machines of reciprocating parts. This requirement, however, is not possessed by the prime mover—the modern reciprocating engine. Velocity was first obtained on the dynamo by means of belts or ropes, but this method of driving was soon discarded: it took up too much available floor space, and was an unsatisfactory and inefficient arrangement at the best. The attention, therefore, of the most prominent engineers in the world was directed towards increasing the speed of the engine, so as to adapt it for direct coupling to the high-speed dynamo or alternator. The efforts of these engineers were attended with very great success in Britain, and they were able, not only to couple their new high-speed engines to the dynamos, but they also obtained those qualities of economy and reliability of working claimed for the slow-speed engine with its belt drive, and the market now supplies high-speed engines of moderate sizes and of British manufacture, which are second to none in the world.

The demand for electrical energy for all purposes has, however, increased by leaps and bounds, and has thus called for larger generators and larger engines with heavy reciprocating parts; therefore, more strain and wear, bringing increased engine troubles. High-speed engines are now being built with pistons considerably over two tons weight. Such a piston will have to start and stop from 400 to 500 times per minute. When this enormous weight, making so many reversals per minute, is considered, it will not be difficult to imagine the steam-hammer effect obtained if the least thing goes wrong with the valve setting or the compression. On account of the increased engine troubles with high-speed engines, manufacturers are now falling back to moderate speeds, and many to slow speeds, although this is attendant with an increased cost of the plant. Taking into consideration the large demands for electrical energy which must be made in the near future, it seems probable that the size of the generator and slow-speed engine will become unmanageable, also great difficulties will be experienced in shipping and erecting the same. The aim of all engineers should be simplicity, and the modern reciprocating engine, with its numerous complications, cannot by any means be considered the embodiment of this principle of simplicity. The great number of its moving parts, which require watching and adjustment, increases the cost of maintenance and attendance. Engineers who have had charge of power stations of from 6,000 h.p. to 10,000 h.p. are fully aware of the laborious and never-ending work and watchfulness required to maintain their reciprocating engines in fair running order; the station calls, incident to the taking up of brasses, repairs and adjustments to valves, gland packing, cylinder lubrication, automatic governors, trip valve gears, and many other things, are items that go to build up the daily and nightly experience of the present-day station engineer. Engineers laying down new plant have to consider the increased cost of building, the larger floor space required, the longer lengths of steam and exhaust piping, valve-opening gears, and heavy cranes for lifting which are required in the case of large reciprocating engines, as against the requirements of a station laid out with steam-turbines. The massive nature of foundations, the time required for delivery and erection of large plants, are items which often seriously delay the speedy completion of contracts.

It was owing to these and similar reasons that the author's attention became directed towards the steam-turbine offering a possible solution of the difficulty, and a short experience with generators of this type has since formulated his belief that progress in the generation of electrical energy lies in this direction. The failure of the steam-turbine to secure earlier appreciation was probably due in great measure to that inherent conservatism to which British engineers are only too liable. Two years ago the author had the opportunity of going through the country to inspect all the larger turbine installations, and the conclusions then arrived at were: (1) it was inadvisable to put down a steam-turbine to exhaust to atmosphere; (2) it was inadvisable to put down a steam-turbine of a small size; (3) it would be policy to instal steam-turbines from 200 kw. to 300 kw. and upwards either for alternating or continuous current generation for lighting or power, provided there was a plentiful supply of cold water available for condensing purposes, and also provided that surface condensers were used, all the water being returned to the boilers.

From the year 1885 until 1890 nearly all the turbines manufactured were non-condensing and of comparatively small type; they were not economical—in fact, many engineers called them steam-eaters, but great improvement, both in construction and design, has since been made in them, and this has led to a very much smaller steam consumption, so that there is now on the market a steam-turbine which, in the larger sizes, and in the matter of steam consumption, is capable of holding its own against any triple-expansion engine yet produced. Even in the early days, when they were considered steam-eaters, their smooth running and general adaptability to the driving of electrical machinery was the subject of much comment. The author, however, wishes to call the attention of the members to a few of the advantages which the adoption of the steam-turbine, when running under ordinary conditions for working in a power station, has impressed upon his mind. As many members are no doubt aware, a steam-turbine of 500 kw. capacity, 100 cycles single-phase, was brought from the Paris Exhibition into the Sheffield station about 18 months ago, and was running on the town load within three days of the time of its arrival at the station doors, and within about three weeks of the date of the order by telegram. It was simply dropped down on the station floor, without any preparation in the way of foundations, and has since, over the period stated above, run more or less continuously and during longer hours than any other plant in the station. It runs in parallel with alternators both of the iron and copper type, with engines of the triple and compound type, and can be brought up to speed to meet the demand of a sudden load much more quickly than any other of the neighbouring plants. Boiler priming or wet steam simply causes momentary slackening of speed until the turbine clears itself of water. Other advantages are as follows: (1) Absolutely steady nature of turning moment. (2) Entire absence of cylinder lubrication, which, therefore, allows of all the condensed steam being returned to the boilers. The saving in this one item alone materially assists in the reduction of station costs. (3) The time occupied in cleaning down is brought to a minimum, and is about one-sixth of that required with a reciprocating engine of similar capacity. (4) The entire absence of rubbing surfaces and packed glands within the steam-chamber will permit of the use of superheated steam without fear or injury. The turbine specially lends itself to the use of superheat of a high temperature, and in this respect possesses a considerable advantage over a reciprocating engine. (5) Exceedingly small costs for attention and repairs, and great reliability of working. These last items bring home to the engineer more forcibly than anything else the advantages of a purely rotary as opposed to a reciprocating motion. When considering the laying down a steam-turbine plant, the main factors to be considered are:

First.—Good vacuum in the condenser. This is even more necessary than with an ordinary engine, as the makers claim that the turbo expands the steam right down to the vacuum of the condenser. The following table of actual tests taken on a 500-kw. set illustrates how important it is to obtain a high vacuum:

CONSUMPTION OF 500-KW. TURBO-ALTERNATORS, RUNNING AT 2,500 REVOLUTIONS WITH 140LB. STEAM PRESSURE AT THE STOP VALVE AND NO SUPERHEAT.

Vacuum constant from full load to no load. Inches of mercury.	Consumption per kilowatt-hour. Full load.	Half load.	Quarter load.	No load.
29	—	—	—	1,500
28	22·2	25·6	32·4	1,700
27	23·1	26·9	34·5	1,900
26	24·0	28·2	36·6	2,100
25	25·1	29·7	39·0	2,300
24	26·2	31·2	41·2	2,500
23	27·5	32·9	44·8	2,700
22	28·9	34·7	46·3	2,900

Second.—Arrangements for high superheat, as tests show that with 50deg. F. of superheat, there is 8 per cent., and with 100deg. F., 12 per cent. economy in steam consumption. From the tests taken on the 1,250-kw. steam-turbine sets, which are now working satisfactorily at Elberfeld, in parallel with Sultzer engines, where the speed ratio is something like 16 to 1, it was

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shown that there was a gain of 12 per cent. with 55deg. C. superheat, and that every inch of vacuum improves the steam consumption by 4 per cent. It was also shown that the steam consumption in the turbines, other things being equal, decreased constantly with increasing loads, whereas the Sultzer engines showed a less economy over three-quarter load.

The steam consumption in a turbine closely follows the right line law, or is proportional to the load added to a constant quantity which represents the consumption of steam at no load. The new 1,500-kw. turbo-alternators which the author is installing at Sheffield power station will, with their own condensers, only occupy the space of 730ft. The foundations will be of the simplest description, and the general compactness of the sets and the ease of erection are expected to effect a considerable saving of time and money. The appearance of the station will be improved by the absence of ugly lengths of steam-piping, or cylinders poised up in mid-air to obstruct the lighting of the building, and altogether the author hopes that there will be a general absence of that complexity of moving parts which to the trained eye of a station engineer offers so many possibilities of failure. The author has been severely criticised for starting a large power-house with steam-turbines, but time may show whether this criticism is deserved. At present, however, he feels quite confident, after considering the problem from all points, that the steam-turbine stands in a most favourable position when compared with reciprocating engines of large powers for the supply of electrical energy.

The Correct Type of Engine for Large Generating Stations.

BY A. A. DAY, BOROUGH ELECTRICAL ENGINEER, BOLTON.

In bringing the subject of the correct type of engines to be used in future electric power stations before this association, I would point out that many stations have now arrived at that state of congestion which will necessitate before long a larger electric supply station being put down. Under these circumstances, it seems to the author very desirable that the type of engine which should be employed in such a station should be discussed by this association. Further than this, it is quite apparent, if the various types of plant employed in central stations throughout the country are considered, that it is not an easy question to settle which is the correct one. I think it may be taken generally that the engines used in the United Kingdom are mostly high-speed with a sprinkling of the low-speed type, both horizontal and vertical. In America the low-speed type, both horizontal and vertical, is almost exclusively employed. On the Continent low speed is also almost universal. It must, therefore, be taken as a matter of fact that all three types can be and are used successfully in electric lighting and power works. It may, perhaps, also be further noted here that in the case of the power schemes which have recently sprung up in England, the engines proposed for these are of the low-speed type, and also that the larger generating sets in the large generating stations of this country have also been put in at low speed. On the whole, therefore, I think it may be taken at the present time, having regard to the fact that larger generating sets are being used, that there is a tendency towards the low-speed type. One great factor in the matter is that the space occupied by large generating sets does not appear so unfavourable to the low-speed type when the set is large, say 2,000 h.p. or upwards.

The whole question of high *versus* low speed I do not propose to enter into in this paper, as I am quite sure the members of this association are quite familiar with the advantages and disadvantages of both types, it having been discussed repeatedly before various societies and in the public Press. If, however, one goes outside electrical engineering and compares the results from the engine point of view only, one finds the low-speed engine still holds the record for low steam consumption. The conditions under which engines in existing electric power stations run are such that very little can be gained from their records which will help towards the solution of this question, as not only is the load factor bad in most cases, but the plant factor also, and the very large amount of steam-piping which is necessarily kept alive (but not to the full extent of its usefulness) all combine to produce the very poor results which most central stations at the present time show in pounds of coal per unit generated. The effect of the above-mentioned factors together is so marked that it is almost impossible to gain any figures from central-station statistics bearing upon the relative figures of merit of different types of plant, for it might even be argued from such statistics that condensing was the reverse of an economy.

The author's opinion on this question of high *versus* low speed is that if one adopts the principle of high speed it should be high speed, and not, as is very frequently the case, and especially with engines developing large power, only a moderately high speed, and the larger the set generally the less the speed, so that when one comes to a set of about 2,000 h.p. the space which is necessary for a high-speed set or a low-speed set is approximately the same. If one adopts the high-speed principle, one must of necessity abandon the idea of personal human supervision of the working parts. If this is admissible, the higher the speed the better the results, both as regards economy of steam, space, and material. The question of space occupied is not, however, of vital importance where a station is being built on large lines for the supply of a considerable amount of power, say on the three-phase alternating system, giving a high-pressure supply, and therefore rendering the position of the power-house a question of much less moment than it was in the case of the first electric light stations put up, when the public were timid as to the utility of an electric supply, and had very small notions of what that electric supply would develop into in the course of a few years. The author also thinks it may be generally taken that the question of the space occupied per horse-power has been very considerably overdone in the past. Many stations now are very cramped, and when repairs are necessary, a good deal of inconvenience is caused by the cramped way in which the engines are arranged, and when, as appears to be the tendency, the generating sets are of much larger dimensions than they have been hitherto, the necessity for space round the engine is much greater, and a larger amount can be allowed without making the horse-power per square yard of the engine-room as a whole too small. It should also be borne in mind that in a station employing large units, if the engines are placed close together, it is impossible to put the boiler power into so compact a space. The consequence is that if one generating set requires half a dozen of any type of boilers to supply it with steam, there is no necessity why that set, from a space point of view, should occupy less than the length of the engine-room covered by the boilers. If this rule be carried out (and it will be found a point of considerable importance in the designing of large stations), it will be found that it is unnecessary to cramp an engine for the sake of saving its floor space, especially in putting down a station such as is here being considered where the power units are large, while at the same time paying due regard to the importance of having as small an amount of steam-piping as possible. It therefore seems to justify the employment of low-speed engines in a station such as we are discussing.

It may be objected that the large unit is not a necessity in the case of an ordinary town supply. If, however, a little consideration is given to the probable demand for electric energy during the next 20 years, the author feels sure that the putting in of small sets, such as one repeatedly sees even now, will cease. There is no reason why large towns such as Manchester, Glasgow, Liverpool, and so on, should not be employing at the end of the period above stated 100,000 h.p. for all purposes. On the Continent, Berlin has already reached half that amount, and the output is seven times that of Liverpool. In England we have just as good an opportunity, and probably the demand for electric energy will be quite as great once the principle is grasped that electric motive power is undoubtedly the coming means of power distribution. This cannot, however, come about in England until the price of current is reduced below the figure at which it now generally stands for motive power, because in England we have a very good supply of cheap coal in the manufacturing districts, where a motor demand is likely to be of the most importance. Nevertheless, the author thinks the figure above stated for such towns is a reasonable one, and if one takes 50,000 h.p. in the same period for towns next in point of size, and 20,000 h.p. for comparatively small towns in the manufacturing districts, it will be at once evident that if these figures are reasonable, large generating sets must be the order of the day; if not, the power stations connected with such towns will become unwieldy in size, and the advantages of large engines will be lost, and the loss in steam-pipes will become enormous.

After very carefully considering this subject from all points of view, the author considers the low-speed type of engine should be the one adopted in the future for large power stations—that it will be condensing goes without saying. The type which the author suggests as most suitable in the long run (and it should be borne in mind that the power stations must be put down to last as a business concern and without anything about them of an experimental nature) is a horizontal low-speed compound or triple-expansion engine with direct-coupled generator between cranks. This type does not appear to have been very largely tried in England. It has, however, succeeded well on the Continent, and in the author's opinion may generally claim to have the following advantages, if the question of the space occupied is left out.

1. *Economy.*—The most economical engines have been built of this type, and certainly it can hold its own, if properly built, with any results obtained in electric light stations. These results as far as they have gone do not require any very economical engine to obtain them, although one is fully aware that the reason why the pounds of coal used per unit in electric light stations generally is very largely due to the poor load factor which these stations have. The author has recently had occasion to enquire very closely into the question of the cost of

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producing power in large cotton factories such as there are in Bolton, and the figures obtained were equally a good advertisement for the horizontal type of engine, which is almost universally employed, and also very useful as a guide to the price at which it is necessary for power to be supplied in order to make its use become general. Such engines are found to give an indicated horse-power hour for less than ·1d. with coal about 7s. per ton, and this on a load having a variation of 10 per cent.

2. The horizontal engine does away with the necessity for steam-pipes in the engine-room, or rather, above the engine-room floor, and enables the steam-pipes to be reduced to a minimum. This is a question of vital importance in a large station, and one of the points which requires very careful consideration. By adopting the horizontal type of engine the difficulty of steam-pipes can be satisfactorily overcome as far as the engine-room is concerned, and at the same time keep the engine-room neat, doing away with all obstructions to the free use of a traveller from one end of the engine-room to the other.

3. The engine can be kept clean at a minimum of expense and trouble.

4. The repairs to such an engine will be found to be reduced to a minimum if the valve gear be of the Corliss tripped type, which appears to frighten some engineers by its complication. The complication seems to the author to be far more apparent than real. It is no more necessary that the gear should be more complicated than in the case of an enclosed high-speed engine, but it is seen in the one case and not in the other, and a good deal of the complication can be done away with if the motion work were not made so that it could be adjusted while the engine was running, which the author considers to be too great an advantage to be thrown away for the sake of appearances.

5. The engine can be easily got at for repairs, and the same applies to the dynamo. It seems to the author that the weak point of a similar type of engine to that under discussion, but vertical instead of horizontal, is that to remove the top half of the field-magnet ring, or to get at anything of importance on the dynamo, necessitates the dismantling of the engine to such an extent that it practically means rebuilding, and if this dismantling has to be done in a cramped space it is a very costly and lengthy business.

6. The dynamo being placed between the two cranks, the shaft is not in any way cut up. We all know the difficulty that has been found to exist in making a crankshaft with built cranks strong and able to withstand the throwing off and on of the full load repeatedly, as must necessarily be the case with electrical generators for power purposes and traction. The author does not mean by this that there is anything extraordinary in the strains set up in a generator on traction supply as it has been attempted to prove—it is obvious that such strains cannot exist; nevertheless, practice bears one out that a three-crank shaft is not so easily made strong enough to stand the shocks which do occur as two cranks at the end of a plain, simple shaft.

7. The bearings of such an horizontal engine can be adjusted both vertically and horizontally, so enabling the armature to be adjusted inside the field, which it is very advisable should be possible. A point about which there has been considerable discussion, and which seems to have been at one time considered insurmountable in connection with low-speed engines, is the difficulty of getting a very even turning moment without an abnormal flywheel. It is, of course, of the utmost importance that the turning moment should be very even in the case of three-phase or polyphase transmission, but a good deal more has been made of this point than is necessary, as there are three-phasers running on the Continent, and running satisfactorily, with engines that have only a single crank, the percentage variation being ·3 per cent. of the angular velocity; and it is not at all difficult to make a two-crank engine such as been described with a far more even turning moment than is possible with such an engine, however well designed. The weight of the magnet wheel in the above-mentioned instance is 43 tons.

This proves conclusively that an even turning moment can be obtained from low-speed engines, enabling such a type to be used in connection with alternating-current machinery; and, therefore, the arguments which have been adduced as to the advantages which high speed gives in this matter are, to a certain extent, done away with, because there can be no need for the flywheel of a low-speed generating set being made abnormally heavy to obtain a sufficiently even turning moment, especially if the engine is not a single-crank one. One knows that the usual way of looking at this question of high *versus* low speed is that a high-speed engine with a short stroke gives a higher mean effective pressure in cylinders and that, in combination with the quick stroke, reduces the condensation in the cylinders to a minimum, and in so far as this takes place the high-speed engine has the advantage over the low-speed one; and as it is not practical to make a high-speed horizontal engine of large size, it has that advantage over that type, but the horizontal type of engine if fitted with Corliss valves is much better drained than the vertical either high or low speed, and if the condensed steam can be easily got rid of, the advantage of the high-speed vertical type due to lessened condensation is minimised. It is also true that the wear and tear of pistons on a horizontal type is greater than in the vertical, but this can be minimised by having tail rods without side bearings, etc., and the amount of wear which actually takes place is, to a certain extent, due to the material of which the cylinder and piston respectively are composed, and in a well-designed engine of good proportions the wear is not excessive. When we see engines that have run for 20 years without new cylinders or reboring, and still show good economy, it may be argued that this wear is a matter of small importance.

A very great point is gained when, in trying to arrive at the correct solution of this question, one can get the various points down to their relative importance. For instance, in taking the question of condensation in cylinders. This is a point on which great stress is laid by some engineers. At the same time the condensation which takes place in the steam-pipes, and which is more easily avoided than that which takes place in the cylinders of the engines, amounts to many times that which takes place in the latter case. The same thing with regard to the friction of the piston and cylinder liner. The difference in this item between a horizontal and a vertical engine does not amount to that which may be caused by a slightly inferior grade of cylinder oil; and although one does not say for one moment that all these points are not of great academic interest, and that we should all strive to obtain as perfect a result in all parts of central stations as is possible, still it is not worth while nor likely to increase the efficiency of the station as a whole, if such small points of economy are to be considered without the question of convenience and the relative importance of such points being taken into consideration, since indirectly they may very materially add to the running costs of the station. In the matter of convenience, for instance, the time occupied in making the bottom cylinder cover joints on a vertical and horizontal engine respectively would probably be somewhere in the ratio of 3 to 1, or if through any cause the work had to be done quickly, the probable time the joint would stand would show a still greater difference in favour of the horizontal type. This matter of convenience in getting at parts for repair work is very much greater in the case of horizontal engines than in vertical engines, and this point very largely outweighs the economy due to the reduction of condensation losses, especially seeing the relation the comparatively insignificant proportion of these losses bear to the total, and if the engine of the slow-speed type can produce an indicated horse-power hour for ·05d. or ·06d. for coal, and the question of the space occupied is not of vital importance, as it should not be in the case of a power station put down on the high-tension alternating-current system, on the whole there can be no question that the horizontal low-speed type is the one which should be employed in the future.

The author has previously stated that with regard to the question of high and low speed, if it is to be high speed it should be a very high speed, and as it is not likely that engines of the reciprocating type would be obtained giving a higher speed than that now usually employed for that type of engine, where space is important, the steam-turbine type would be the correct one to adopt. The author has not had any recent experience with the steam-turbine from which he is able to draw conclusions, and after the paper we have had from Mr. Fedden he does not propose to enter upon that question, but some years ago, in the early days of the steam-turbine, he ran one which was very satisfactory except in one point, and that was the question of governing. He has since seen engines of this type running, and in their case the governing seemed to be excellent. There is a great future for this type of engine, and where space is of importance it seems likely to come to the front. However, he would give preference to the low-speed type for power-station work of the size which is being considered in this paper, because, as in the case of both alternators and dynamos, it is an advantage to build them of such a size that it is not necessary to employ a high speed of rotation in order to get the necessary E.M.F., and at the speed at which a turbine runs the rotating part of the dynamo or alternator will become too cramped to make a thoroughly sound engineering job of it, which is very necessary at such a high speed of rotation. There is one point in connection with low-speed engines of large power which some members may be inclined to bring forward, and that is, on large sets, especially on the Continent, it seems necessary to employ a large number of men. In the engines recently erected in the power station at Pinkston a very large number of men were employed, but this is not necessary, and was mainly due to the contractors wishing to have no mishaps on a brand-new engine. At any rate the number of men required is not excessive in the case of horizontal low-speed engines, and there is no reason whatever why two men, one to drive and one to grease, should not run a 5,000-h.p. set of the horizontal type, and not have a very hard life at that.

It has always appeared to the author that an electric supply station is somewhat analogous to that of a pumping station, and the contrast between the quiet, cool, and clean engine-room of a pumping station which runs night and day, and the easy and

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very-free-from-anxiety sort of life that the drivers of such engines seem to have, when compared with the unrest which takes place in the electric power-house, is very great. This notwithstanding that the high-speed engineer would probably say that the valve gear of such pumping engines was the most complicated box of tricks that he ever saw in his life. There is no reason why the future power-house should not be as clean and tidy and free from noise and heat as the ordinary pumping station, and this will be most easily obtained without the sacrifice of any economy by the employment of low-speed engines of the horizontal type, coupled to steam-pipes carried underneath the floor direct to the boiler-house. We should, then, in our future power-houses probably be able to show results such as some members of the Institution saw during their trip to the Continent, where the cleanliness of the engine-room and machinery was remarked by everybody, and where, notwithstanding complications and the alleged disadvantages attached to low speed, the results obtained were sufficient to advance the business at a much more rapid rate than any English stations can show, and sufficiently low to bring electricity into far more general use than it has yet attained in England. The author does not wish to be misunderstood in this matter. The claims of the high-speed engine to economy of space and steam, at any rate in small sizes, he admits, also the advantages of all engines of the vertical type as regards floor space; but the horizontal type has advantages as above stated, and these outweigh those of the other types except in the matter of space. If an electric light station were not so largely affected by its load factors, the relative values of the different types would be apparent, and we, as station engineers, should be able to lay ourselves out to get the very utmost economy of coal, as in the long and steady runs of marine engines; but as in the very nature of the case we cannot hope to establish records for coal consumption per indicated horse-power in electric supply stations, the refinements which lead to the utmost economy in steam may be dearly purchased, and it is for this reason that the convenience, economy of oil and labour, easy access for repairs, with the other points already mentioned, the horizontal engine of low-speed type appears to the author to be the most suitable for large sizes where space is not of supreme importance.

The author has not gone into the question of the arrangement of cylinders, or the question as to whether compound or triple-expansion engines should be used. Personally, he would divide the plant up, some triple-expansion and others compound. This is a matter which has to be settled generally for each individual station, but generally triple-expansion is not warranted except in the case of very large sets when they can be kept fully loaded. In any case the horizontal engine can be made triple-expansion or compound, and the cylinders can be so arranged that the turning moment for either will without doubt enable alternators to run perfectly in parallel. The question of price the author has not gone into in this paper (although this is not against the type proposed), because in the question of electrical machinery price is of secondary importance, the more so as the importance of the electric supply increases. It is also rather difficult to discuss the question of engines without taking into consideration the kindred question of boilers, or, indeed, the question of the whole of the station plant, any part of which is so much dependent upon the other. If, however, sufficient has been said to bring about a discussion on this important point, it may be of use to us in the future.

Discussion.

Mr. H. Kilgour, of Cheltenham, thought the association was to be congratulated on its choice of subjects for discussion that afternoon, because all of them must be very interested in the large power plants about to be put down in this country. With regard to Mr. Fedden's conclusions derived from a tour through England, he was inclined to disagree with them. In the first place, he did not agree that it was inadvisable to put in steam-turbines to exhaust to atmosphere, and he gave the results of some tests of the steam consumption of turbines running condensing. For a 50-kw. turbine the steam consumption was 28lb. per kilowatt-hour, for a 100-kw. turbine 24lb., for a 500-kw. turbine from 20lb. to 24lb., and for a 1,250-kw. turbine the steam consumption came out at from 19lb. to 22lb. Then again he did not quite agree with Mr. Fedden's statement that the use of surface condensers with turbines was essential. He, however, was entirely in accord with the author's statement of the advantages of turbines. The steam-turbine was the absolutely ideal form of engine for driving machines, in which you only wanted rotation. Again, the higher the speed of the working parts of the dynamos, the more economical was the engine used. The next point was of extreme importance—*i.e.*, the entire absence of cylinder lubrication, and, taking with that the question of superheated steam, they all knew that the use of superheated steam led to marked economy, especially with turbines. With reciprocating engines many makers disliked the use of superheated steam beyond a certain point. One great advantage of the absence of all cylinder lubrication in the turbine was that the exhaust steam was absolutely clean, and could be sent back to the boilers. Then, again, in the 15 months he had been using turbines the repairs had been exceedingly small. His own feeling was very much in favour of turbines.

Mr. C. H. Wordingham observed that on the subject of steam-turbines Mr. Fedden had said nothing about price. Now, this was a very important consideration. When getting in tenders the other day for prime movers, the speaker received one from the makers of these steam-turbines, and he found that the price was about 50 per cent. more than for the other type of engine. Looking into the question of steam-turbines recently, he discovered that in the case of one station, where the turbine had been in use for 16 months and just before certain repairs were executed, the steam consumption was 57lb. per kilowatt-hour. He thought, however, that Mr. Fedden had pointed out some very important advantages of the steam-turbine, not the least important of which were its shape and its low height. The shape of the turbine was very like that of the alligator at Earl's Court, and its low height enabled the height of the engine-room to be very greatly reduced. For alternating work especially there was no doubt that the steam-turbine had a very large field before it. He questioned, however, whether this type of prime mover had yet quite emerged from the experimental stage. Passing to Mr. Day's paper, one was a little startled to find him advocating horizontal engines, which he (Mr. Wordingham) characterised as old-fashioned. No doubt these engines were very economical, but they took up a large amount of floor space, which was an important matter. The saving of floor space must not only be regarded from the point of view of land; land might be cheap, but buildings were not. Mr. Day claimed in favour of the horizontal engine that the length of the steam-pipes could be reduced to a minimum, and that they could be carried underground. He thought this latter advantage was somewhat counteracted by the large space occupied by the boilers. He agreed, however, that horizontal engines could be kept clean at a very much lower cost than the vertical engine. The fourth point urged by Mr. Day, that the repairs to a horizontal engine would be found to be reduced to a minimum if the valve gear be of the Corliss tripped type, was not of much importance, as this type of gear could also be applied to the vertical engine. Mr. Day looked forward a long way in his paper. It seemed to him (the speaker) that if they were going to look as far ahead as this, they must be prepared for gas-engines, and not for steam-engines.

Mr. Kilgour remarked, with reference to the cost of steam-turbines, that in some tenders he got in the other day the price for a turbine set was 20 per cent. lower than the lowest of the other tenders.

Mr. T. P. Wilmshurst, of Derby, was of opinion that since the majority of the engines in the past had been of the high-speed type, the reasons which weighed in their favour then were a sufficient justification for using this type in the future, especially in view of the excellent performance of the best high-speed engines. He took it that the principal points which had determined in favour of the high-speed engines were the small floor space occupied, the requirement of high speds, and also indirectly on account of the no-load factor which they used to have in the early types. These points, however, did not weigh now with the same force as they used to. There was no doubt that the tendency at the present time was to place the stations further out, and he was rather inclined to agree that the slow-speed engine would be used to a very large extent in the future. With regard to the question raised by Mr. Wordingham as to slow-speed horizontal engines being old-fashioned, he thought that those of them who went over the power station at Shepherd's Bush the previous day would hardly call the horizontal engines there installed old-fashioned. He had seldom, if ever, seen a

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station working more smoothly and evenly than that at Shepherd's Bush. He predicted a great future for the horizontal slow-speed engine. He should like to hear a few remarks from the other speakers about gas-engines. Personally he knew nothing about them, and he should like to have the views of others on the subject.

Mr. S. Z. DE FERRANTI said the only complaint he had to make against the two admirable papers before them was that the subject which they embraced was such an enormous one, that it was quite impossible to give to it any sufficient discussion in the short space of time available that afternoon. With regard to the first paper, it did seem strange that there were any other engines in use in this country but steam-turbines, seeing the time that the turbine had been on the market. One would have thought, looking at the beatiful simplicity of the turbine—even as early as in 1894—that there would hardly have been any business for any other class of motor for driving electrical machinery, and it was hard to form any accurate idea as to why it was that it had not made greater progress. He had done some little work, however, on the subject himself, and had just got far enough to see what a difficult problem it was. One of the reasons why turbines had not progressed more rapidly, he thought, was because of their somewhat unsatisfactory partners in the form of the dynamos which they had to drive. No good at all had been done with continuous-current generators driven by turbines. The commutator trouble and that of balancing still remained. In regard to alternators, his opinion was that the steam-turbine had also been very greatly retarded by not having a better alternator to drive. He did not think that the cost of the turbo-driven alternator should be a very great handicap to turbines, as the other economies resulting from their use were very great. With regard to the turbine taking any sort of "food," it was not a good thing to give them wet steam. There was no motor which it was more important to give dry steam to than the turbine. Someone had spoken of the question as to whether the turbine was out of the experimental stage yet. It was very hard to say when anything had got out of the experimental stage — at any rate in engineering matters. Taking the case of the Metropolitan Company in London, this company some years ago used steam-turbines; but when they built their large power station at Willesden, they put down for their first section moderate-speed reciprocating engines, and for their last section they used slow-speed engines. He thought this case said a great deal as to whether or no they had got out of the experimental stage in this matter. Mr. Fedden recommended the engineer to look to the gas-turbine. It was a problem of exceeding great difficulty, and he regarded the gas turbine as yet a long way off. With regard to the second paper, he entirely disagreed with Mr. Day when he said that there was one thing right, and that was the horizontal slow-speed engine. He thought, however, that if one was prepared to pay for the buildings to contain this type of engine, one could get most excellent results from it. But one could get just as good results with other types, and from the point of view of cost he thought it would be found that with other types of engines one could get very much lower charging costs. He suggested that the order in which the different types would come into general use was probably the steam-turbine first, the gas-engine second, and the gas-turbine—if it ever was used at all—last. At present the gas-engine for electrical purposes had not got out of the experimental stage.

Mr. W. A. CHAMEN, of Glasgow, asserted that the first cost of turbine sets as compared with ordinary high-speed engine sets was less, and not more. With regard to the point that steam-turbines were still in the experimental stage, he instanced the case of the two turbine steamers now doing service on the Clyde—the "King Edward" and the "Queen Alexandra"—and remarked that if marine engineers were really come to the conclusion that the steam-turbine suited them, he was sure electrical engineers would get something to suit them. There had been some difficulties with the dynamos used with turbines. Undoubtedly the commutator was a trouble, but at the same time the cost of the commutator was small compared with the cost of the commutator for slow-speed dynamos to give the same output. The trouble with the Parsons turbine-driven dynamo was that the friction was so great that the carbon brushes often took fire. In spite of this it was interesting to note that the Manchester Corporation had ordered two 1,800-kw. sets of the Parsons steam-turbine to be used with continuous-current generators. With regard to gas, he thought it possible that in the end they might get gas-turbines, and, in conclusion, he referred to the loss the industry had sustained by the death of the late Mr. Willans, who had brought the high-speed engine to its present position in the front rank.

Mr. F. A. NEWINGTON, of Edinburgh, expressed the hope that turbines would come to the front. He was well satisfied with all high-speed engines.

Mr. MARTIN, of the Parsons Steam-Turbine Company, explained that as a rule his firm's price for turbines was about the same as for the best class of reciprocating engines. In regard to the question of turning out turbines alike, he assured the meeting that there had been very little alteration in turbines in the last five or six years. It was true that there was a certain amount of vibration with turbines when running them up, but when properly balanced there was practically no vibration at all. As regards wet steam for turbines, it was merely a question of efficiency. The wet steam had about the same effect on a turbine as on a reciprocating engine. Referring to the suggested possible use of carbon brushes in continuous-current machines with turbines, he stated that at the present time the speed was too great to allow of their use.

Mr. A. B. MOUNTAIN, of Huddersfield, said he could not help thinking that a high speed was essential wherever electrical work was concerned, and that sooner or later the turbine with its high speeds must win the day. He could not agree with the author of the second paper that horizontal engines were the correct thing. He suggested that if they could get some really reliable tests of their plants, and could compile the results for future discussion, they would have some basis on which they could calculate the true merits of the different types of engines. It was almost impossible in making calculations to take the guaranteed figures of the engine builders as the figures that could be obtained in ordinary practice.

Mr. CRAWFORD, who has had experience with the Parsons turbines since 1883, was prepared to say that as soon as electrical engineers could produce an electric generator to couple up to a turbine he could introduce one firm at least in England to build the stationary engine. After referring to the use of turbines in torpedo-boat destroyers on account of their high speed, he gave it as his opinion that the question between the high-speed and the low-speed engine was altogether a commercial one. In conclusion, he mentioned a case in which an installation of steam-turbines had been in use for seven years, and were only now about to undergo their first serious overhaul.

Mr. L. ANDREWS, of Hastings, stated he had had a steam-turbine running at Hastings for eight months now, and up to the present he had had no reason to regret the step taken in installing it. He desired to emphasise the statement of Mr. Fedden in the first paper, that it was necessary to have a good dynamo to get a good economy. The turbine at Hastings was recently tested to see what the coal consumption was. On an eight hours' shift the total use of coal for generating the steam when condensing was 76cwt. His experience had been that the weak end of the turbine was the alternator end Another experiment he made was to run the turbine plant for 36 hours at a stretch. As a result, the steam consumption came out at practically the same as was required to work the 100-kw. plant; in fact, the most economical thing he could do would be to run the turbine plant from one year's end to another. As regards price, the cost of a 500-kw. turbine with condenser was practically the same as the reciprocating type without condenser.

Mr. H. W. BOOTH referred to the question of the condensation of the turbine. He thought that when the turbine had a constant load on it, the question was not so important as when it was unloaded. In the latter case, the air was apt to get back into the turbine and get churned up in the plates. This caused friction and loss of

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economy. With regard to Mr. Day's paper, he was pleased to see that the author had spoken up for the horizontal engine. The vertical engine was very badly drained, whereas in this respect the horizontal engine was about as perfect as it could be.

Mr. J. S. HIGHFIELD, of St. Helens, said that the low-speed engines had had too good a time that afternoon. It seemed to him that the makers of high-speed engines had not been given sufficient credit, and he could not help thinking that the high-speed reciprocoating engine was still a good type to use. With regard to drainage, there was at least one pattern of high-speed engine in the market which was absolutely perfectly drained. It was certain that with high-speed engines the station could be kept at least as clean as with horizontal slow-speed engines. He had been closely considering gas-engines in the last 18 months with a view to using this type of engine at an early date, and he quite expected to be using gas-engines of small size soon. There was no question but that there were great difficulties in the way of gas-engines, and he could not help thinking that they were not yet upon the road to have gas-engines of very large power in stations. If they could use gas-engines, however, they could get rid of a lot of steam-pipe troubles, and be able to dispense with a quantity of auxiliary plant.

Mr. W. H. TITTENSOR, of Dundee, commented favourably upon the plan of extensions adopted at Bristol—*i.e.*, erecting the new buildings on top of the old station. The difficulty of the use of turbines at present was to get generators suitable to the prime movers, and therefore he thought it best at this stage, at any rate, to adapt their engines to the electrical machinery of the times rather than of the future. With regard to the figures for steam consumption they had heard that afternoon, he asked whether these were the results of tests, because, if so, they did not help matters much. The figures they wanted must be taken from the weekly report sheet of coal and water consumed.

Mr. ROGERS, of Halifax, said that reference had been made by one speaker to the steam consumption of the turbines at Halifax, the figure having been put at 57lb. per kilowatt. He wished to state that this figure had now been reduced to 33. A point in favour of turbines was that they could be started and got running in about one-eighth of the time of any other prime mover.

Mr. V. A. H MCCOWEN, of Belfast, had had two years' experience of gas-engines in that city, and he agreed with some speakers that there was a number of points in favour of this type of engine The largest sets at Belfast were about 100 h.p., but they had now gone in for steam as being more economical at the present. Whereas with gas the cost per unit of electricity was about 1¼d., with steam the cost came out at about ½d. There was no doubt, however, that when they were able to get larger units and cheap gas, the gas-engine would be the engine of the day

Dr. J. E. PANTON confessed that personally he had not yet come to any conclusion from the discussion that afternoon, and seeing the very low costs obtaining in the various mills in Bolton, he was still in the position for the time being of standing by Mr. Day and his low-speed engine. His ideal of a prime mover, however, was the gas-turbine.

Mr. J. F. C. SNELL, of Sunderland, discussed particularly the merits of the moderate-speed engines. With respect to the long life and low costs of the mill engines and low-speed engines, there could be no question as to the value of both, but on the question whether after 25 years' use of high-speed and low-speed engines there would be found any gain in the latter, he did not know. The question of space, he thought, was not one of very vital importance

The PRESIDENT here observed that, having regard to the lateness of the hour, the authors would prefer to reply to the discussion through the medium of the association's *Journal*.

THIRD SESSION.

The third day's proceedings of the convention were held on Friday at the Institution of Mechanical Engineers, Westminster, Mr. J. H. Rider presided, and there was again a large attendance of members and others interested in the work of the association. The papers read treated of subjects of considerable importance in electrical engineering practice, and elucidated a sustained and lively discussion. The first was entitled "Notes *re* Earthing," by Mr. H. Faraday Proctor, city electrical engineer of Bristol; while the second paper, by Mr J. F. C. Snell, borough electrical engineer of Sunderland, dealt with "The Relative Advantages of Two and Three Wire Distribution." For want of space we are compelled to hold over both of these papers, with the discussions, for a future issue.

General Meeting.

The annual general business meeting of the association took place on Saturday morning at the Institution of Mechanical Engineers, Mr. J. H. Rider in the chair.

The report of the council for the past year stated that during the period under review there has been a large increase in the membership, which now comprises 338, made up as follows: committees (members), 122; electrical engineers (members), 139; associate members, 12; associates, 65. Of these, 79 have been elected since the last convention. The sub-committee appointed to deal with the subject of the repayment of loans has held a number of meetings, and has also met the council of the Borough Treasurers' Association, and as a result of the sub-committee's report to the council of the Incorporated Municipal Electrical Association, a special general meeting of the members was held at the Westminster Palace Hotel, London, S.W., on Feb. 21, 1902. The resolutions passed at this meeting have already appeared in the *Electrical Engineer*. Shortly, they advocated the suspension of the operation of the sinking fund during the first three years from the date of the loan; that no depreciation or further writing off of capital is necessary when the period allowed for repayment of loans is not greater than 30 years; and that a reserve fund should be formed up to the full limit allowed by the provisional order before any contribution is made on behalf of the rates. Subsequently the Borough Treasurers' Association intimated that it approved of the resolutions passed at a special general meeting of the Incorporated Municipal Electrical Association, subject to the following modifications: "Resolution I.—That the suspension of the repayment of the loan (by sinking fund or otherwise) should be deferred until the opening for use of the works for which the money is borrowed, or until the expiration of three years from the borrowing thereof, whichever shall be the earlier." Resolution III.—"That with regard to the third resolution as to the formation of a reserve fund, the council desire it to be made perfectly clear that, whilst agreeing with the principle of the establishment of a reserve fund, the amount thereof should be a matter entirely within the discretion of the respective local authorities, as in their opinion it depends to a very large extent upon local conditions," adding that it would be made known to the Select Committee that the Borough Treasurers' Association supports the views of the Incorporated Municipal Electrical Association upon the subject, subject to the modifications referred to.

In November last Mr. Alderman G. Pearson was presented with the illuminated address unanimously voted to him by the members at the annual business meeting in 1901 in recognition of his invaluable services, particularly in connection with the incorporation of the association. Since the last convention a sub-committee has been appointed, with Mr. H. Faraday Proctor as its hon. secretary, to consider what steps should be taken to forward the objects of the benevolent fund by making it better known to the members, and as a result of the committee's report the following resolution was passed: "That it be a recommendation from this council to a special general meeting of the subscribers, to be held after the 1902 convention, to discontinue the benevolent fund, and to hand over accrued donations and subscriptions to the like fund of the I.E.E."

On the subject of wiring rules, Mr. H. Faraday Proctor, the representative of this association on the Institution of Electrical Engineers Wiring Rules Committee, has reported from time to time to the council of the former, the members of which have received copies of the draft rules drawn up by the Institution, and have made a number of suggestions for their amendment, following which Mr. Proctor has circularised the engineering members of the association asking for their opinion on certain points, particularly on the advisability of permitting or requiring the use of switches and fuses in both or all conductors of electrical installations under different conditions. The matter will continue to receive the attention of the council of the association until the rules are finally approved by the Institution. Mr. S. J. Watson, borough electrical engineer, of Bury, having sent a copy of the "stand-by clause" which they had been successful in getting through the committees of both Houses of Parliament, a copy of the clause was sent by the association to every town clerk and electrical engineer on the list of members. The clause referred to is as follows: "That notwithstanding anything contained in the Electric Lighting Acts, 1882 and 1888, a person shall not be entitled to demand from the corporation a supply of electrical energy to premises having a separate supply, unless such person shall have previously agreed to pay to the corporation such minimum annual sum as will give to the corporation a reasonable return on the capital expenditure and other standing charges incurred by the corporation to meet the possible maximum demand of such person. In case the corporation and the person demanding such supply of electrical energy shall fail to agree on the amount of such minimum annual sum to be paid by such person, the amount of such minimum annual sum shall be fixed by an electrical engineer to be appointed as arbitrator by the president of the Institution of Civil Engineers." Mr. E. T. Ruthven

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Murray has represented the association on the Institution of Electrical Engineers' Committee having charge of the proposed model general conditions for electrical contracts, and copies of the draft conditions approved by the Institution have been submitted to the council of the association.

The council has had under consideration the question of obtaining an amendment to the Board of Trade regulations necessary to allow series incandescent lighting at 500 volts, and has appointed the president, with Mr. W. A. Chamen and Mr. J. S. Highfield, as a deputation to approach the Board of Trade on the matter. A sub-committee has been appointed to consider the advisability of drawing up a set of rules for the use of the police in cases of emergency. These rules have now been drafted. The council has also passed the following resolution: "That in the opinion of this association experience has proved the use of guard wires to be a source of danger to the public, and as there are other and more satisfactory means of protecting telegraph and telephone wires, that the use of guard wires should be abolished wherever possible. This association therefore suggests to the Board of Trade and the Post Office authorities that the proposed regulations should be modified, and that the Board of Trade and the Post Office authorities be asked to receive a deputation from the association." The council has been approached on the subject of its taking up the question of obtaining some modification of the Factory Act to suit the conditions of electric generating stations, but in view of the fact that the Institution of Electrical Engineers was also about to move in the matter, it was resolved to support any reasonable action which the Institution might take.

Mr. R. C. Quin, of Blackpool, has resigned his seat on the council on leaving municipal employ, and Mr. R. A. Chattock, of Bradford, has been appointed in his place. Mr. Councillor Worthington, of Wigan, has resigned his seat on the council, and Mr. Alderman Potter, of Taunton, has been appointed in his place. The council has had under consideration the advisability of forming a parliamentary committee to keep in touch with and to obtain information as to Bills before Parliament affecting electrical undertakings under municipal control, and has passed the following resolution: "That it is desirable to appoint a parliamentary committee which will report from time to time upon clauses and decisions affecting municipal electrical matters." Generally the council is pleased to find that the association continues to receive the support of an increasing number of electrical engineers and representatives of municipalities, and takes this opportunity of expressing its appreciation of the kindness extended by municipalities and others to the members at the annual conventions.

In the short discussion which followed the reading of the above report, the subject of the repayment of loans was especially referred to, and it was resolved to circularise town clerks with a view to obtaining from them copies of any clauses in relation to the matter that have been inserted in parliamentary Bills and in Acts of Parliament, and any other like information of interest to the association.

The report was adopted unanimously.

The next business on the agenda was the election of a president for 1903.

Mr. T. P. WILMSHURST proposed Mr. F. J. C. Snell, of Sunderland, for the vacant post, and the motion was seconded by Mr. J E. Edgcome. There being no other nominee, Mr. Snell was unanimously elected president for the ensuing year, and it was also decided to hold the next annual meeting of the association in Mr. Snell's town.

On the subject of the new council to be appointed, Mr. RIDER said he had been informed that there was a certain amount of dissatisfaction as to the composition of the council. It had been said that the council was a clique, a suggestion which he absolutely denied, pointing out that such a state of things was impossible in view of the fact that the practice of the association was to elect the members of the council in open meeting. In this way any clique was prevented.

Mr. GAY expressed the opinion that no better method of election could be adopted.

Balloting for the officers and council for 1903 then took place, with the following result: vice-presidents—Mr. J. E. Edgcome (Kingston-on-Thames) and Mr. T. P. Wilmshurst (Derby); chairmen of committees (members)—Alderman Bruce (Sunderland), Councillor Skinner (Hull), Councillor J. P. Smith (Barrow-in-Furness), Dr. J. E. Panton (Bolton), and Alderman W. Potter (Taunton); electrical engineers (members)—Mr. J. Christie (Brighton), Mr. L. Andrews (Hastings); Mr. V. A. H. McCowen (Belfast), Mr. H. Faraday Proctor (Bristol), Mr. A. S. Barnard (Hull), Mr. R. A. Chattock (Bradford), Mr. J. S. Highfield (St. Helens), Mr. F. A. Newington (Edinburgh), and Mr. C. D. Taite (Pendleton); hon. solicitor—Alderman G. Pearson; hon. treasurer—Mr. J. H. Rider; and hon. secretary—Mr. E. T. Ruthven Murray.

[It will be observed that this year the number of committee members has been increased from four to five, and that of engineer members from eight to nine.]

The PRESIDENT next moved the adoption of the statement of accounts and balance-sheet for the year ending Dec. 31 last. Commenting on the deficit there shown of £57. 1s. 11d., he explained that this was mainly due to the expenses attending the incorporation of the association last year. This year, however, there were additional sources of income, the membership having increased considerably, but he warned them that in the near future they might have to face an increased annual subscription for all classes of members.

The accounts were then agreed to.

Votes of thanks were next passed to the committee of the tramways exhibition for their hospitality during the convention, to the council of the Institution of Mechanical Engineers for the use of their building, and to the following companies, whose works were left open for inspection by members of the association during the convention: Central London Railway Company, Metropolitan Electric Supply Company, Incandescent Electric Lamp Company, City of London Electric Lighting Company, and Messrs. J. G. White and Co, Limited, the contractors for the conduit system of tramways on the Tooting lines of the London County Council.

The official business of the meeting being over,

Mr. J. H. CLOTHIER (Stafford) rose to request the council to take into consideration the question of the affiliation of technical schools and colleges in municipal and city boroughs with this association. He urged that if this were done the students would have opportunities of gaining knowledge from central stations which would be of great value to them in after-life, and would also reap various other advantages.

The PRESIDENT promised that the council would take the matter into consideration.

A vote of thanks to the president for the able way in which he had conducted the affairs of the association during his year of office brought the proceedings to a close.

At a special general meeting of the contributors to the benevolent fund of the association, held immediately afterwards, it was unanimously resolved to discontinue the fund and to hand over the accrued donations and subscriptions to the like fund of the Institution of Electrical Engineers.

SMOKING CONCERT.

On Friday evening a smoking concert in connection with the convention was given in the banqueting hall of the St. James's Hall Restaurant, Regent-street, W. Heretofore it has been the practice of the association to hold a dinner on the occasion of their annual convention, but this year the opinion of the members was taken on the point, and as a result the smoking concert on Friday night was substituted in place of the usual banquet. The excellence of the programme provided was testified to by the good reception accorded the artistes throughout the evening. A small string orchestra cleverly executed a number of acceptable items, including the overture "Poet and Peasant" (Suppé), "Czardas" (Michels), "Intermezzo" (Mascagni), "Benedictus" (Mackenzie), and "A Frangesa" (Costa). Dr. Byrd Page was very successful in his numerous tricks of deception, which he performed with considerable skill, and Mr. T. E. Gatehouse was equally welcome in a couple of violin solos, gaining a sympathetic hearing. The vocal element was provided by Mr. Thos. H Harrison in "Love's Coronation" (Florence Aylward) and "When the Boys Come Home" (Francis Allitsen). Both songs were rendered in good style, and received a well-deserved ovation. Mr. Tom Clare caused much amusement with his musical sketches, and altogether the concert may be voted a great success. To the majority this form of entertainment was much more acceptable than a banquet, especially at this time of year, and it is probable that the precedent set this summer will be followed at subsequent conventions of the association.

Manchester.—The Corporation have accepted the tender of Messrs. Rowland Carr and Co., of London, for the supply of the whole of the cast-iron troughing required by their electricity department for the next 12 months.

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CONTENTS.

Notes	37	Forthcoming Events	60
Tramways and Light Railways Exhibition at the Agricultural Hall	42	Appointments Vacant	60
		Special Illumination Work	61
		Legal Intelligence	61
Incorporated Municipal Electrical Association	46	Companies' Meetings and Reports	61
Crompton and his Critics	54	Contracts for Electrical Supplies	63
Correspondence	55	Traction Notes	64
The "Castelli" Coherer and the "Royal Italian Navy" Coherer	55	Lighting Notes	66
		Provisional Patents, 1902	70
Questions and Answers	56	Traffic Returns	72
Sunderland Electricity Accounts	60	Companies' Stock and Share List	72

TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed*

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CROMPTON AND HIS CRITICS.

It would seem a work of supererogation to champion Colonel Crompton's views as regards tramways in certain positions and under certain unfavourable conditions. Colonel Crompton is quite capable of taking care of himself—perhaps too much so, as thereby he often stops those friendly to his views from expressing their approval because of a seeming lack of *sauviter in modo*, leaving them to imagine that his sole reliance is on the *fortiter in re*. Colonel Crompton is one of those accustomed to look a little ahead and to enquire carefully if all things are what they seem. His detractors, or, rather, his critics—if critics they can be called—have no thought for to-morrow, and no thought but for themselves. They act as if they conceived all who do not express favour with everyone of their schemes to be actuated by selfish motives, and not for the good of the industry at large. The promoters of tramway schemes also have our sympathies, so that in this case we may be said to blow both hot and cold. But there are schemes and schemes. Many which appeal most forcibly to the promoter are those which work worst against the general community, while those which show in the first instance the worst estimate for dividends, are generally those which will greatly assist the development of trade. Every promoter wants to jump into a nice little nest egg without working very hard for it; nor is the promoter a *rara avis* in this particular, for 'tis in man's nature so to do. Why then blame him too much? On the other hand, why is the man who points out fads which militate against the general utility of a tramway in a particular neighbourhood to be sneered at? Not one of the individuals that have sneered at Colonel Crompton's statement of facts have troubled to advance proof of their inaccuracy. Their aim has been to try and make it appear that Colonel Crompton spoke with two separate voices, and, therefore, neither voice ought to be credited. We have suggested that this is only what might have been expected, and that each voice must be considered with the conditions attached to the argument, and then each voice savours of experience and sound judgment, and is perfectly trustworthy and true. One of the most ridiculous statements that has ever been flaunted before an ignorant public, is that tramways present the best means of getting a large number of people to and from a particular place. That statement is only true in exceptional cases and under extremely favourable conditions; generally it is absolutely incorrect, and in many cases the conditions are so unfavourable that tramways form the very worst means to move a large number to or from a place. Anyone who cares to do so can give all sorts of examples—good, bad, and indifferent; hence to generalise from special cases is a kind of special pleading, and altogether misleading. Colonel Crompton has not condemned tramways *en bloc*. He has, however, pointed out conditions wherein they fail, and in that has shown the true instincts of an engineer. The principle of admitting tramways at all in the public streets is one that has never been properly considered, and we are exceedingly doubtful if every such tramway is not constitutionally illegal. It looks like gross ignorance to say that Parliament can err, and that an Act duly passed may be unconstitutional. Yet, peculiar as that may seem, it may just be possible. Parliament may pass special Acts, but it cannot generally legalise thieving or murder. We have never yet been able to see why the streets—which really belong to the community, their construction and maintenance being vested in an authority subject to the community—can ever by a special Act of

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Parliament be handed over to a section for the purposes of a section of the people. Street obstruction is illegal and punishable; hence if tramcars obstruct, as Colonel Crompton says they do, their proprietors—public or private—can be proceeded against for such obstruction. Of course, obstruction has to be proved; and here comes the crux of the whole matter. Where no obstruction exists, tramways are probably a great advantage. In many cases the obstruction is insufficient to outweigh the advantages, and in neither of these cases will there be found anyone ready to put the law in force. In another—and we admit the smallest number of cases—obstruction is clear to everybody, and we believe a combined action by those obstructed would lie, and a favourable verdict be obtained.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE INSTITUTION.

SIR,—In a recent number you reprinted the letter which is now being circulated amongst the Institution of Electrical Engineers dealing with subscriptions, and you make certain remarks regarding the same.

I now write to say that I am in entire accord with what you say on the subject. In my opinion the building fund can very well afford to increase naturally by compound interest, as it is now £10,000 or more, and if higher subscriptions are required—to which I do not object provided they are properly applied—I think that a strong political fund should be started, as the recent indifferent—or it might be called contemptuous—attitude of the Board of Trade to the deputation of some of our leading electrical engineers convinces me that without it very little practical results may be expected in the shape of reform of the present tyrannical and unjust state of the law relating to electrical industries.

In my opinion, all we need for the present is to allow the building fund to go on accumulating naturally at compound interest and to keep up a suitable set of offices, and a fighting political staff, whose primary object would be to push the electrical interest in Parliament and make it disagreeable for presidents of the Board of Trade who flout the profession.—Yours, etc., T. P. OSBORNE YALE.

Blaenau, Festiniog, North Wales, July 2, 1902.

[Quite a number of members have expressed their accord with our remarks as regards subscriptions, etc., but, on the other hand, we do not go all the way with Mr. Osborne Yale about a "political fighting staff."—ED. *E. E.*]

TRAMWAYS.

SIR,—What a blessing it will be when the sensible, common-sense views of Colonel Crompton have been driven into our local authorities! I have always maintained that there was an area at the heart of our crowded cities within which no tramway should be permitted, because the congestion of traffic would only be accentuated by its monopoly of the centre of the roadways; but after reading Colonel Crompton's letter one is convinced that the construction of tramways on our main suburban roads is also an unmixed evil. Let anyone watch a motor vehicle threading its way among the traffic in a crowded road where there are no trams, and then watch the same thing where there *are* tramrails, or where the local authority has narrowed the road by placing lamps on refuges every 40 or 50 yards along the centre of the street, and he will be convinced the tramway authority (or the local authority in the case of lamps) has greatly interfered with the user of the road by the general public for the fancied benefit of some particular class of persons.

You, Sir, have consistently opposed the extension of tramways in crowded towns, but it seems a hard matter to convince local legislators. I only hope that Colonel Crompton will spare no efforts to educate public opinion in the matter.—Yours, etc., T. W. E. HIGGENS.

Chelsea, July 5, 1902.

THE "CASTELLI" COHERER AND THE "ROYAL ITALIAN NAVY" COHERER.

(*The End of a Scandal.*)

BY PROF. ANGELO BANTI.

[We had prepared a note on the subject of this coherer, but Prof. Silvanus Thompson, F.R.S., has kindly sent us the accompanying translation of Prof. Banti's article, which is herewith given in full.—ED. *E. E.*]

Our article (in the May number of *L'Elettricista*) on the work accomplished upon wireless telegraphy in the Royal Italian navy has brought down upon us certain courteous observations to the effect (*a*) that we have attributed to Castelli a merit higher than that due to the work accomplished by him; (*b*) that we have neglected to speak of the experiments executed at Spezia under the direction of Lieutenant Solari; (*c*) that we have erroneously affirmed that the coherer adopted by Marconi in his (telephonic) Transatlantic transmission was that of Castelli, while the coherer adopted by Marconi was of a type baptised a few days before by the characteristic denomination of the "Royal Italian navy coherer."

Well now, since the foregoing observations, however courteous, might constitute an accusation against us, we believe it needful to justify what we have done. First of all let us pause to inform our readers that the notes contained in the article of May last were gathered from certain official reports, kindly communicated to us by the Ministry of Marine, and were compared with the extract of a memoir by Captain Quintino Bonomo, which was contemporaneously published in the *Rivista Marittima*. Let us now examine separately the three questions:

I. *The Castelli Coherer.*—Castelli, a semaphorist, corporal in the Royal Italian Navy, was occupied on the experiments on wireless telegraphy which were executed at Livorno under the direction of Captain Bonomo. Bonomo, in a report sent to the Ministry of Marine, and thence communicated to us, as was said, wrote as follows about Castelli:

"Faithful to the principle of never initiating new experiments before having completed those in course, and in the hope of obtaining other advantages over those announced with the Marconian apparatus, I postponed till later experimenting on telephonic methods of receiving . . . " etc.

"But toward the end of January of this year (1901) the insistence of the petty officer, Semaphorist Paolo Castelli, urged me to experiment earlier with this system of reception with the telephone."

Furthermore, Bonomo observes:

"Castelli asserts that he had first thought of the possibility of telephonic reception in the spring of 1900, and his assertions are to be trusted, since he could not have known of the experiments of Tommasina, nor of those of Popoff, since, so far as I am aware, these were only reported by scientific journals which were certainly not read by Castelli."

Captain Bonomo himself relates the results obtained by telephonic reception, and expresses himself with respect to the Castelli coherer in the following terms:

"The sensitiveness of ordinary coherers being such as to exclude them from use in telephonic reception, recourse must have been had to self-decohering tubes of carbon powder, when *Castelli conceived the use of a tube with electrodes of carbon holding two drops of mercury separated by a short cylinder of iron.*

"Although this tube was roughly *constructed*, the results were surprising, and on Wednesday, Feb. 20, 1901, not only could the transmission from Palmaria be received, but one could accurately distinguish the rhythm of the oscillator at that station, so as to be able to count the component sparks."

Bonomo finishes by saying that the telephonic method of receiving by means of the Castelli coherer was completely substituted for the Marconian method of receiving.

Referring now to the publication made by Captain Bonomo himself in the *Rivista Marittima*, we find in it confirmed and completed what he had already communicated to the Ministry, as may be gathered from the following paragraphs, which, for the sake of precision, we will transcribe:

"It was our intention to work out completely the studies on the Marconi apparatus before experimenting with the methods

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proposed by Popoff and by Tommasina, when the desire expressed by the Semaphorist Castelli to experiment on telephonic reception with a tube *constructed* by him impelled us to make some experiments independent of those in progress."

"The result was excellent, and the tubes invented (*ideati*) by Castelli, with electrodes of *iron* or *carbon*, with *one* or *more drops of mercury*, besides presenting an extreme sensibility, decohered perfectly immediately on the cessation of the action of the electric waves, similarly to those of carbon, yet with greater constancy and precision than those possessed or constructed by us."

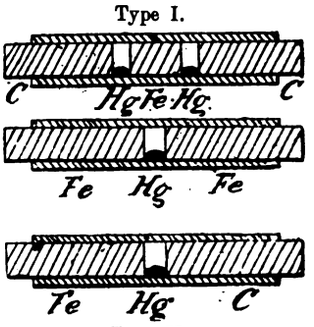
On page 58 of the same memoir Captain Bonomo repeats that the tube was *invented* (*ideato*) by Castelli, and *proposed* by him for telephonic reception.

In conclusion, Castelli *invented* the coherer, *constructed* it, and *proposed* it for telephonic reception. *Eh, via* (now then), what more could the poor corporal have done?

II. *Solari's Experiments.*—We were not able in our article of May to speak of these experiments on wireless telegraphy at Spezia by the *personnel* of the Royal navy, under the direction of Lieutenant Solari, for two very simple reasons: the first, because the Ministry of Marine did not communicate to us any Solari report; the second, because Solari himself, with whom we have had opportunity to speak on divers occasions, never informed us, for reasons of military discipline, that he had carried out experiments at Spezia, still less that he had contributed to the construction of a new coherer. Certainly we could not have divined it!

But, nevertheless, to-day we are in a position to refer to the studies of Solari carried out at Spezia. It is needful here only to relate that the result of the aforementioned studies was the construction of a tube consisting of two electrodes, one of iron and one of carbon, enclosing a drop of mercury. With this design it is useful to call to mind that the tubes invented by Castelli were composed, as we have above related, of electrodes of iron or of carbon enclosing *one* or *more* drops of mercury. The difference, then, as the annexed figure shows, between the Castelli tubes, type I., and that of type II., called "Royal Italian navy coherer," would consist in this—that in type I. one electrode of iron should be suppressed and one of carbon substituted.

Type I.



Type II

We do not wish to enquire whether the "Royal Italian navy" coherer is derived from the other, or whether it is quite one and the same thing as the tube of type I., since the intelligent reader can draw his own conclusions. For our purpose it is enough to raise the following point. Let us admit that the experiments directed by Bonomo at Livorno, and those directed by Solari at Spezia, were made secretly and independently of one another. Since, as the secrecy of military discipline certainly excludes any exchange whatever of ideas, or, still more, of notes between these same officials, it must equally have prevented the experiments of Livorno from being known at Spezia, or *vice versâ*. For this we have nothing but to rejoice, because it demonstrates the traditional fecundity of Italian genius. But merely for accuracy in dates we are in duty bound to state that the experiments of Bonomo were begun in September, 1900, and yielded on Feb. 20, 1901, the best results, thanks to the adoption of the Castelli coherer, while the experiments executed under the direction of Lieutenant Solari were initiated in January of 1901, and were terminated in the summer of the same year.

III. *Coherer Adopted by Marconi in the Transatlantic Transmission.*—Lieutenant Solari, being sent by the Italian Government to London to acquire some syntonised apparatus, made a present to Marconi of a tube with one electrode of iron, one of carbon, and a drop of mercury interposed. Having it, Marconi asked who had invented that tube. Solari answered that this coherer was not invented by him, but was the fruit of the studies made by the Royal Italian Marine. From this came about the characteristic name "Italian navy coherer." But this denomination, which may content Marconi and Solari in London, cannot have any consideration for us in Italy, this baptism of the coherer being a wholly personal affair between Marconi and Solari. Since in Italy no distinction between types I. and II. of the coherers was made, the iron-mercury-carbon tube was considered as belonging to Castelli—so much so that the news of the successful Transatlantic transmission by means of the Castelli tube was learned by us *at the Ministry of Marine.*

Let us then correct ourselves that the coherer adopted by Marconi ought to have been called the "Italian navy coherer" instead of Castelli coherer; but let us, nevertheless, honestly avow that we have not published any *false* thing, but that instead there has been raised a question of "soup and sops"* for the purpose of concealing some manœuvres to which we are strangers.

And this suggests that——?

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

497. In fixing a system of electric signals for pit and tank work, wires to be carried down rather wet shaft 500 yards deep, five sets of give and return signals and one telephone are required. The signals, one set are required give and return from pit bottom to banksman, the others from dips to surface give and return. What system of wiring would you adopt—multiple cable or single wires? Would you use iron pipes to run wires in, also would you use pipes for return, or one common wire? Give sketches of connections.—D. E. J.

498. With a series motor of about 50 h.p., run at 500 volts, 1,000 revolutions per minute, being used for winding at colliery, in case of signal being given to stop when running at full speed, is it safe or advisable to reverse and put the current against it while the motor is still running for the purpose of stopping it? If not, why not, and what is the danger?—G. H. O.

ANSWERS.

Question No. 491.—Explain in detail why triple-concentric, lead-covered cables cannot be used for three-phase work. What advantages are obtained by using three core cables for this work?

Best Answer to No. 491 (*awarded* 10*s.*).—It is not correct to state that triple-concentric cables cannot be used for three-phase work, as they are successfully employed on many installations, but it is true that three-core cables are preferable, especially in the case of heavy currents and long distances. The difficulty with triple-concentric cables is the inequality of the inductive drops in the three conductors, and the consequent unbalancing of the load on the three phases, due to the relative positions of the conductors.

The effect can perhaps be most clearly explained by assuming that the alternator supplying the cable has a star-coupled armature, with the neutral point earthed, and that the far ends of the three conductors are also earthed, as shown in Fig. 1. In this way it is possible to consider

* Italian proverb for a storm in a teacup.

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the current and voltage to earth of each conductor separately. The actual effect would, however, be exactly the same with a mesh-coupled armature, and without any earth connection. The inner conductor I. (Fig. 2), carries a current, C_I, which gives rise to a certain amount of magnetic flux, being partly in the metal of the conductor I., and partly in the insulation between I. and II. The

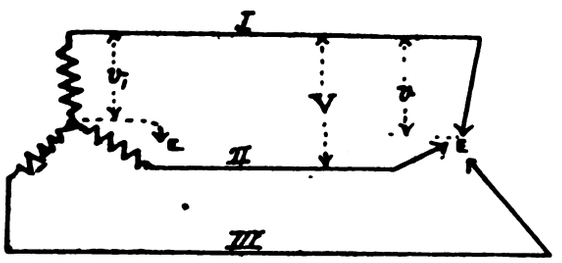

FIG. 1.

value of this flux in C.G.S. lines per ampere per centimetre length of cable—*i.e.*, in henrys per centimetre length of cable $= L = \left(2 \log_e \frac{b}{a} + \frac{1}{2}\right) \times \frac{1}{10^9}$, where a is the ratio of the inner and b of the middle conductor (Fig. 2).

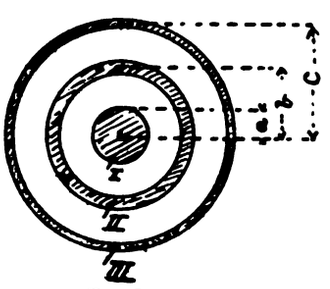

FIG. 2.

This flux induces a voltage in conductor I. equal to

$$2\pi \sim l\, C_I\, L \quad . \quad . \quad . \quad . \quad (1)$$

where $\sim$ = periods per second,
l = length of cable in centimetres,
and a sine wave current is assumed.

This voltage lags 90deg. behind the voltage between conductor I. and earth. The above flux has no effect whatever on conductors II. or III. There is, however, an additional flux in the insulation between II. and III. due to the combined action of the currents in conductors I. and II., and the value of this flux per ampere of combined current per centimetre length of cable is $2 \log_e \frac{c}{b} \times \frac{1}{10^9}$ where c is the radius of the outer and b of the middle conductor (the thickness of the conductors II. and III. is neglected, as it is usually relatively small). The current in conductor I. is displaced 120deg. in phase (either leading or lagging) from the current in II., and the combined effect of two such currents can be shown to be the same as that of a current equal in amount to either of the separate currents, and having a phase displacement of 60deg. from both the separate current (60deg. ahead of one and 60deg. behind the other). The total flux per centimetre of cable in the insulation between conductors II. and III. is consequently $2 \log_e \frac{c}{b} \times \frac{1}{10^9} \times C_I$, the currents C_I, C_{II}., and C_{III} being assumed equal. This flux induces a voltage in both cables I. and II. of an amount equal to

$$2\pi \sim l \left(2 \log_e \frac{c}{b} \times \frac{1}{10^9} \times C_I\right) \quad . \quad . \quad (2)$$

and this voltage is at a phase angle of 90deg + 60deg. (= 150deg.) to the voltage of one of the cables (I. or II.), and at an angle of 90deg. – 60deg. (= 30deg.) to the voltage of the other. Conductor I. is therefore affected by both fluxes, while conductor II. is only affected by the flux lying between II. and III., and conductor III. and the lead covering outside it are unaffected by any flux, and have no direct influence on the inductive drop.

The actual value of the drop as a percentage of the supply voltage is best obtained by means of diagrams, as in Figs. 3 and 4. Fig. 3 shows the conditions of the inner conductor I.; A B is the voltage required between the far end of the conductor I. and earth (= v, Fig. 1); B C is the reactive voltage given by formula (1) due to the current C_I in the inner conductor; C D is the reactance voltage (Formula 2), due to the combined action of currents I. and II. (taken as at 150deg. to A B). A D is then the actual voltage (v_1, Fig. 1) required at the generator end of conductor I., and A D – A B is the voltage drop (or rise), neglecting the resistance drop. Fig. 4 refers to the

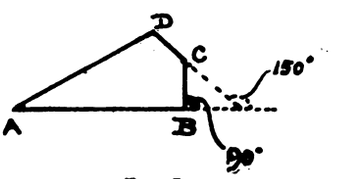

FIG. 3.

FIG. 4.

middle conductor II. A B again equals the voltage between the far end of the conductor and earth; B D = reactance voltage (Formula 2) due to the combined action of currents C_I and C_{II} B D is shown lagging 30deg. behind A B, but might have been shown with a 150deg. lag, the lag of C D in Fig. 1 being altered at the same time from 150deg. to 30deg. A D – A B is the drop in voltage of the middle conductor II. In the case of the outer conductor, III., the voltages at the two ends of the line would be alike (neglecting the resistance drop).

The following example will indicate the sort of values obtainable:

Let the current per line = $C_I = C_{II} = C_{III} = 500$ amperes.

Voltage between any two lines = 500 (= V, Fig. 1).

Voltage of any line to earth = $\frac{500}{\sqrt{3}} = 290$ volts (= v, Fig. 1).

$\sim = 100$. Length of cable = 100 yards = 91,000cm. = l.

Let the inner conductor I. be ·75in. diameter (a = 375), b = ·575in, c = ·8in.

Then (Formula 1)

$$2\pi \sim L\, l\, C_1 = 2\pi \times 100 \left(2 \log_e \frac{\cdot 575}{\cdot 375} + \frac{1}{2}\right) \times 91{,}000 \times 500 \times \frac{1}{10^9} = 39 \text{ volts};$$

and (Formula 2)

$$2\pi \sim l \times \left|2 \log_e \frac{c}{b} \times 500 \times \frac{1}{10^9}\right. = 19 \text{ volts.}$$

Combining these as in Figs. 3 and 4, we find the drop in the middle conductor (A D – A B, Fig. 4) to be about 5 per cent., whilst the inner tube is not only free from drop, but has an actual rise in voltage of about 1½ per cent. (= A B – A D) as the current rises from zero to 500 amperes.

The outer conductor has no reactive drop The differences in drop in the several conductors may become accentuated when there is an inductive load on the circuit. The employment of a three-core cable with the three conductors placed at the corners of an equilateral triangle entirely prevents this unequal distribution of the drop, as all the conductors are symmetrically situated with regard to one another.—Q.

Answer to No. 491 (*awarded* 5*s.*).—Three-phase concentric cables are not suitable for working at very high pressures, as, owing to the great electrostatic capacity between the two outer cylindrical conductors, the capacity current in them is so large that it makes regulation almost impossible.

In Fig. 1, circles 1, 2, and 3 represent the sections of the copper conductors, and 4 that of the lead sheathing. The areas of the sections of the copper conductors must, of course, be equal, and the thickness of the dielectric between 1 and 2 must equal the thickness of the dielectric between 2 and 3. If l be the length of the cable in centi-

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metres, the capacities between 1 and 2, 2 and 3, and between 3 and 4 will be

$$\frac{K\,l}{2\log_e \frac{r_1+d}{r_1}},\quad \frac{K\,l}{2\log_e \frac{r_2+d'}{r_2}},\text{ and }\frac{K\,l}{2\log_e \frac{r_3+d'}{r_3}}$$

respectively. In these formulæ K is the specific inductive capacity, d the thickness of the dielectric between 1 and 2 or between 2 and 3; d' the thickness of the dielectric

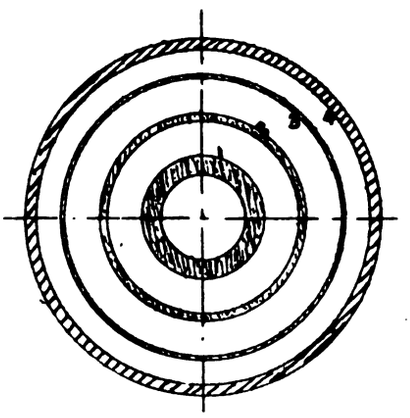

FIG. 1.

between 3 and 4; r_1, r_2, r_3 are the outside radii of the three copper cylinders. The formulæ give the capacity in electrostatic units. To get the capacity in microfarads, we have to divide by 900,000.

In Fig. 2 a rough representation is given of the relative magnitudes of the three condensers. The effect of the extremely large capacity between the outer conductor and the lead sheathing will be to make the potential difference between 3 and earth always very small, and hence the

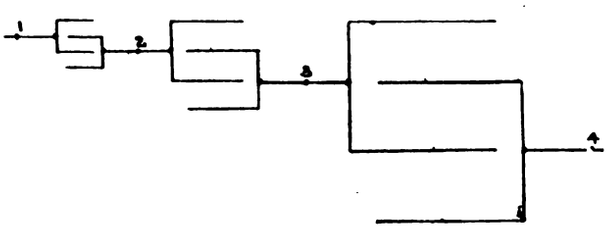

FIG. 2.

potential difference between 1 and earth will be very high. We cannot, therefore, arrange so that the three mains will be at the same potential difference from earth, and hence we shall lose what is supposed to be the saving effected by the three-phase system.

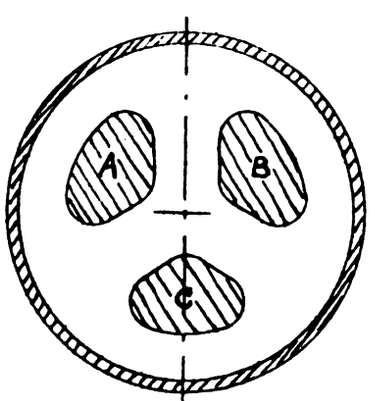

FIG. 3.

With a three-core cable, on the other hand, such as the well-known "clover leaf" cable (Fig. 3), it is well known that all the capacity currents are equal. In fact, the capacities between the mains and the sheathing are equivalent to the diagram shown in Fig. 4. (See Russell on "The Capacities of Polyphase Cables," *Journal* of the Institution of Electrical Engineers, vol. xxx.). The capacities A, B, and C, shown in Fig. 4, are less than the capacity shown between 1 and 2 in Fig. 2. For example, in the three-core, extra high tension cable used by the Manchester Corporation the capacities of A, B, and C are only about 0·3 of a microfarad per mile. Hence the condenser current in each of the mains is only 0·39 of an ampere per mile, the pressure between a main and the sheathing being 3,750 volts and the periodicity 50. An examination of Figs. 1 and 3 shows that much less insulation is required for 3, and hence it can be made more cheaply. The only advantage of concentric three-phase mains would be that

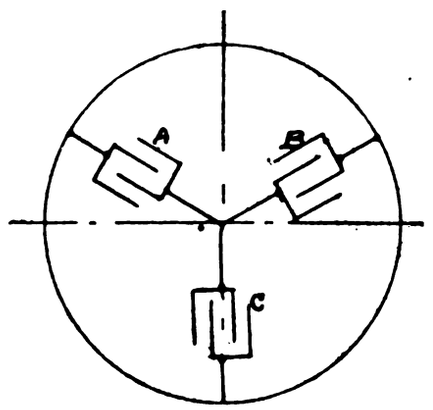

FIG. 4

they would not disturb telephone lines in their vicinity. The disturbance made by three-core cables would, however, be small.—J. C. R.

Answer to No. 491 (*awarded* 5*s.*).—It is a well-known fact that concentric mains possess a high capacity relative to other forms of mains. This is the chief objection to their use for alternating-current work. When a capacity is placed in series with an alternating E.M.F. it absorbs current. This "condenser current," as it is called, is given by the expression

$$I = 2\pi e \sim K\,10^{-6},$$

where e = effective volts,
$\sim$ = frequency, and
K = capacity in microfarads.

Now, in the case of a simple "lead and return" concentric cable

$$K_1 = \frac{\cdot 129\ l}{\log_{10}\frac{R}{r}}\text{ microfarads,}$$

where l = length in miles,
R = radius of inner circumference of outer cable, and
r = radius of inner core.

In this expression Kapp's ("Transmission of Energy") 3·3 is taken as the specific inductive capacity. If the same number is taken as above for two wires (lead and return) running side by side

$$K_2 = \frac{\cdot 0192\ l}{\log_{10}\frac{d}{r_2}},$$

where l and r_2 are as before, and d = distance apart of the centres of the wires.

Now,
$$\frac{K_1}{K_2} = \frac{\cdot 129}{\cdot 0192} \times \frac{\log_{10}\frac{d}{r}}{\log_{10}\frac{R}{r}}.$$

Thus it will be seen that the capacity of the concentric cable is very much greater than the capacity of two cables side by side, or of a two-core cable.

The case would be similar for three-phase work. Now, the effect of this high capacity is to make an idle current flow in the conductors, which, when the voltage is high and the length of the cable long, amounts to no inconsiderable amount. This current does nothing whatever except heat up the cable. It will be remembered that at Deptford concentric cable was laid from the London Electric Supply Corporation's station to London. This cable, Kapp informs us, had a capacity of ·367 microfarad per mile (a very appreciable amount). Also, to quote his "Trans-

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mission of Energy," he says: " . . . if such a cable were used for a pressure of 10,000 volts, was 20 miles long, and the periodicity was 50 per second, the condenser current would be 23 amperes." Now, if power was being transmitted at the pressure stated, the current it would be transmitting would probably be comparatively low. Hence 23 amperes would have an appreciable effect. Thus a concentric cable would have to be larger in cross-section, thereby defeating the great object of economy in first cost of the cable. There is also another thing to note. The effect of the capacity is not only to require a slightly increased current, but it also requires a slightly *decreased* voltage. In fact, in the case of the Deptford mains already mentioned, the pressure drop along them was found to be much less than anticipated. With a three-core cable the above disadvantage is not by any means nearly so great.—T. T.

Question No. 492.—Is there any remedy, other than a metallic return, for reducing the cross-talk of a single earth-return telephone circuit, whose line runs parallel for 10 miles with other telephone wires, which have in no way any connection to the telephone in question. Loud noises, and other conversations, are heard even better than its own.

Answer to No. 492 *(awarded 7s. 6d.)*—The question does not state whether the telephone line on which the disturbances are heard, is run on the same poles as those lines which accompany it for 10 miles of the route. If such is the case, a direct leakage of current from wire to wire over the arms may cause the fault; if so, attention to the details of earth wiring each pole with a properly connected and earthed lead will remedy the cross-talk. Assuming, however, that the details of construction are correct, or that the lines run on separate poles, the loud noises and cross-talk arise from inductive disturbances. There are two kinds of induction—electromagnetic and electrostatic. The former is negligible where telephone circuits only are concerned, but electrostatic induction is a serious source of trouble, and the case under consideration is, no doubt, the whole cause. This is very difficult to eliminate.

A charge of electricity induces charges of opposite sign in all surrounding objects, and, as the primary charge varies in sign or quantity, so the induced charges also vary to a degree depending on distance. In telephone wires a current is continually circulating, and alternates with high frequency, thus rapidly charging and discharging the whole length of line. The earth return telephone circuit is consequently charged and discharged correspondingly with induced electricity of opposite sign, and it is, therefore, obvious that currents flow through the telephone receiver at either end to and from earth, which is at zero potential. These currents reproduce the vibration of the inducing currents, and clear speech or confused noises are overheard from the parallel wires. Where the circuit is metallic, twisting the wires produces neutralisation of the electrostatic effect, and is the only sure method of eradication. A similar arrangement is obviously impossible with an earth return, for the earth, which takes the place of the return wire, is permanently at zero potential, and the discharges must pass through the telephones to earth.

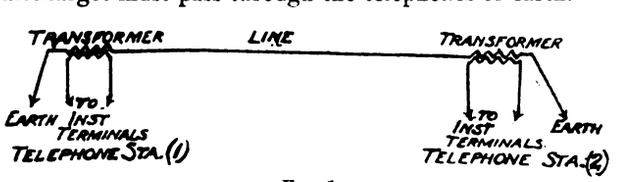

FIG. 1.

It is possible, however, by means of a transformer, to practically neutralise cross-talk and reduce noises to such an extent that speech is not interrupted. The primary and secondary of the transformer coil should be wound to approximately the same resistance. That form of transformer known as the "Liverpool repeater" is most suitable on account of the closed magnetic circuit. They are usually wound to resistances of 290 and 140 ohms. Put the line to earth through the secondary coil at each station (see Fig. 1). Join the line terminals of the instruments to the ends of the primary as indicated, making a complete metallic circuit through instrument and primary coil.

Electrostatic charges produce very small currents of high voltage, and as the effect on the transformer coil is equal to E × C minus the energy lost in transformation due to dissipation in heat, etc., the cross-talk and earth disturbances are lost in the transformer coils, for current is the only factor which affects the telephone receiver. If the line is long, it should be noted that a good form of granular transmitter gives the best results over circuits in which transformers are introduced, as larger variation of current is obtained from that pattern. It will also be necessary to use a magneto-generator for ringing.—H. T.

Answer to No. 492 (*awarded 7s. 6d.*).—The cross-talk in a telephone like this may be due to two causes, which are very often difficult to get rid of: (1) static induction, (2) dynamic induction. Let us consider these two separately.

1. *Static Induction.*—When one body, A, is charged with positive electricity, and another body, B, is brought up near to it and is connected to a third body, C, farther away, by a wire, all the negative electricity in B and C is attracted to the side of B nearest to A, and all the positive electricity passes to the side of B farthest from A, and hence flows through the wire to C. This is because, unlike forms - *i.e.*, positive and negative—attract one another and like forms—either both positive or both negative—repel one another, which is one of the first laws of static electricity. This shows that by positively charging one body a current of momentary duration may be made to flow through a wire joining two other bodies entirely separate from it. Now, exactly the same is the case in a telephone circuit. A is the disturbing wire or wires, B is the disturbed wire which we are considering, C is the earth and the wire connecting B, and C is the wire joining the line wire B to earth, C, in which the instruments are put. When a conversation is passing on the wire A, which must necessarily have some capacity, this is continually being charged and discharged both positively and negatively. This will cause the attraction of a negative or positive charge on our line wire, B, and a positive or negative momentary current will flow through our instrument wires to earth, C. Thus, it will be seen that for every separate charge A gets on it, we have a corresponding flow of electricity through the instruments from the line to earth. Hence a conversation in A may be heard on the B receivers, because of the static induction in the lines. It will be noticed that the current flows in the same direction through the instruments at each end of the line to earth.

2. *Dynamic Induction.*—When a current is flowing in a wire, A, there is a magnetic field round it. If this field cuts another wire, B, it induces a current in the latter, only in the opposite direction to that flowing in A. This is also a momentary current, but every time there is a variation in the current in A there will be a corresponding variation in the current in B, only in the opposite direction. This must flow through each receiver and the earth to complete the circuit. Thus, a current started in A may be detected in B, and so a conversation held on the A line may be heard on the B line receivers.

Let us now consider the case where both static and

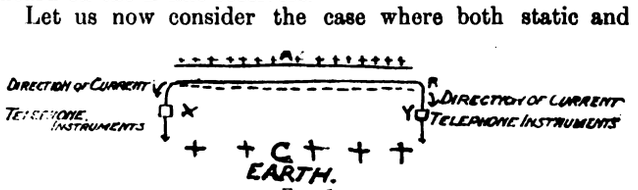

FIG. 1

dynamic induction may be found occurring on a pair of wires. If Figs. 1 and 2 be studied it will be seen that at station X the currents are flowing in the same direction in both diagrams, whereas they are in opposite direction at station Y. This fact goes to point that any cross-talk effects there may be experienced on the two lines will be greater at X than at Y, and if the effects due to static and dynamic induction were equal, then no cross-talk effects would occur in the instrument at Y. Now as to methods of counteracting or preventing this cross-talk. The simplest way would be to have only one wire per pole, or, in our case, to have the wire under consideration on a separate pole a few feet away from the other disturbing wires, but

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this would very likely be impracticable. A better method might be to run straight and parallel with the others on the same poles as at present for halfway, and then complete the other half on exactly the opposite side of the wires. If there be only one disturbing wire among the others, this could be tested for and found out by using only one telephone at a time at each end, and seeing which

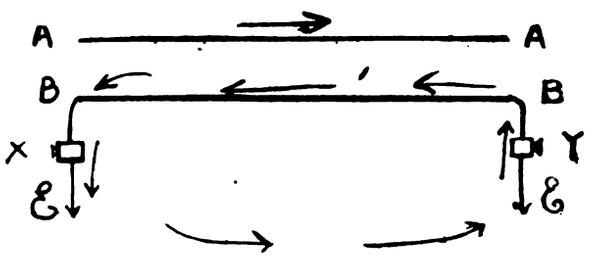

FIG. 2

one affected our line. If this disturbing wire could be singled out, then the above remedy could be applied to this one alone, as in Fig. 3, and the disturbances in each half will be seen to cancel out against each other. The best

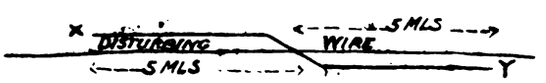

FIG. 3.

remedy of all would possibly be out of the question as regards practicability. This is to give all the wires a symmetrical twist; this will probably be more clear on reference to Fig. 4. It will be seen from this that each wire does not occupy the same position on one pole as on that preceding it, and

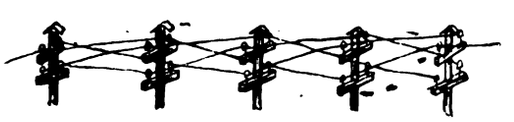

FIG. 4.

each wire goes to each insulator in each position on succeeding posts in a regular way. By this means both static and dynamic induction causing cross-talk in a telephone may be counteracted, as any effect there may be in one span will be neutralised in the next three. This method, though probably the best, would entail complete rewiring for the whole 10 miles, and so would be costly. This is the method of construction used by the General Post Office in their telephones, and should prove satisfactory.—E. R. ALEXANDER

[Several answers to Question No. 492 are unavoidably held over.—ED. *E E.*]

FORTHCOMING EVENTS.

FRIDAY, JULY 11.

Association of Municipal and County Engineers.—Annual meeting at Bristol—second session. The meeting closes the following day.

MONDAY, JULY 14.

Municipal Officers' Association.—District meeting at Hampstead.

SATURDAY, JULY 19.

Institution of Civil Engineers.—Birmingham students' visit to Paris

The following fixtures for meetings have also been made:

Sanitary Institute.—Sept. 9-13, congress, Manchester. Sept. 9-27, health exhibition.

Sanitary Inspectors' Association.—Aug. 7-9, autumn meeting, Middlesbrough.

Waterworks Engineers.—July 22-25, annual meeting, Leicester. December, London.

Iron and Steel Institute.—Sept. 2-6, Dusseldorf.

Institution of Civil Engineers.—Birmingham students' visit: Sept. 25, Crewe.

Institution of Junior Engineers.—Aug. 9 to 16, summer meeting.

British Association.—Meeting at Belfast commences Sept. 10.

SUNDERLAND ELECTRICITY ACCOUNTS.

From the accounts of the Sunderland Corporation electricity works for the year ended March 31, 1902, it appears that the total expenditure on capital account to date amounts to £199,782. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s	d.
Generation of Electricity.			
Coal £7,194 9 6			
Oil, waste, water, and stores 699 4 0			
Wages 1,936 4 8			
Repairs, etc., of buildings and plant ... 808 13 4			
	10,638	11	6
Distribution of Electricity.			
Repairs of mains and services 322 7 2			
Repairs of meters, switches, etc. 71 4 10			
	393	12	0
Public lamps—attending and repairs	409	11	3
Rents, rates, and taxes	1,470	5	0
Management Expenses.			
Salaries	1,294	0	8
General establishment charges, etc.	667	7	4
Legal expenses	56	6	6
Insurances	282	11	0
	15,212	5	3
Amount carried to net revenue account	11,365	18	5
	£26,578	3	8

Cr. Income.	£	s.	d.
Sale of current per meter, less irrecoverables	25,106	1	0
Public lighting	1,070	10	7
Rental of meters and other apparatus	352	14	5
Rents receivable	35	4	2
Charging batteries	8	18	0
Deposit fees forfeited	2	2	0
Sale of casks, etc.	2	13	6
	£26,578	3	8

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account, less amount repaid	186,105	0	0
Sundry creditors for materials supplied, etc.	1,197	11	0
General district rates—balance of advances	1,849	0	0
Balance due treasurer	6,278	15	10
	£195,430	6	10

Cr. Assets.	£	s.	d.
Capital account—amount expended	184,821	17	2
Stores on hand March 31, 1902	2,663	19	1
Sundry debtors for current supplied	7,924	10	7
Amount advanced for incidentals	20	0	0
	£195,430	6	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units			2,646,315
Quantity sold	Public lamps	140,500	2,375,557
	Tramways	1,232,910	
	Private consumers by meter.	1,002,147	
Quantity used on works			144,097
Total quantity accounted for			2,519,654
Quantity not accounted for			126,661
Number of public lamps			150
Total maximum supply demanded (kilowatts)			1,640

APPOINTMENTS VACANT.

Distribution Engineer, London County Council Tramways Department, £350 per annum, July 14. For particulars see advertisement.

Switchboard Attendant, burgh of Motherwell Electricity Works, £65 per annum, July 14. Particulars from Mr. E. Britton, Electricity Works, Motherwell.

Resident Electrical Engineer, Erith Urban District Council, £3. 3s. per week, rising to £200 per annum, July 16. See advertisement.

Draughtsman and Test-Room Assistant, Jandus Electric Company. See advertisement.

Engineer to take entire charge of testing staff, both in the works and outside. See advertisement.

Engineer-in-Charge, Willesden Board of Guardians, July 19. See advertisement.

Electrical Engineer, Cleckheaton Urban District Council, £200 per annum. Particulars may be obtained from the chairman, Mr. F. W. Birkett. July 21.

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SPECIAL ILLUMINATION WORK.

THE CORONATION BAZAAR.

At the invitation of Messrs. Laing, Wharton, and Cunnington, of 93, St. Martin's-lane, W.C., we had the opportunity of inspecting the small installation they have put down in the Botanical Gardens for the electrical illumination of the Coronation Bazaar, which was opened yesterday afternoon by Queen Alexandra in aid of the funds of the Great Ormond-street Children's Hospital. The work has had to be carried out under rather unfavourable circumstances, and it reflects much credit on those responsible for its accomplishment. An 85-kw. steam plant has been erected on an open space adjoining that part of the gardens where the bazaar is being held, under the personal supervision of Mr. J. S. Cunnington, of the above-named firm. The boilers, which are of 160 h.p. each, were kindly lent by Messrs. Davey, Paxman, and Co., as were also the engines. Some 400 yards of inch cable have been laid from the dynamos to the distribution board, which controls 16 main circuits. This board was especially designed by Messrs. Laing, Wharton, and Cunnington for this purpose. There are in all six bays of canvas under which the stalls for the bazaar are erected, and along each bay run two circuits from the distribution board. There are also two circuits laid to the main entrance to the gardens and the grand concert-room respectively, making the total of 16 mentioned above. For the illumination of the bays some 100 or so five-light hoops, from which are suspended incandescent lamps, have been brought into service, and these extend the whole length of the canvas in each case. In addition to these, a large number of incandescent lights enclosed in Chinese lanterns have been fitted between the poles supporting the canvas, so that an exceedingly brilliant illumination is obtained. In all about 2,500 incandescent lights have been requisitioned for lighting up the bazaar, of which 1,000 are of 16 c.p. and the remainder 8 c.p. At the bandstand four arcs, assisted by some 160 incandescent lamps, provide illumination, and at the entrance to the bazaar there are several more arc lamps installed. An interesting feature of the electrical installation is the Royal coat-of-arms, made of coloured sheet metal, which appears over the gateway, and which at night-time is illuminated by a number of incandescent lights. The whole equipment, it may fairly be said, has been carried out in a very complete manner, and, in passing, we should state that special precautions have been taken against any possibility of a fire. Wherever possible, fuses have been used, and the chances of an outbreak arising from the electrical installation are practically nil. Mr. Adrian Collins acted as honorary consulting engineer for the work.

EMPIRE BALL, CRYSTAL PALACE.

The Electric Lighting Boards Company contributed to King Edward's Hospital Fund by undertaking the entire illumination of the Crystal Palace transept on the occasion of the great Empire Ball last week. The installation comprised 2,200 lights, worked in the form of an enormous velarium over the centre of the transept, and in outlining the galleries and Royal box in festoons. The lights and festoons were covered with artificial flowers, and the number of connections required some two miles of cable, as the distance from the supply source was considerable. The whole of this work was executed in three days of ordinary working hours, including the garland work. The effect was so artistic that the Crystal Palace authorities retained the work for the American Festival on Saturday.

LEGAL INTELLIGENCE.

TRAMWAY BY-LAWS.

On Tuesday in the King's Bench Division of the High Court, Mr. Justice Channell and Mr. Justice Jelf heard a motion on behalf of the National Carriage and Horse Owners' Accident Insurance Union, Limited, and Mr. R. Wiseman, a ratepayer of the city of Manchester, for an order for the issue of a mandamus against the Manchester Corporation requiring them to comply with the conditions of Section 44 of the Manchester Corporation Tramways Act, 1900. It was stated that this section provided that within six months from the time of the taking over of any section of the tramways the Corporation should make by-laws in respect of such section, regulating the distance at which cars using the tramways should be allowed to follow one another. On June 6, 1901, the Corporation took over the first section and substituted electric traction for the horse traction. Since then a number of other sections had been taken over, but the regulations had not been made.

Mr. Justice Channell asked what the plaintiff company had to do with the matter.

Counsel said his company was a company which insured owners of horses and carriages against risk caused by accidents in the streets, and in addition to that one of the objects of the company was to procure the amendment or repeal of by-laws and regulations of local authorities which might prejudicially interfere with the convenience of their clients.

Mr. Justice Channell thought there ought to be no rule in this case. The company and their manager who came forward as prosecutors asking for this mandamus were obviously people who had no more right than any ordinary member of the public. The Corporation were considering the matter, and had a draft of by-laws in preparation, and under these circumstances it seemed to him the Court, in the exercise of its discretion, should not grant to the applicants a mandamus directing the Corporation to make these by-laws. If anybody chose to set the law in motion by indictment he might do so, but he did not think such an indictment would be met favourably by any grand jury. The Corporation were not neglecting their duty, and as the matter was one which it was very desirable should be done carefully, he thought it would be wrong to grant a mandamus.

Mr. Justice Jelf concurred, and the application was dismissed.

COMPANIES' MEETINGS AND REPORTS

EDMUNDSONS' ELECTRICITY.

On the 3rd inst., at Broad Sanctuary-chambers, Westminster, the ordinary general meeting of the above Corporation was held, Mr. F. E. Gripper presiding.

The **Chairman,** in moving the adoption of the report, said that the profit for the year, including the balance brought forward from the previous year, amounted to £30,962, which indicated an increase of £6,000 during the 12 months. After providing for dividend on the preference shares and for the interim dividend on the ordinary shares, which was paid in January, and adding an amount of £6,807 which had been received as premiums on the issue of shares and debentures, there remained a sum of £26,631 to be dealt with, of which the directors recommended that £10,000 should be carried to the reserve fund. They also proposed a dividend at the rate of 9 per cent. per annum on the ordinary shares for the half-year ended March 31, making a total dividend of 7 per cent. for the year, and they further recommended a dividend at the rate of 7 per cent. per annum upon the ordinary shares issued in October last, and a dividend of 7 per cent. upon the deferred shares. After paying these dividends £6,179 would remain to be carried forward. The £100,000 of new capital and £40,000 of debenture stock which had been issued during the year had been principally required for new works and the extension of existing works in connection with the Urban Electricity Supply Company. That company, which was formed a few years ago, had made satisfactory progress, and its works at Twickenham, Weybridge, Godalming, Stamford, and Hawick had already commenced to supply current. In their contracts with the Urban Company the Corporation had agreed to work their various undertakings for a term of years, guaranteeing a minimum of 5 per cent. upon the capital of that company. The item in the balance sheet of "investments in and advances to subsidiary companies after deducting reserves, £512.102," was nearly £180,000 larger than last year's. The difference represented outlay upon the Urban Company's and other new works and extensions of existing works. The Corporation of Woolwich had entered into an agreement to purchase the Company's undertaking in that town, and it was expected that the sale would be completed within the next few months. The return made upon the £1 shares would be considerably over £2. Very satisfactory progress had been made in the working of the various undertakings. Since the last meeting a new station had been opened at Newport, in the Isle of Wight, and powers had been obtained for lighting Ryde and Cowes. The Board had been in negotiation for several valuable contracts for erecting electric lighting works for local authorities, on the terms of the local authority finding the necessary capital for constructing the works, and afterwards leasing these to the Corporation for a term of years upon favourable conditions. Contracts on these lines had been entered into at Hamilton and Dorking, and the arrangements for two or three other places were expected to be completed shortly. The Board hoped to extend this class of business, which admitted of all additional profit being made without adding to the capital commitments of the Company.

Mr. W. R. Davies seconded the motion, which was carried.

ELECTRIC AND GENERAL INVESTMENT.

Mr. George Herring, presiding over the general meeting of the shareholders in the above Company on the 3rd inst. at Winchester House, stated that the investments at cost stood in the balance-sheet on May 31 last at £222,670. Hitherto he had been able to tell the shareholders that the Company's investments were worth more than they appeared at in the books, but he could not say that on the present occasion, although, at existing market quotations, they were worth within a fraction of the amount shown in the balance-sheet. After paying the preference dividend and all charges, the net profits were £20,470. Of this amount, the directors proposed to transfer £10,470 to the contingencies account in order to strengthen the funds available for dealing with further business. The directors felt that the dividend recommended was a good one—35 per cent., in addition to what was to be paid out of the reserve fund—and he hoped that the shareholders would agree with the Board as to the advisability of strengthening the position of the Company. The payment of £50 a share on the founders' shares was absolute dividend, but this could not be said of the other £10 a share which they proposed to pay on these shares, although the amount, or the greater part of it, came out of dividends that had been received. There being, however, some doubt whether the directors could reinvest dividends, they determined to distri

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bute the sum mentioned. The same remarks applied to the payment from the ordinary shares reserve fund. They began with a dividend of 10 per cent., and in the course of their 11 years' working dividends of £3. 12s. had been declared on the £1 share. During the same time they had either assisted or promoted 24 companies, of which not one had been a failure. They were all more or less flourishing and all of them were paying dividends. They received a certain amount for promotion money, but their profits were principally derived from the "lines" they took in the companies which they assisted or brought out. When the latter were proved to be successful the directors disposed of the Company's interest in them at a premium. The amount now received for trustees' fees was nearly sufficient to pay the whole of the expenses, and the dividends obtained from their securities nearly sufficed to pay the dividend on the preference shares. If, therefore, they did no further business in the current year they would be very little short of the expenses and the preference dividend, and any profits which might be derived from any venture they might make would go to the ordinary shareholders. He concluded by moving the adoption of the report and accounts, "with the provision for contingencies shown therein."

Mr. J. B. Braithwaite, jun., seconded the resolution, which was carried *nem. con.*

WEST AFRICAN TELEGRAPH.

The ordinary general meeting of the shareholders in this Company was held on the 3rd inst. at the offices, Electra House, Moorgate-street, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, stated that since the date of the accounts they had received the first instalment of £112,000 due from the French Government on account of the cables purchased by them. The cash received from the French Government would be principally devoted to the repayment of the outstanding mortgage debentures. If, therefore, their receipts were maintained, the Company would be in a better financial position, inasmuch as the £24,000 which had hitherto been required annually for interest on and redemption of 5 per cent. debentures would be saved. Arising out of the agreement with the French Government, however, the Company had to lay a new cable between Bathurst and Bissao, a distance of about 213 knots, and, in conjunction with the African Direct Telegraph Company, one between Kotonou and Lagos, a distance of about 65 knots. They had also to carry out certain works in connection with joining up the different sections taken over by the French Government to meet the latter's requirements, and in order to maintain the through line to the Cape *via* Loanda. It was not easy to state at the present time how much this work would cost, but it would probably come to about £40,000. The directors had not decided yet how this expenditure would be met, but full details would appear in next year's accounts, when all these outstanding matters would have been finally dealt with, and the financial position of the Company would be more clearly understood. He concluded by moving the adoption of the report and accounts.

Sir J. Denison-Pender seconded the motion, which was carried.

RAND CENTRAL ELECTRIC WORKS.

Sir C. Rivers Wilson presided over the annual general meeting of the shareholders in this Company at Winchester House on Tuesday.

In moving the adoption of the report, which has appeared in a previous issue, the **Chairman** observed that after a long interval of anxiety and loss the Company had at last emerged into a period which, he hoped, would prove a prosperous one. Considering the events of the past year, the shareholders could not have expected that the Board would be able to submit a favourable report. Nevertheless, it was not altogether unsatisfactory, because, although for eight months of 1901 the whole of the plant was entirely idle, the earnings amounted to within £9,500 of the working expenses. During the time of enforced idleness, however, the staff was employed in improving the plant and in other ways to the advantage of the property. As to the claims against the Imperial Government, mentioned in the accounts, he explained that these were for repairs to plant damaged by the Boers, amounting to £2,358; the cost of military protection, £1,265; sundry and incidental items, £100; and £1,500 deposited with the late Transvaal Government as caution money. With regard to damage to the plant, he mentioned that the completion of the repairs had recently been effected, but the total cost was not yet known on this side. The Company were in the position of having a deficit of £25,231, against which they had a special reserve of £4,722, which had been applied in reducing the deficit to £20,509. Ample provision had been made every year for depreciation. He had every expectation that the Company were going to benefit by the improved state of affairs in South Africa, but before they could do so to the full they would have to deal with the deficiency and liquidate the past. Speaking of the business, he said that their customers included the Johannesburg Municipality, and they had contracts in respect of two stations on the railway—Elandsfontein and Johannesburg. They also supplied power to 10 mines and to various minor industries, including chemical works. The Board had grounds for hoping that as the contracts expired they would be renewed on favourable terms; failing that he thought there could be no doubt of the disposal of the whole of their power to new customers. It had been considered wise to modify the Company's tariff, and he believed that the new scheme would work well. So far as the labour question was concerned the Board did not anticipate much trouble. The Company only employed from 80 to 100 natives. Having said that he thought the shareholders might look with confidence to the future. He moved the adoption of the report.

Mr. G. Gorrissen seconded the motion, and, referring to the new tariff, stated that the charge was 6d. a unit for the first two hours, with a mimimum payment of 30s. a month for each kilowatt installed. For every additional hour the charge was 1d. a unit. The motion was carried.

CALLENDER'S CABLE AND CONSTRUCTION.

Presiding over the ordinary general meeting of the shareholders of this Company, held on Friday at Hamilton House, Victoria-embankment, **Mr. H. Drake** expressed the hope that they would consider the result of the year's working satisfactory. The competition in the business was as keen as ever, and became more so year by year, but the accounts, nevertheless, showed a larger profit than the Company had previously earned. The amount standing to the credit of the profit and loss account was £71,978, and after paying the interest on the debentures, the dividend on the preference shares, and writing down the plant and machinery, as well as carrying £3,000 to the machinery renewal fund, there was an available balance of £58,621, including the sum brought forward. The directors had already paid to the shareholders £23,500, being 15s. per share, and they proposed to pay a special bonus of 5s. a share and to carry forward £28,621. The total payment to the holders of the first 30,000 ordinary shares for the past year would, for dividend and bonus, be thus equal to 20 per cent. The reserve stood at £100,000, and for the present the Board were content to leave it at that amount. Since the last general meeting their purchase of land at Erith had been increased by about 16 acres. The Company had now a long frontage to the river, and altogether about 45 acres. The capital had been increased by £25,000. The Board intended to issue a further sum of £110,000 in debenture stock, and this would be utilised in the ordinary working of the Company. The shareholders had already been informed that the negotiations with Henley's Company had fallen through. He concluded by moving the adoption of the report.

Major W. M. Mackenzie seconded the motion.

Mr. T. O. Callender remarked that, in common with other cable-makers, they had suffered from the severe fall in the price of copper, but as the Company did not speculate in the metal the matter was not so serious as it might have been. In reply to the remarks of one or two shareholders, Mr. Callender further observed that the Company had adopted a conservative policy in regard to the amounts written off for depreciation. He was afraid that the general expenses would tend to increase considerably, following upon the keen competition for business. This feature was present not only in their particular branch of electrical business, but also in the engineering trade generally.

The report was adopted.

ELECTRICAL POWER STORAGE.

The report of the directors for the year ended May 31, 1902, states that the profit for the year, including the balance of £432. 9s. 1d. brought forward, is £11,346. 2s. 9d. This result of the year's trading the directors believe will be satisfactory to the shareholders; and, as they feel strongly the necessity of strengthening the Company's reserves, they have carried £5,000 from the above profits to the reserve fund and £1,000 to the contingent fund. They recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb a further £4,491. 8s. and leave £854. 14s. 9d. to be carried forward. The buildings, plant, tools, etc., have been maintained in thorough repair and condition at a cost of £3,059. 15s. 10d., which sum has been provided out of revenue. The directors have pleasure in recording a continued increase in business, the output having been larger than in any previous year. This is especially gratifying, as the increase has not been confined to one class of cell, the smaller as well as the larger types, and, still more, the batteries designed for the propulsion of electrical vehicles, having shared in the growing demand. Among the orders completed during the year have been some very large contracts for public lighting and traction undertakings, and the directors have pleasure in stating that the Company enters on a new financial year with its order book well filled. The directors have to announce with deep regret the death of their valued colleague, Sir Daniel Cooper, Bart., G.C.M.G., who has been associated with the Company since its commencement.

ELECTRIC CONSTRUCTION.

The report of the directors for the year ended May 31 states that the net profit of the year is £20,496. 19s. 11d., and, adding the balance brought from last year, £2,853. 18s. 2d., the amount available for distribution is £23,350. 18s. 1d. The directors recommend that this profit be appropriated as follows: dividend at the rate of 7 per cent. per annum on the preference shares (to be paid on July 31 next), £4,394. 12s.; dividend at the rate of 6 per cent. on the ordinary shares (one-half to be paid on July 31 next, and one half on Jan. 31, 1903), £13,452; general reserve fund, £2,000; balance carried forward to next account, £3,504. 6s. 1d. The general reserve fund will then amount to £32,000. The buildings and plant have been thoroughly maintained out of revenue, and £5.000 has been credited to depreciation account, which now amounts to £43,000. The contract for the electrical equipment of the Islington extension of the City and South London Railway, referred to in last report, was completed in the end of last year, and the plant has since been working to the full satisfaction of the railway company. Large machines have also been supplied to the Corporations of Leeds, Sheffield, Halifax, Shoreditch, Croydon, Brighton, Devonport, Wolverhampton, and others. Notwithstanding the keen competition in the manufacture of electrical plant, especially during the latter half of the financial year, the works are fairly supplied with orders, and it is believed that the Company's staff, workmen, and plant at Bushbury can turn out electrical

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machinery on as favourable terms as any other establishment. The relations between the management and all classes of the employés continue cordial, and in acknowledgement of zealous co-operation in promoting the Company's interests the directors have much pleasure in recommending the distribution among them of the usual bonus. The compensation paid under the Workmen's Compensation, 1897, Act, is for the year £36. 13s. 3d. The revenue of the Madras electric tramways show a healthy increase, and the development so far during the current year promises even a larger improvement. The directors have to deplore the death of their greatly esteemed chairman—Sir Daniel Cooper—whose valuable services to the Company for many years the directors gratefully acknowledge. It is recommended that the vacancy at the Board be not at present filled up.

ABSTRACT OF PROFIT AND LOSS ACCOUNT.

Dr. Expenditure.	£	s.	d.
Interest on loans and debentures, paid and accrued ...	12,584	7	5
General charges	18,688	11	3
Maintenance of plant and depreciation account	7,995	10	11
	39,268	9	7
Net profit carried to balance-sheet	20,496	19	11
	£59,765	9	6

Cr. Income.	£	s.	d.
Gross profit on manufacturing and contracting	49,304	3	6
Rents, pupils' premiums, and sundry profits	3,182	6	5
Profit on running Madras electric tramways	4,100	17	9
Dividends on shares of other companies	3,140	4	4
Transfer fees	37	17	6
	£59,765	9	6

CALCUTTA ELECTRIC SUPPLY.

In their last report, our readers will remember, the directors of the above Corporation stated that owing to the rapidly growing demand for electricity supply in Calcutta they had been compelled to order a large quantity of materials for extensions and for the increase of the mains and feeders. The Board has now issued a circular stating that the outlay in connection with the above renders it necessary that an increase of the capital of the Company should be made without delay, and as the growth of the business appears likely to continue for a long time to come, the directors consider it advisable to pass a resolution increasing the nominal capital to £500,000 by creating 60,000 new shares of £5 each, and they propose to issue 20,000 of these to the shareholders forthwith. Accordingly, a special meeting is called for the 18th inst. for the purpose of obtaining shareholders' sanction to the proposed capital changes.

CHILI TELEPHONE.

The annual report of the directors for the year ending March 31 last states that the aggregate number of subscribers at all centres at the end of the year was 4,981, as compared with 4,723 at the beginning, or a gain of 258 for the year. The gross revenue in Chili from all sources was 759,139dol. as compared with 683,170dol. the previous year, an increase of 75,969dol. The expenditure amounted in 1901-2 to 365,776dol., an increase of 18,363dol. over the previous year. The net income from all sources was 393,362dol., an increase of 57,605dol. over the year 1900-1. The average rate of exchange for the year was 14·85d. as compared with 16 65d. in the previous year, giving a decrease for the year of 1·80d. Converted into sterling at these rates, the net income for the year was £24,340, compared with £23,290 in the previous year, an increase of £1,050. The balance to the credit of the revenue account, including £2,680 brought forward, is £21,720, of which £7,986 has been carried to reserve for depreciation and renewals. The directors recommend the payment of a dividend of 5s. per share, free of income tax, being at the rate of 5 per cent. per annum, absorbing £11,000, and leaving a balance of £2,733 to be carried forward.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Pontypridd.—The Urban District Council invite tenders for cables and dust destructors. Tenders by July 31. See advertisement.

Barking Town.—The Council invite tenders for construction of tramways in their district. Tenders by July 31. See advertisement.

Hammersmith.—The Borough Council invite tenders for the supply of electric light carbons. Tenders by 6 p.m. on Wednesday, July 16. See advertisement.

Wigan.—The Electric Light and Tramways Committee invite tenders for the supply of 1,500 yards of ·1 square inch lead-covered, paper-insulated cable. Tenders by July 14. See advertisement.

Edinburgh.—The Corporation invite tenders for the supply of arc lamp-posts. Specification, etc., can be obtained from the Resident Electrical Engineer, Dewar-place, Edinburgh. Tenders by July 14.

Leskovatz (Servia).—The Société d'électricité de Leskovatz require two turbines of 200 h.p. and two dynamos for three-phase current; also accessories for a power installation with a radius of 11 miles Tenders by July 14.

Accrington.—The Electricity Committee invite tenders for one steel Lancashire boiler, and steam and other piping. Specifications, etc., can be obtained from Mr. H. Gray, borough electrical engineer. Tenders by July 21.

Guernsey.—Tenders are invited for the supply, laying, erection, and fitting of cables, wires, fittings, and other appliances required for the electric lighting of the new isolation hospital, Castel. Tenders by 19th inst. See advertisement.

Finchley.—The Urban District Council invite tenders for the construction of an electricity generating station. Specifications, etc., can be obtained from Mr. Edward Calvert, chief electrical engineer, 2, Broadway, Finchley, N. Tenders by July 21.

Lowestoft.—The Corporation invite tenders for the construction of tramways, rails, fishplates, and bolts, and permanent-way construction. Specification, etc., may be obtained from Mr. R. Beattie Nicholson, town clerk, Lowestoft. Tenders by July 12.

Hapton (Lancs.).—Tenders are invited for lighting Hapton township with electricity from Sept. 1, 1902, to April 30, 1903. Full particulars on application to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, 16, Hammond-terrace, Padiham. Tenders by July 31.

Manchester.—The Electricity Committee invite tenders for supply and delivery of three electric locomotives at their Stuart-street works. Specifications, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by July 17.

Malvern.—The Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work); engines, alternators, exciters, and switchboard; high and low tension concentric cables; and transformers. Tenders by Aug. 23. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1. The Government also propose to lay a cable between Punta-Arenas and Puerto-Montt.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Falkirk.—The Corporation invite tenders for storage batteries, generators, transformers, switchboard, cable work, crane, lamps, and fittings. Specifications can be inspected at Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster. Tenders by July 14. See advertisement

Stratton St. Margaret (Wilts).—The Swindon and Highworth Board of Guardians invite tenders for a complete installation of electric lighting at their workhouse and infirmary at Stratton St. Margaret, Swindon, Wilts. Tenders by 9 a.m. on 29th inst. See advertisement.

Budapest.—The Principal of the Machinery Department of the Hungarian Government Railways ask for tenders for the erection and equipment of a central station at Pressburg. Conditions (5s.) may be obtained from the Printing Department of the Royal Hungarian Railway at Budapest. Tenders by July 15.

Bishop's Stortford.—The Urban District Council invite tenders for lighting such of the public streets as are at present lighted by electricity or otherwise. Tenders, endorsed "Tender for Lighting," to be sent to Mr. Thos. Swatheridge, clerk, Council Offices, North-street, Bishop's Stortford, by 4 p.m. on 22nd inst.

Gillingham.—The Urban District Council invite tenders for the supply and erection of two water-tube boilers, steam and exhaust piping, condenser, cooling tower, high-speed engines, three triphase alternators (250 kw. each), switchboard, underground cables, arc lamps, crane, and well. Tenders by July 17. See advertisement.

London, S.W.—The London County Council invite tenders for the manufacture and delivery of 80 double-decked electric tramcars, complete with trucks, motors, controllers, ploughs, etc., for the service of the Council's conduit tramways. Specification and other particulars at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 15.

Epsom.—The Urban District Council invite tenders for the supply and erection of semi-marine dry-back boiler, with fittings, etc.; ejector condensers, circulating pumps, and pipework; spray cooling pond; steam, feed, and drain pipes, etc.; and one 150-kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, etc. Tenders by July 18. See advertisement.

Devon.—The Visiting Committee of the Devon County Asylum, Exminster, invite tenders for wiring alterations and additions, 2,000 lamps, booster, dynamo, motors, switchboard, and replacing of a battery of 120 700-ampere-hour cells, etc. Specification, etc., can be obtained from Messrs. O'Gorman and Cozens-Hardy 82, Victoria-street, Westminster. Tenders by July 23.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of one electric power overhead travelling crane, to lift 25 tons, three hand-power overhead travelling cranes, to lift 10 tons each, at certain of the Council's depots in the south of London. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 15.

London, S.W.—The London County Council invite tenders for the trenchwork, concreting, bricklaying, repaving, etc., in connection with the laying of stoneware cable ducts for the Council's southern tramways, including the laying of the ducts provided by the Council. Specifications and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 15.

Teddington.—The Urban District Council having obtained a provisional order enabling them to supply electricity within the urban

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district of Teddington, invite tenders from persons and companies able to carry out electrical undertakings, stating terms upon which they would be willing to take over such provisional order, and to submit a scheme of electric lighting for the district, with particulars of cost. Tenders by July 12. See advertisement.

Madrid.—The Public Works Department invite tenders for the extension of electric tramways in the east of Madrid, and also for a new line and working of the same for not more than 60 years. A preliminary deposit of 3,368 pesetas and a final deposit of 16,844 pesetas is required, also the repayment of 3,189 pesetas and interest to the Sociedad del Tranvia del Este for preparation of the scheme. Particulars may be obtained from the above. Tenders by Aug 26.

Selangor (Malay States).—The Crown Agents for the Colonies invite tenders for certain plant and materials in connection with the electricity supply scheme for the town of Koala Lumpur, in the protected native state of Selangor, Federated Malay States: (Contract A, Section 1) supply, delivery, and erection of a generating station, consisting of two 600-h.p. high-pressure turbines, with pipes, two 400-kw. three-phase alternators, switchboard, and sundries. (Section 2) The supply, delivery, and erection of a sub-station plant, consisting of three 150-kw. motor-generators, two balancers, switchboards, and sundries. (Contract B, Section 3) The supply and delivery f.o.b. at a European port of steel poles, cross-arms, insulators, copper wire, &c., for the high-pressure transmission line. (Contract C, Section 4) The supply and delivery f.o.b. at a European port of arc lamps, iron posts, controlling apparatus, incandescent lamps and fittings. Tenders may be sent in for any or all of above three contracts. Specifications, drawings, general conditions, and forms of tender may be obtained from the Crown Agents for the Colonies, Downing-street, London, S.W., on and after 7th inst., on payment of £2 for Contract A, £1 for Contract B, and £1 for Contract C. Sealed tenders, endorsed "Selangor Electric Lighting Contract," and addressed to the Crown Agents for the Colonies, are to be delivered at Downing-street, London, S.W., by 12 noon on Aug. 21. All information regarding above contracts is to be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

RESULTS OF TENDERS.

Southend.—The Town Council have decided to accept the tender of Willans and Robinson, at £2,400, for the provision of a steam dynamo.

Dewsbury.—The Town Council have accepted the tender of E. Chadwick and Sons for the construction of a cooling pond at the electric lighting station.

Camberwell.—Willans and Robinson, Rugby, have received an order through Crompton and Co. for three 100-h.p. compound engines intended for Camberwell infirmary.

Battersea.—The Borough Council have accepted the tender of Callender's Cable and Construction Company, Limited, for supply of 500 yards of ·035 cable, at £17. 10s.

Wigan.—Willans and Robinson, Rugby, have received an order through Dick, Kerr, and Co. for the Wigan electricity works for one of their 700-h.p. compound central-valve engines.

Tunbridge Wells.—The Corporation have accepted the tender of Henley's Telegraph Works Company, Limited, for trenching, cable laying, and temporarily reinstating the surface in connection with the cable from London-road to Malyneux-park, at £118. 8s. 4d.

Barking.—The following tenders for extensions to the power station have been accepted by the Electricity Committee: Babcock and Wilcox, pipework and lagging; Norton Bros., Ilford, chequer plating, etc.; Bergtheil and Young, motors for auxiliary plant.

Hampstead.—The Lighting Committee have recommended the Borough Council to accept the tenders of the St. Helens Cable Company, Limited, Warrington, and the Callender's Cable and Construction Company, Limited, of Victoria-embankment, for the supply of electric lighting cable.

Rotherham.—The Town Council have accepted the following tenders: T. Glover and Co., Manchester, work in connection with extension of feeders, etc., £6,726. 1s. 6d.; Hawksley, Wild, and Co., Sheffield, extension of boilers, £1,770; W. H. Allen, Son, and Co., Bedford, extension of generating set, £2,721.

Worthing.—The Corporation have accepted the following tender for the erection of a circular brick chimney shaft at their electric generating station, High-street, Worthing, 140ft. high from the ground level and 7ft. 6in. inside diameter at the top (the Corporation constructed the foundations and other brickwork to the ground level): Myles and Warner, Stalybridge, (1) £679; (2) £604.

London County Council.—The Council have accepted the following tenders: Jackson Bros., to execute the wiring and supply the fittings for electric light installations at the Camberwell and Battersea stations and the Battersea river station, at £121. 8s., £133. 18s., and £111. 17s.; W. Mossop and Co., to execute the wiring and supply the fittings for an electric light installation at the Battersea Park-road sub-station, at £58. 11s.

Incandescent Lamps.—The Premier Electric Lamp Company have recently obtained contracts for the Premier incandescent lamp from H.M. Office of Works, H.M. War Office, London United Tramways, Portsmouth Tramways, Mersey Docks and Harbour Board, Brighton Corporation Tramways, St. Helens Tramways, Manchester Tramways, Liverpool Tramways, Liverpool Overhead Railway, Southend Tramways, Queen Anne's-mansions, Hyde Park Court.

Eastern Extension, Australasia, and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended March 31 of 2s. 6d. per share, tax free.

BUSINESS NOTES.

TRACTION.

Nelson.—The charge for the electric current for motive power has been fixed at 2d. per unit.

Wrexham.—On June 25 the work of constructing the tramways at this place was commenced.

Brighton.—It has been decided not to extend the tramways to Preston Park, just outside Brighton.

Hull.—The tramway receipts for the week ended July 5 last amounted to £1,789, as compared with £1,726 the corresponding week last year.

Leigh.—The South Lancashire Tramways Company have entered into negotiations with the Town Council for constructing a branch tramway within the borough.

Batley.—The amended agreement between the Town Council and the British Electric Traction Company has been submitted to the company for final approval.

North Staffordshire.—The North Staffordshire Tramways Bill has been referred to a Select Committee of the House of Commons, who held their first meeting yesterday.

Wolverhampton.—The Corporation hope to be able to run the electric cars to Tettenhall in about two weeks' time. Six new cars are due to arrive in the town this week.

Bilston.—Lieut.-Colonel Yorke inspected the Bilston and Willenhal tramway track, laid by the British Electric Traction Company, yesterday on behalf of the Board of Trade.

Halifax.—A proposal has been approved by the Town Council to run special cars at special fares "whenever such a course is expedient in the opinion of the Tramways Committee."

Birkenhead.—The Tramways Committee have referred the whole question of the revision of the present fares on the tramway system to a sub-committee for consideration and a report.

Elland.—The Halifax Corporation have replied to a petition of the Elland District Council, asking for a tramway in the district, that they are not prepared to construct the line at present.

Barrow.—Efforts are being made to persuade the British Electric Traction Company to put a service of 'buses on the old tram routes during the reconstruction of the lines for electric traction.

Wallsend.—Substantial progress has been made by the tramways company with the construction of the tramways at this place, and the Board of Trade inspection is expected to be made very soon.

New Malden.—Negotiations are proceeding between the District Council and the London United Tramways Company in respect of the small length of proposed tramway route along Burlington-road.

Burslem.—The Town Council have under consideration a letter from the Potteries Electric Traction Company, intimating that they propose to apply for powers to supply electric energy in the borough.

Bournemouth.—The Board of Trade have granted an order prolonging for 12 months the period limited for the completion and opening for public traffic of the tramways (other than tramway No. 6).

Stroud.—The Urban District Council have agreed to the County Council becoming the purchasing authority of the whole of the proposed light railways, including those of the Stroud urban district, at the end of 35 years.

Bakewell.—The Council have resolved to approach the Midland Railway Company with a view to supporting the project put forward in 1885 for a railway between Grindleford and Hassop, or a similar scheme for connecting the two places.

Hebden Bridge.—During the week a deputation from the District Council have had an interview with the Board of Trade, and have satisfactorily arranged for the Hebden Bridge high-tension tramway cable to be passed with very little further outlay.

Somerset.—Plans for a light railway from Clutton to Monkton Combe, Camerton, and Midford have been deposited with the County Council, who have decided to oppose the order unless the requirements of the county surveyor, already indicated, are complied with.

Crewe.—The Corporation at present have some three or four offers from syndicates to lay down electric tramways in the town. One is from the Electric Haulage Company, Limited, who have made a proposal to put down a short experimental line on their particular system and at their own cost.

Private Bills.—In the House of Lords the Aberdeen Suburban Tramways Order Confirmation Bill has been read a third time and passed. In the Commons the Hastings Tramways Bill, the Mexborough and Swinton Tramways Bill, and the Saddleworth and Springhead Tramways Bill have been read a second time.

Chester.—The figures relating to the traffic on the Corporation tramways last month are highly satisfactory. During June no fewer than 113,445 people used the trams, against 48,824 in June last year, the increase being 64,621. The total receipts were £536. 12s. 4d., being an increase of £95. 4s. upon the takings for June, 1901.

Hampstead.—The London County Council have notified the Borough Council that it has been decided not to proceed at present with the scheme embracing the suggested widening of West End-lane and Fortune Green-road, in connection with a proposal for the construction of a tramway from Edgware-road to Child's Hill.

Dewsbury.—Negotiations are in progress between the Town Council and the British Electric Traction Company to agree upon terms for the supply of electric energy for the working of the tramcars in Dewsbury, Ravensthorpe, and Thornhill. In connection with the matter, it is proposed to spend £10,000 on additional plant at the power station.

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Dundee.—The laying of the permanent way of the new tramways has now been practically completed, and operations have been commenced in connection with the overhead electrical equipment. The construction of the generating station is well advanced. It is not expected, however, that the cars will be running much before the close of the year.

Worthing.—A special meeting of the Town Council has been convened for to-day to receive a report from the Parliamentary Committee on the tramway question. The committee recommend that application be made to the Light Railway Commissioners for an order authorising the construction of a series of tramways in the borough and adjacent neighbourhood.

Bradford.—Traffic has been commenced on the section of the city tramways between the Royal Engineer Hotel, Dudley-hill, and a point some two-thirds of a mile nearer the terminus at Westgate-hill. Nearly a mile of track has to be dealt with before the electrical equipment of the Wakefield-road section is completed, but the work is being pushed forward as rapidly as possible.

Mumbles.—A new electrical accumulator car—the first of a series which are to be used on the Mumbles Railway—has been delivered here. These cars will be charged at the Swansea terminus, and will run in addition to the steam trains. Until the company can make arrangements for the doubling of the line and for extra passing-places an accelerated service cannot be given.

Wednesbury.—In reference to the suggestion made in several quarters locally that the Town Council are delaying the proposed extension of the Wolverhampton tramways to Darlaston, it was stated at the last meeting of the Wednesbury Corporation that they were most anxious that the whole tramway system in the two places should be completed at the earliest possible moment.

Glossop.—At the last meeting of the Town Council considerable discussion took place with respect to the delay on the part of the Urban Electric Supply Corporation in the establishment of an electric tramway system and an electric light installation for Glossop, and a resolution was passed to the effect that the town clerk write the Electric Supply Corporation asking for substantial proof of progress beyond the purchase of land for the generating station.

Yarmouth.—The Tramways Committee reported at the last meeting of the Town Council that they had considered the report from the Board of Trade inspector with reference to the new cars. Lieutenant-Colonel Von Donop stated that the tramline appeared to be in every way substantially constructed and in accordance with approved designs. Speed on the lines should be restricted to eight miles an hour, with several exceptions, which were named.

Belfast.—A long discussion took place at last week's meeting of the Town Council on the question of the purchase of the street tramways by the Corporation. Some lengthy correspondence between the Corporation and the company was submitted, and eventually consideration of the matter was postponed. At the quarterly meeting of the Town Council on Monday the recommendation of the special committee to offer the tramway company £380,000 for their undertaking was adopted.

Aberdeen.—Now that the whole tramway system has been electrified, the Tramways Committee have had under consideration a remit as to the propriety and practicability of fixing the fares at the rate of ½d. per half-mile upon all the routes, and have resolved to report that, in their opinion, it would be inexpedient to give effect to the proposal for ½d. fares; that the short-distance ½d. fares be abolished on the Woodside route; and that the estimates for the ensuing year be prepared on this basis.

Nottingham.—The Sherwood-rise section of the electric tramways, making the fifth section of the system, was opened last week for public use. The line connects with the Mansfield-road route at the junction with Gregory-boulevard, and runs thence up Sherwood-rise, ultimately effecting a junction with the Bulwell section at Vernon-road, Basford, the total length being nearly 1½ miles. The Council at their meeting on Monday adopted the annual report of the Tramways Committeee, showing a profit of £19,000 on the year's working.

Electric Traction in Lancashire.—A New York correspondent says that one of the largest contracts for electric railway construction ever received in this country has been awarded to the firm of Thomas Nevins and Son, in connection with the electric traction systems in Liverpool, Manchester, Blackburn, Warrington, and other English cities. Expert American workmen will sail from New York on Saturday, to begin the preliminary work, and it is expected that within two years the end of the work will be in sight. The company has a backing of 20,000,000dol.

Gateshead.—By Section 20 of the Gateshead and District Light Railway Order, 1900, it is provided that if the whole of the light railways authorised by the order are not completed within two years from the commencement of the order, the powers of the Gateshead and District Tramways Company to construct the said railways should cease. The period of two years expires on Aug. 22, and the company have given notice of their intention to make application to the Board of Trade to prolong the time limit for the completion of the light railway to Wrekenton authorised by the order till Feb. 22, 1903.

Twickenham.—The London United Tramway Company's electric car service to Twickenham has been opened for traffic. The capacity of each car is 69 passengers, 30 inside and 39 on the top. The distinguishing colour of the cars is blue. From Twickenham to Shepherd's Bush the journey costs 4d., with intermediate 1d. fares. The branch line for Twickenham divides from that to Hounslow at Busch's Corner, which is a few hundred yards farther from London than the bridge across the Brent towards the west side of Brentford. Passengers to Brentford may consequently take either Hounslow cars from Hammersmith-broadway, or Isleworth cars from Shepherd's Bush.

Stourbridge.—The construction of the permanent way for the Lye tramways is completed, with the exception of a short length in Foster-street and Birmingham-street, which has to be paved. The Enville-street and Bridgnorth-road permanent way has also been completed, with the exception of a short length of paving connecting up to the High-street trams. The wet weather has considerably interfered with and delayed the completion of the above during the last month. The completion of the widening in Foster-street will now be proceeded with. The erection of the poles has been commenced in Bridgnorth-road, and the work of the overhead construction on both routes is to be completed within a month.

Warrington.—The accounts show liabilities to have been incurred for tramways up to the end of March to the extent of £39,980. 18s. The cost of the permanent way was £31,978. 12s. 3d.; overhead equipment, £2,007. 6s. 9d.; car-sheds, £1,407. 7s. 6d.; land and property for widening streets, £770; consulting engineers' commission and charges, £1,886. 5s. 10d.; and preliminary expenses, £1,353. 16s. 4d. Messrs. Preece and Cardew have been asked to furnish an estimate of the cost of carrying out Railway No. 1 of the Warrington light railway order. The loan of £27,000 (sanction to which was noted in last week's issue) is required for the Manchester-road and Winwick-road sections of the tramway system.

Bury.—The Board of Guardians have requested the Town Council to consider the advisability of extending the proposed Fairfield section of tramways as far as the workhouse. It was explained at the last Town Council meeting that the delay in the laying down of the track for the proposed tramways was now over, and that the Johnson-Lundell Electric Traction Company, Limited, were now prepared to proceed with the laying down of the experimental track on the surface-contact system. Immediately that experiment had been decided the committee hoped to come before the Council, and although they were pledged to the overhead system, it would be in the Council's power to say which of the systems they would go on with.

Brighouse.—For some time there has been a growing feeling in the district that it is time some attempt was made by the Corporations of Halifax and Huddersfield to redeem their promises to take tramways to Brighouse. At a recent meeting of the General Purposes Committee of the Brighouse Town Council a lengthy discussion ensued, and a resolution was passed to appoint a deputation to wait upon the Halifax Corporation Tramways Committee, and press for an extension to Hove Edge and Brighouse. The same deputation was appointed to wait upon the Huddersfield Corporation and ask for an extension of their tramway system to Rastrick. Powers for these extensions are provided for in the parliamentary Bills of both Corporations.

Rhondda.—The Bill promoted by the Urban District Council under which powers are sought to lay down a system of electric tramways in the district, has passed the Select Committee of the House of Commons of which Mr. Egerton Tatton is chairman. In giving the decision of the committee the chairman said that the evidence adduced did show distinctly that there was an element of uncertainty as to these trams paying, but the committee considered that the Council were entitled to have the first preference of trams within their own district. Therefore, some clause must be brought up in the shape of leasing for a term of years to a company, who should make, equip, and maintain the trams, and the amount paid as rent should be provided until it amounted to a sum equal to the cost of the installation. We understand that this decision of the committee has given great dissatisfaction locally, many looking upon it as equivalent to a rejection of the measure.

Mersey Railway.—A dispatch from New York announces that the Westinghouse Company are ready to make large shipments of machinery from their Pittsburg works to be installed in the power plants of the Mersey Tunnel Railway. As already stated in these columns, the plant will consist of three main railway-type generators of 1,200 kw. capacity each. These machines are to be direct-connected to cross-compound engines of 1,500 h.p. each. The power-house lighting, and the electric light of all stations, sidings, etc., will be supplied from a separate generating plant. Two compound-wound generators, each having a capacity of 200 kw., direct-connected to compound engines, are to be installed for this purpose. The rolling-stock will consist of 60 cars. The trains are to be formed of five cars each. No locomotives will be used; the first and last cars of a train will be motorcars, each equipped with four 100-h.p. motors. The price to be paid to the Westinghouse Company is £635,303, payable as to £620,000 in new 4 per cent. first perpetual debenture stock and £15,303 in cash. The contract calls for completion by Jan. 15, 1903.

East Parisian Tramways.—The Paris correspondent of the *Financial Times* says that the East Parisian tramways have fallen to 85fr., and the only surprise is that the slump should have been so long in coming. The investing public happily has long since ceased to take an interest in this concern. This was shown by the small attendance at the last general meeting, when only 23 persons were present, the majority of whom were big capitalists or their representatives. In the opinion of the correspondent, the East Parisian Company is overburdened with its heavy capital, and under existing conditions it is impossible for it to become a lucrative concern. That the line does possess the elements of prosperity in the shape of a heavy traffic is undeniable, but, as is often the case, it will in all probability be some future reconstruction which will reap the advantages, and not the present company. It must be borne in mind, however, that in another two or three years the company will have to deal with competition in the shape of the ever-extending tube railway. It is very curious that the slump in East Parisians should have come so quickly on top of the president's optimistic statements at the general meeting. It should be remembered that the fortunes of this company have all along been bound up with the Compagnie Générale de Traction.

Islington.—At the meeting of the Borough Council on Wednesday, the Parliamentary and General Purposes Committee presented a report

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Robertson Lamp.—In connection with the seventh annual convention of the Incorporated Municipal Electrical Association a party of 60 members visited the Robertson lamp works at Brook Green on the 2nd inst. at the invitation of the Incandescent Electric Lamp Company and the General Electric Company. The party was shown all the details of the processes of manufacture, and at the conclusion of the visit Mr. Chamen (Glasgow) proposed a vote of thanks to the directors for their kindness in throwing the factory open to the members. A display by the Robertson fire brigade concluded the proceedings.

St. Marylebone.—Notices from the Metropolitan Electric Supply Company, Limited, have been agreed to as follows: to lay 5in. cast-iron pipes along the west side of Loudoun-road, and the south side of Springfield-road, from the north side of Clifton-hill to 59, Springfield-road, also across Loudoun-road, at the south side of Langford-place, and along the east side of Loudoun-road to No. 8; along the south side of Union-street, and the west side of Candover-streeet, from the west side of Nassau-street to 4, Candover-street; and along the north side of Union-street, from the west side of Candover-street to 24, Union-street.

Grantham.—The Town Council last month received from the Board of Trade a description of the systems proposed to be adopted by the Urban Electric Supply Company, as the undertakers for the supply of energy under the Grantham Order, 1900, and that the undertakers proposed to connect part of their electrical circuits with earth. The Council approved of the description and proposal, subject to certain conditions set out in the committee's last report. Those conditions have been submitted to the Board of Trade, and after considering the Board's reply, the Council have now agreed to withdraw the conditions, and give their approval unconditionally.

New Firms.—Mr. Albert Barron, formerly with the Electrical Company, Limited, of 162, Shaftesbury-avenue, W.C., as manager of their fittings department, has gone into partnership with Mr. J. J. Smith, of 47, Holborn-viaduct and 48 and 49, Farringdon-street, E.C., under the style of J. J. Smith and Co.—Mr. Saml. Buckley, St. Paul's-square, Birmingham, has acquired the business of Messrs. Bohler Bros. and Co., of Sheffield, and will continue to carry on the business exactly as hitherto at their Styrian Steelworks, Rockingham-street, Sheffield, with the exception that the correspondence, etc., will be carried on from the head office, St. Paul's-square, Birmingham.

Barking.—Colonel Durnford has held an enquiry into the application of the Urban District Council for sanction to borrow £11,744 for electric lighting. The clerk to the Council (Mr. E. H. Lister) said the extra money was required owing to the increased demand for the light. The price charged is 4½d. per unit, and 5d. by prepaid meters. For heating the charges are 1½d. and 1½d. There was a loss on the undertaking the first two years of £900 and £1,000, but the last financial year the loss was reduced to £273. The present year they looked forward to extinguishing the outstanding debt. The Council are providing for the lighting of 1,000 houses, and many already have the light.

Birkenhead.—From Sept. 30, 1902, the charges to consumers of electrical energy for power and heating purposes within the borough are to be: for the first 500 units per quarter, 2½d. per unit; for each additional unit up to 1,500 units per quarter, 2d. per unit; for each additional unit beyond 1,500 units per quarter, 1½d. per unit The previous charges, now rescinded, were as follows: winter quarters—for the first hour and a half of maximum demand, 4d. per unit; second hour and a half of maximum demand, 3d. per unit; afterwards, 1½d. per unit; summer quarters—first half-hour of maximum demand, 4d. per unit; second half-hour of maximum demand, 3d. per unit; afterwards, 1½d. per unit.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Cape Town Consolidated Tramways and Land Company's 400,000 shares of £1 each; Isle of Thanet Electric Tramways and Lighting Company's £150,000 4 per cent. debenture stock; and to allow the following securities to be quoted in the official list: Edmundson's Electricity Corporation's further issue of 10,000 ordinary shares of £5 each, fully paid, Nos. 40,001 to 50,000, and 4,500 ordinary shares of £5 each, fully paid; London United Tramways (1901), Limited, 60,000 ordinary shares of £10 each, fully paid, Nos. 8 to 60,007.

Colchester.—The Town Council have adopted a special report with regard to improving the lighting of the principal streets, in the course of which they recommended that 150 Nernst electric lamps should be substituted for 150 gas lamps in the principal streets of the borough. The committee's proposals involve an increased annual expenditure of £169. 15s. 6d., and an initial capital outlay of £450. The effect, would be, however, that an illuminating power four times larger than the present would be obtained. A distributing cable is to be laid in Butt-road for a distance of 97 yards, and the War Office No. 3 Contract (Goojerat), which includes the whole of the remainder of the barracks, is to be proceeded with.

Catalogue.—The Campbell Gas-Engine Company, Limited, have recently issued several new sections of their ill strated catalogue and description of oil-engines suitable for ordinary power purposes and for electric lighting plants, together with particulars of their special type of self-starting apparatus suitable for large engines. One section contains particulars of small combined pumping plants, consisting of oil-engines and pumps suitable for various duties, and another section contains particulars of oil-engines and winding gear of various types, and in another the company's designs of mining pumps are shown for moderate and high lifts, as well as special types for water supplies, and for pumping sewage and other thick liquids.

London Gazette.—A receiving order has been made out in the estate of A. Pollock, electrical engineer, 20, Dunning-street. Middlesbrough, Yorks, on debtor's petition.—The first meeting in the estate of D. Roberts, electrical and motor engineer, 3 and 5, Whiston-street, Derby. will be held to-day (Friday) at 11 a.m. at official receiver's offices, 47, Full-street, Derby, and the public examination on July 15, at 11 a.m., at Court House, 20, St. Peter's-churchyard, Derby. — A first and final dividend of 4⅞d. per pound has been declared in the estate of S. F. Rogers, 41, Maxilla-gardens, Notting Hill, London, payable any day (except Saturday) after July 14 between 11 and 2 at Bankruptcy-buildings, Carey-street, London, E.C.

Farnham.—Attached to the Corporation draft agreement with Messrs. Edmundsons is the following schedule of plant, etc.: boilers, pumps, feed heater and erection, steam-pipes, etc., £1,706; engine, dynamos, balancers, boosters, etc., and erection, £2.375; engine-room accessories, tools, cranes, etc., £230; switchboard and erection and wiring buildings, £875; accumulators and erection, £1,550; cables and services, £3,330; land and buildings. £1,500; total, £11,566. The charges are not to exceed 7d. per unit for the first hour, and 4d. per unit for any further quantity to private consumers for private lighting, and 4d. per unit for the first hour and 1½d. per unit for any further quantity for power. The Council will be supplied with current for public lighting by agreement, at a price not exceeding 2½d. per unit.

Double-Current Generators.—The power-house of the British Electric Plant Company at Alloa, from which electricity is supplied in bulk for distribution by the local authority, in common with the supply of power for the company's own works, is fitted with two 175-kw. double-current generators, one double-ended rotary converter—a combination of two double-current machines—and one double-current battery booster. The three-wire system installed is also balanced solely by static polyphase transformers, there being no running balancer. We are informed that specifications for this plant were issued as early as June 1, 1900, the generators were ordered on Aug. 3, 1900, and were delivered to Messrs. Willans and Robinson's works in April, 1901. They were erected in Alloa in September and October, 1901, and the public supply was started Dec. 31, 1901.

"The Advertiser's Guardian."—In this book, published by Thomas Dixon, Oxford-street, W. (2s. 6d.), the author rightly took for granted that advertisers in general do not want only a mere *résumé* of the country's papers, but require to be shown some practical examples and given advice as to the most effectual means of getting good returns on their expenditure, and a number of well-written articles, the result of 20 years' practical experience in the advertising profession, are included in the volume, and they will repay perusal, while the contributions by Walter R. Warren, LL.B., barrister-at-law, on trade marks and on the law for advertisers, are extremely valuable for handy reference. The article on the mail-order trade refers to a subject the importance of which is as yet not fully recognised by many merchants in this country, who are otherwise well suited to profit by the system.

Wireless Telegraphy.—Last Friday it was reported that messages by wireless telegraphy were exchanged between Mr. Marconi's stations at Tablehead, Cape Breton, and the Cornwall coast. The Tablehead station is now completed and equipped with instruments, and it is quite probable that some attempts have been made to transmit signals across the Atlantic, but with what success is unknown. The London offices of the Marconi Company consider that the report is, to say the least of it, premature by a good many months. In other words, no communication between Cape Breton and Cornwall is possible at present, for the simple reason that the apparatus being erected for this purpose at Poldhu has not yet been completed, the former construction having been blown down during last winter. The new structure, consisting of four wooden towers (instead of 20 or 30 masts), will not be ready for use for weeks.

Fire.—A fire was discovered about 8 o'clock on Wednesday evening in the testing-room of the National Telephone Company's exchange at London-wall. Fortunately, all the staff, with the exception of two or three girls and five men, had already left the premises, and there was no difficulty in getting the girls safely away. The five men made an attempt to keep the fire in check. Within two minutes the first escape arrived, quickly followed by engines, until there were over 100 firemen at work, with 17 fire-engines and seven escapes, on the spot. Commander Wells directed the fire brigade and Major Fox the salvage men. In about an hour the fire was got under, but by this time the roof had collapsed, and the three floors below had been practically burned out. Great alarm was felt lest a huge derrick erected on the roof, concentrating several thousands of overhead wires, should tumble with the roof, but, fortunately, this was built of iron, and was supported by pillars which passed to the lower floors; hence it stood intact. Happily, too, the rooms in which the books of the company are kept, as well as shops beneath, escaped injury, save such as was caused by the percolation of water. The damage is estimated at over £20,000, and will result in a complete stoppage of telephone operations from this exchange for some little time, as most of the wires have been destroyed. It is feared that the dynamos and engines in the lower part of the building will be irretrievably damaged. This exchange supplied about 3,000 subscribers within an area of about a quarter of a mile.

Teignmouth.—The Gas Committee reported at the last meeting of the District Council that they had considered the agreement submitted by Mr. Purves, on behalf of Crompton and Co., who were desirous of supplying electric light within the district, and were prepared to make an application to the Board of Trade for an extension of time in which to carry out the works authorised by the Council's provisional order of 1899. Mr. Purves explained that they would be prepared to pay to the Council a sum not exceeding £200 in respect of the costs of the provisional order, and also the costs of obtaining the extension, as well as £30 as a yearly rental. Two companies wrote giving notice of their intention to apply for a provisional order for electric lighting purposes. The principle of Crompton and Co.'s scheme was accepted.

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Under this scheme the Council would retain some control of the undertaking, and would have the option of purchase in 14 and 21 years.

Postal Anomalies.—In a series of articles in the *Daily News* Mr. Henniker Heaton, M.P., rides his hobby horse, and makes a number of valuable suggestions, from which we extract the following with regard to telegraph and telephone rates: "I should like now to ask you whether the time has not arrived for reducing the extraordinarily high cost of a telephone message between London and Paris. It is 8s. for three minutes' conversation. Surely half-a-crown ought to be sufficient to pay well. May I also ask you to reduce the charges for telegrams to France to 1d. a word? It is ½d. a word all over England to Ireland and the Channel Islands, and less than ½d. throughout France. Surely the combined sums amounting to 1d. per word would pay well from here to France. And the French Government wishes the reduction. With regard to our own inland telegram system, surely you can see your way, in 1902, to give us eight words, with name and address free, or a total of 20 words, for 6d."

Middlesbrough.—The Corporation have adopted a scheme at a cost of £1,701. 13s. 1d. by which they will be enabled to lay mains for the present supply in Commercial-street, and also lay a feeder which will be required at an early date. The borough electrical engineer (Mr. Taylor) in his last monthly report states that during the month of June 14,996 units have been sold, as compared with 5,957 units during June last year. The revenue amounted to £322. 8s. 4d., as against £130. 2s. 1d., whilst the total works cost was £197. This was equal to an average cost per unit of 3·15d., which showed a decrease of 1·35d. per unit as compared with June, 1901, and a decrease of ·09d. per unit as compared with the previous month. The total lights connected numbered 20,444, and he had received applications from 45 consumers representing 330 more lights. The total load would then be 613 kw. Mr. Taylor has been authorised to engage an apprentice on a premium.

Walsall.—At the last meeting of the Walsall Chamber of Commerce a letter was read from the National Telephone Company replying to the resolution passed by the chamber, protesting against the refusal of the company to make any concession to telephone subscribers for the inconvenience occasioned by the breakdown of the service in December last. The company stated that everything which skill or money could do was done to restore telephonic communication, and there was no ground for the allegation that the company failed to exercise due diligence. The snowstorm which occasioned the breakdown was an act of Providence, which the company could not prevent. It cost them £25,000, and they were unable to accept any responsibility other than that of making good the damage done with all possible speed. The opinion was expressed that if the Telephone Company did not possess facilities for meeting an emergency of that kind they must take the responsibility, and the letter was referred to a committee for consideration.

Crystal Palace.—On Saturday the members of the Institution of Junior Engineers paid a visit to the American Exhibition at the Crystal Palace, the exhibits of Messrs. Babcock and Wilcox, the Fairbanks Company, Messrs. Charles Churchill and Co., Messrs. W. C. Horne and Sons, the Blaxton Engineering Company, the Niles Bement Pond Company, and Messrs. Stirlings' Motor Carriages Company receiving special attention. Another feature of engineering interest noticed was the reglazing of the centre transept roof, consisting of 100,000 square feet of Mellowes patent glazing, in which no putty or paint is used. Previously to entering the exhibition, Mr. J. W. Wilson and Mr. Maurice Wilson, the principal and vice-principal, showed the members over the Crystal Palace Company's school of practical engineering, carried on in the south tower, which is fitted up for instruction in mechanical, civil, electrical, and Colonial engineering. For the facilities which had been extended in connection with the occasion, the chairman of the institution, Mr. Percival Marshall, expressed the members' acknowledgments before they dispersed

Chesterfield.—The borough electrical engineer, Mr. R. L. Acland, has prepared a statement giving particulars in connection with the electrical undertaking, showing that the expenditure on capital account to March 31, 1902, was £26,098. 7s. 1d. The detailed revenue account for five months ending March 31, 1902, gives to generation and distribution costs: coal and cartage, £95. 13s. 11d. (cost per unit, ·325d.); oil, waste, water, etc., £11. 2s. 1d. (·039d.); wages at generating station, £101. 1s. 11d. (·344d.); repairs and maintenance of machinery, mains, etc., £11. 16s. (·040d.); repairs and maintenance of public lamps, £29. 1s. 7d. (·099d.); works costs, £248. 15s. 6d. (·847d.); management expenses, etc., £165. 5s. 11d. (·562d.); total costs, £414. 1s. 5d. (1·409d.); balance, being gross revenue, £867. 17s. 7d.—£1,281. 19s. The units sold totalled 70,500. The revenue from electricity supply was £1,262. 13s.; to which is added revenue from other sources, £19. 6s.; making a total of £1,281. 19s. This gives a gross profit on five months' working of £867. 17s. 7d., which is to be used for working capital of the undertaking,

Accrington.—The electrical engineer's last report states that the plant and mains generally are in good order. The length of street run with main cable during the past month was as follows: Blackburn-road North, from Hartmann-street to the borough boundary, 890 yards; road crossing at Tanpits-road; Blackburn-road South, from Paxton-street (railway arch) to near borough boundary, 1,460 yards; Manchester-road East, from Hargreaves Arms southward, 200 yards; road crossing at Hargreaves Arms—total, 2,550 yards. The units delivered to mains for week ended June 14 were 1,257; units for corresponding period last year, 654; increase, 603; equal to 92 per cent. The Finance Committee have been considering the amount of subscriptions paid by the Corporation to the National Telephone Company for telephone instruments and the rentals payable to the Corporation in connection with the company's underground services, and have decided that the last-named rental should be relinquished in exchange for the free use of all the Corporation instruments. This arrangement is to hold good for three years, after which it is open to revision.

Devonport.—The accounts of the electricity works for the nine months ending March 31 show an income of £5,024. 7s. 9d., the expenditure was £3,563. 16s. 9d., leaving a gross profit of £1,460. 11s. Owing to the form in which the accounts have to be kept, this profit has been converted into a net loss of £1,266. 9s. 11d., made up as follows: to the gross profit of £1,460. 11s. is added £601. 7s. 6d., interest on money at deposit, making a total of £2,061. 18s. 6d. From that has to be deducted the interest on debt amounting to £2,046. 14s. 7d., as well as the contribution to the sinking fund of £1,281. 13s 10d. The committee therefore had to pay out of income the whole of the working expenses, interest on capital borrowed, and £15. 3s. 11d. towards the sinking fund for the purchase of the undertaking. Had the works been in the hands of a company, and if the whole capital had been raised as the Corporation have raised their capital, the company would have been able to pay their shareholders a dividend of 2½ per cent. on the first nine months' working. The income shown in the revenue amount is based on the award of the arbitrator. The total capital outlay in connection with the works is £79,027. 8s. 11d.

Carnarvon.—A meeting will be held on the 14th inst., when Sir Wm. Preece, K.C.B., will explain a scheme for supplying electricity for lighting and traction purposes throughout Carnarvonshire by himself and Mr. Charles H. Rees, of Carnarvon, who have been for some time active in this direction. In the course of an address at the Cymmrodorion Section of the National Eisteddfod, held at Carnarvon in 1894, on the industrial resources of Wales, Sir William Preece referred to the unusual facilities afforded by the district for an electric installation on a large scale. Since then various schemes have been propounded, but it is only now that anything like a workable scheme has been presented. It is proposed not only to introduce electric light into the populous centres of the county, but to construct electric tramlines, and to seek the co-operation of quarry owners with the view to the substitution of electricity for steam as motive power. Considerable local support is now assured, and although a very large sum will be needed to carry out the scheme, it is believed there will be no difficulty in raising the necessary capital. Several smaller schemes for isolated districts have for some time been maturing, but it is felt that one large and comprehensive scheme for the whole county is more likely to be carried to a successful issue.

Woolwich.—In their last report, which was adopted after some debate, the Electricity Committee recommended that Mr. G. W. Keats be appointed chief assistant electrical engineer under the terms of his present appointment; that Mr. T. M. Colson, at present resident engineer at the Woolwich works, be offered the appointment of station engineer at the Plumstead works; that Mr. H. Walker, at present assistant under Mr. Colson, be offered the appointment of station engineer at the Woolwich works, and that in the event of these two offers not being accepted, advertisements be issued inviting applications for the two appointments; that Mr. S. H. Penning, at present assistant electrical engineer under the Council, be appointed distribution engineer under the terms of his present appointment; that Mr. B. Beatty, at present assistant at the Woolwich works, be offered the appointment of assistant distribution engineer, and that in the event of the offer being declined the appointment be advertised. That advertisements be issued inviting applications for the following appointments: two charge engineers for the Plumstead works at £2. 2s. per week each; junior draughtsman at a commencing salary of £80 per annum; general clerk at £80 per annum; store clerk and timekeeper at £70 per annum; office youth at 8s. per week. The committee also recommended that one of the members for Eltham be elected on the Electricity Committee.

Airdrie.—The Town Council have adopted a report referring to a visit to the Scottish House-to-House Electricity Company's works at Coatbridge to inspect lamps, etc. The committee state that they saw fitted up in globes belonging to the burgh of Airdrie (formerly in use for gas lighting) incandescent electric lights, one showing a lamp of 16 c.p. and the other showing two lamps of 8 c.p. each, and they instructed the electricity company to fit up in Airdrie globes containing two 8-c.p. lamps each, equal to 16-c.p. lamp referred to in the agreement with the electricity company, it being understood that the annual charge for current and maintenance for the two 8-c.p. lamps is to be the same as that for one 16-c.p. lamp referred to in the agreement. With reference to the question of square or round globes, the committee decided to adhere to the present pattern of round globe, the lamp being hung from a single-arm bracket, and instructed the electricity company accordingly. There was also fitted up for their inspection a series of five Johnson and Phillips single-carbon 18-hour arc lamps, which is the pattern of lamp the Scottish House-to-House Electricity Company, Limited, propose to erect. The committee did not care to select any particular type of arc lamp, and instructed the clerk to write to the company to that effect and to say that the Town Council leave that matter in the hands of the company, with the provision that whatever lamp may be erected will fulfil the conditions of the contract entered into between the Town Council and the company. The electricity company have begun to lay down the cables for the supply of electric light in the burgh.

London County Council.—The Council have approved of an estimate of £500 for the purchase of an additional electric testing plant, consisting of an alternator and a motor, for use at the electricity-meter testing station at the Victoria-embankment; also an agreement with the Lewisham and District Electric Supply Company with respect to the removal, if so required by the Council, at any time within a period of three years, of certain works in High-street, Lewisham, and Rushey Green, executed in contravention of the provisions of the Lewisham Electric Lighting Order, 1901, but to which the Council, on June 24, 1902, gave conditional approval. Notices under Electric Lighting Acts

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and orders have been agreed to as follows: the Blackheath and Greenwich District Electric Light Company, low-tension mains along Beaconsfield-road, Ingleside-grove, Hardy-road, Humber-road, and Station-road, across Lee High-road, and along Old-road, and mains of high and low tension along a portion of Woolwich-road; the Brompton and Kensington Electricity Supply Company, mains of high and low tension along a portion of Edwardes-square; the Charing Cross and Strand Electricity Supply Corporation, mains to Beaufort-buildings and Savoy-buildings; the County of London and Brush Provincial Electric Lighting Company, mains of high and low tension along a portion of Bournemouth-road and across Rye-lane, and a transformer box in Bournemouth-road; the London Electric Supply Corporation, mains of high and low tension along High-road, Lewisham, Wickham-road, and Brockley-road; and from the Westminster Electric Supply Corporation, mains across Tenterden-street.

Manchester Telephones.—The Special Telephones Committee on Wednesday presented a report describing the results of the visit of their deputation to Glasgow when they inspected the municipal telephone installation of that city. The deputation arrived at the following conclusions: (1) that the Glasgow Corporation are quite satisfied with the success of their municipal telephone undertaking and its prospects; (2) that as regards the advisability of the trunk wires remaining in the hands of the Post Office, it is, in the opinion of the Glasgow Corporation, a satisfactory arrangement, and will work well in connection with the municipal telephone systems established from time to time in various parts of the kingdom; (3) that, considering the expenditure incurred for further extensions, the Corporation are of opinion that the expenditure has harmonised with the original estimate; (4) that the municipal telephone system has given satisfaction to the subscribers in Glasgow. This is evidenced by the number of applications received since the commencement of the system, as shown by the figures already quoted. The committee also endorsed the following recommendation: "That in view of the approval of the City Council, which has been already given to the establishment of municipal telephony for the Manchester area and the information as to the satisfactory working of the Glasgow municipal telephone service above set forth, it is advisable that the applications to his Majesty's Postmaster-General for concurrent licenses to carry on telephone exchange business by the Corporations of Manchester, Salford, and Stockport should be proceeded with, and that all necessary arrangements be entered into by those Corporations with this object." The committee also resolved that regulations should be drawn up and submitted to the Board of Trade with a view to safeguarding the public against the danger of telephone wires falling on to the trolley wires of the electric tramway system.

Maidenhead.—A recent report by the resident engineer, Mr. C. O. Milton, states that the general progress of the contract work has been materially retarded by the bad weather, but that a fair amount of work has been done since the committee's last meeting. The distributor cables have been drawn in in a number of streets, and considerable lengths of the feeders and pilot wires. The work of jointing up the network has been commenced, and pushed rapidly forward as far as the weather has allowed, and the first batch of the arc lamp pillars have arrived and are now being erected. Up to date applications have been received for a total of 430 lamp connections. There are, besides, premises being wired and some actually wired, for which the application forms have not yet come in, the aggregate demand of which will more than equal that figure. It is a fact, also, that nearly half the demand is made up by private houses, which is most encouraging; shops will come on from sheer business necessity. Taking the actual demand at the moment as being equivalent to 800 lamps, and considering that a connection of 1,000 at starting might be taken as representing a fair working load, the prospect indicated in the engineer's last report was not overdrawn. The rate of application for lamp connections will be bound to increase as the supply draws nearer. The engineer particularly draws the attention of the committee to the fact that applications for a supply of electricity have been received from Cookham, Bray, and Holyport, and that the important question arises of the advisability of the Corporation applying for an extension of powers for enabling them to supply electrical energy outside the borough. The engineer finds that it will be advisable to lay further cables in some of the districts at once—viz.: (1) Boyndon-road and along Laburnham-road; (2) Cookham-road as far as St. Luke's-road; (3) Crauford-rise as far as Mr. Vardy's; (4) Ray Park-avenue as far as Mr. Gingold's; (5) Bath-road as far as Mr. Shrewsbury's. The cost of running an electric lamp with a 25-c.p. bulb would be approximately £3 per annum, giving a much better light than an ordinary gas lamp, which costs about £3. 2s. per annum. Using a 32-c.p. bulb instead of a 25-c.p., which the engineer would strongly recommend, the cost of the electric lamps would come out at about £3. 12s. per annum. The total estimated cost of carrying out the whole of the work is £421, and the engineer recommends the committee to lay these extensions at once, as there is no doubt of their expediency, and the cost will be practically embraced by the provision for the present scheme. As the question of extending the public lighting by means of electric lamps along the line of existing mains may be discussed, the engineer has taken out an approximate estimate of the cost of replacing existing gas lamps with electric lamps, the total for 29 lamps being £295, the average cost per lamp being about £10 with main and erection complete. The figures given above relating to the cost of running the lamps would be the same for these—viz., £3. 12s. for a 32-c.p. lamp and £3 for a 25-c.p. The engineer would recommend the higher power as giving a much greater advantage on the charge at very little extra cost. Upon this report the committee make the following recommendations, which will come before the Council at their next meeting: (1) that the extension of mains referred to in the report be carried out; (2) that the extension of public lighting, also referred to, be deferred for the present.

PROVISIONAL PATENTS, 1902.

JUNE 23.

14158. Improvements in brakes for railway trains, electric cars, and the like. Elliott Holden, 10, Farringdon-street, Swindon, Wilts.

14194. Improvements in electrical interrupters. Lars Gustaf Nilson and Isaac Henry Kuh, 53, Chancery-lane, London. (Complete specification.)

14195. Improvements in controllers for electric motors. Lars Gustaf Nilson and Isaac Henry Kuh, 53, Chancery-lane, London. (Complete specification.)

14196. Improvements in driving mechanism for electric vehicles. Lars Gustaf Nilson and Isaac Henry Kuh, 53, Chancery-lane, London. (Complete specification.)

14201. Improvements relating to trolleys or collectors for overhead electric conductors. Amédée Fayol, 45, Southampton-buildings, Chancery-lane, London.

14202. Improvements in self-regulating dynamos specially applicable to electric lighting of trains. Harry Leitner and Richard Norman Lucas, 44, St. Martin's-lane, London.

14203. Improvements in electro-gasoline vehicles. Lars Gustaf Nilson and Isaac Henry Kuh, 53, Chancery-lane, London. (Complete specification.)

14205. Improvements in and relating to electrical sparking devices for explosion engines. Henri Charles Brasier, 60, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, Feb. 11, 1902, being date of application in France.) (Complete specification.)

14228. Improvements in electromagnetic friction clutches. Wenzl Schuster and Heinreich Ast, 46, Lincoln's-inn-fields, London. (Complete specification.)

JUNE 24.

14254. Improvements in and relating to the generation of electricity. John Macdonald, 96, Buchanan-street, Glasgow.

14270. Improvements in generators of electric currents. Edward Wythe Smith, 66, College-street, Chelsea, London.

14293. Improvements relating to the control of the speed of electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

14294. Improvements in or relating to regulating devices for dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

14295. Improvements in electric protection devices. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

14296. Improvements in or relating to systems of electrical distribution. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

14297. Improvements in electric time switches. Clarence Florian Heath, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14319. Improvements in electric incandescent lighting devices. Carl Schwabe, 6, Lord-street, Liverpool.

14329. Improvements in storage batteries. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (The Smith Storage Battery Company, United States.) (Complete specification.)

14334. Improvements in or relating to trolley wheels for electric tramcars. Frederick James William Hatch, 37, Chancery-lane, London.

14344. Improvements in or relating to electric arc lamps. Hugo Bremer, Westinghouse-building, Norfolk-street, Strand, London.

JUNE 25.

14348. Improvements in electrically-driven centrifugal machines. John Laidlaw, 154, St. Vincent-street, Glasgow.

14349. Improvements in electrostatic apparatus for measuring potentials. James Ferguson and Kelvin and James White, Limited, 154, St. Vincent-street, Glasgow.

14373. Improvements in the mode of and in apparatus for regulating the charge and discharge of storage batteries used in conjunction with dynamo-electric machinery for supplying electrical energy. The Lancashire Dynamo and Motor Company, Limited, and Robert Stafford McLeod, 34, Castle-street, Liverpool.

14374. An improved swivelling electrical collector trolley head. The National Rail and Tramway Appliances Company, Limited, and Phelam McCullough, 10, St. George's-crescent, Liverpool.

14386. Improvements in or relating to the electrolytic manufacture of chlorates and perchlorates. Pierre Louis Eugéne Lederlin, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Jan. 8, 1902, being date of application in France.) (Complete specification.)

14387. Improvements in or relating to the electrolytical manufacture of chlorates and perchlorates. Pierre Louis Eugéne Lederlin, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Jan, 8, 1902, being date of application in France.) (Complete specification.)

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14461. Improvements in electric incandescent lamps. Richard Bruno Roxby, 18, Featherstone-buildings, Holborn, London.

JUNE 30.

14464. Improvements in portable electrical transformers. Ernest Edmund Maddox, Glenartney, Bournemouth.

14471. Improved regulator for electric instruments. William Thomson, Baron Kelvin, 154, St. Vincent-street, Glasgow.

14479. Improvements in shade or globe holders for incandescent electric lamps. Arthur Albert Guest, 128, Colemore-row, Birmingham.

14482. Improvements in magnetic separators. George Leach Adamson, Julius Elias, and Edmund Ernest Adamson, 70, Market-street, Manchester.

14487. Improvements in electrical automatic cut-outs. Edward Woodrowe Cowan and William Bourne Dale, Springfield-lane, Salford, Manchester.

14489. Improvements in electrical recording instruments of the maximum demand meter type. Thomas Hesketh, Belvedere, Cheriton-road, Folkestone.

14496. Improvements in and connected with magnetic separators. George Leach Adamson, Julius Elias, and Edmund Ernest Adamson, 70, Market-street, Manchester.

14507. Improvements in controlling devices for electric motors. John Somerville Highfield, Windle House, St. Helens, Lancs.

14523. Improvements relating to electric ignition devices for motor cycles and other services. Alfred Pericles Maxfield and Charles Riley Garrard, 18, Southampton-buildings, Chancery-lane, London.

14542. An improved coupling for electric lamps and the like. Edwin Ruthven Gill, 19, Holborn-viaduct, London.

14547. Improvements in and relating to electrical measuring instruments. Edward Weston, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14572. Improved lightning conductor for electrical installations. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

14573. Improvements in switches for electrical glow lamps. The Edison and Swan United Electric Light Company, Limited, Joseph Shepherd, and Hugh Donald Gover, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14574. Controlling apparatus for electrically-propelled cars. George Henry Hill, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14583. Improvements in electrolytic interrupters. Georges Eugéne Gaiffe and Georges Gallot, 53, Chancery-lane, London.

14605. Improvements in starting switches for electric lifts. Easton and Co., Limited, Philip Ibotson Unwin, and Jorgen Björnstad, 47, Lincoln's-inn-fields, London.

14612. Improvements in incandescent electric lighting. Ignace Hippolyte Hegner, 18, Buckingham-street, Strand, London.

JULY 1.

14623. Improvements in continuous-current dynamos, motors, and converters. James Atkinson, Benavie, Marple, Cheshire.

14652. Improvements in or relating to electric arc lamps. George Westinghouse, Westinghouse-building, Norfolk-street, Strand, London.

14667. Improvements in electricity meters. Ernest Schattner, 55, Chancery-lane, London.

14670. An improved method of operating the points of electric tramways and the like. Henry Walker, 23, Coleman-street, London.

14676. Improvements relating to electric railways. William Milton Brown, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14680. Improvements relating to electric arc lamps. Adolf Schwehr and Paul Wagner, 45, Southampton-buildings, Chancery-lane, London.

14683. Improved driving mechanism suitable for electrically-driven machine tools. Caspar Wüst-Kunz, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, July 20, 1901, being date of application in Switzerland.) (Complete specification.)

14716. Improvements in automatic electric lock and block signalling. Thomas Harison Jones, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 17.

1901.

13033. Polyphase electric motor. Siemens Bros. and Co., Limited, and Lydall.

15448. Recorders for use in submarine telegraphy. Pelenc.

15514. Electrical primers, vent sealing tubes, and the like. Ashton.

16340. Means for electrically operating railway switches. Riggs.

16762. Electric switches. Farrell.

16814. Means applicable for use with overhead electric conductors for the prevention of danger in the case of telephone, telegraph, or other wires falling across them. Wilson.

16827. Apparatus for the electric ignition of the charges in internal-combustion engines. Edmondson.

17088. Dynamo-electric machines. Mackie and Glyn.

17618. Current distributing and collecting devices for use in connection with electric railways, tramways, and cranes, and for like purposes. Knowles. (Stierlin.)

18732. Contacts for electric glow lamps. Electric Lighting Boards, Limited. (Lefebre.)

19657. Mechanism or devices for communicating step-by-step motions for controlling and for encasing and mounting electric switches. Kingsland.

20651. Electric arc lamps. Schmidt.

24096. Method of readily attaching or fixing the containing cases of electrical or other apparatus to telegraph, telephone, and tramway poles or the like supports. Byng and Bell.

25146. Switching apparatus for electric lighting, telephones, and other purposes. Andrews.

26634. Means for connecting an alarm bell in a local system to the telephone exchange. Rabbidge.

1902.

252. Switch for electric currents. Hintze.

2825. Time electric switches. Cogswell.

4650. Signalling systems for electric railroads. Hart.

5129. Electric switches. Loewen.

8020. Controlling and engaging apparatus for railway points and signals operated by electricity. Neelemans.

8189. Electric circuit regulating devices. McDonnell.

9801. Telephone jack-strips. Ericsson.

9977. Pole-pieces for dynamo-electric machines. British Thomson-Houston Company, Limited. (Churchward.)

9978. Pole-shoes for dynamo-electric machines. British Thomson-Houston Company, Limited. (Churchward.)

10856. Switchboards for illuminating electric lamp signs and cards or tickets for automatically actuating the same. Norden.

11080. Multipolar electric switches. British Thomson-Houston Company, Limited. (Sargent.)

To be published on July 24.

1901.

8883. Electric signals for railways. Netter and Queyroul.

13510. Electrical workmen's time-checking clock. Mason and Brown.

13958. Indicating devices for electrical measuring and other instruments. British Thomson-Houston Company, Limited. (Haskins.)

15475. Systems of telegraphic intercommunication. Justice. (Rowland Telegraphic Company.)

15664. Electric clocks. Murday and the Standard Time Company, Limited.

16941. Electric arc lamps. Codd.

16950. Electric switches and combinations of the same with wall plugs and the like. Marsh and Lucas.

17192. Braking apparatus for tramcars and the like. British Electric Car Company, Limited. (Trimble.)

17485. Incandescent electric lamp socket or holder. Hartig and Glaser.

17656. Manufacture of glass by electricity. Redfern. (Soc. Anon. de l'Industrie Verrière et ses dérivés.)

18962. Prepayment electric meters. Gowlland.

1902.

1435. Coupling joint or connection for electric wires and fittings. Railing and Ide.

3811. Electrical signalling apparatus for railways. Mildon.

5818. Arrangement for the prevention of pulsations and sudden alterations in periodicity in alternating-current generating plants. Evans. (Allgemeine Elektricitäts-Gesellschaft.

8315. Couplings for electrically-lighted table decorations. Chapman.

8747. Locking devices of electrical blocking apparatus for railways. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

9849. Means or methods of connecting incandescent electric lamps in festoons and for other like temporary uses. Barker.

9946. Telephone call-list. Michaelis.

10097. Conduits for electric mains and the jointing of same Barlow and Young.

10943. Trolley guards for electric railways and the like. Gagne and Bonneau.

11950. Brush-holder for dynamo-electric generators and motors and the like. Mitchell.

12547. Making electrolytic baths. Von Liebermann.

12578. Current-reversing mechanism for oscillating electricity meters. Justice. (Theiler and Co. and Eibig.)

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	July 5	4,830	4,888	− 58	128,871	117,718
Blackburn Corporation	,, 4	930	682	+ 242	19,428	16,239
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 7	762	784	− 22	9,566	9,955
Bolton Corporation	,, 6	1,664	1,608	+ 56	39,888	37,927
Bradford Corporation	—	—	—	—	—	—
Bristol Tramways Company	,, 4	5,065	4,872	+ 193	—	—
Carlisle Tramways Company	,, 5	286	274	+ 11	4,151	4,057
Central London Railway	,, 5	7,196	6,077	+ 1,117	—	—
City and South London Railway	,, 6	2,821	1,972	+ 849	—	—
Cork E. T. and L. Company	,, 3	803	644	+ 159	12,231	11,593
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 5	264	254	+ 8	5,314	5,108
Dublin & Lucan Electric Railway	,, 6	119	142	− 23	—	—
Dublin U. T., electric cars	,, 4	4,586	4,362	+ 224	—	—
Dublin S. District, Electric	,, 4	1,194	1,142	+ 50	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 5	12,410	12,353	+ 57	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	,, 5	1,045	998	+ 47	14,002	12,464
Hull Corporation, E. S.	,, 5	1,789	1,726	+ 63	24,120	23,222
Liverpool Corporation	June 28	15,032	9,634	+ 5,398	243,602	221,639
Liverpool Overhead Railway	July 6	1,595	1,732	− 137	—	—
Newcastle-on-Tyne Corporation	,, 5	2,635	—	—	—	—
Portsmouth Corporation	June 28	3,291	926	+ 2,365	—	—
Sheffield Corporation	,, 29	4,965	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Sunderland Corporation	July 6	1,320	1,204	+ 116	16,208	14,405

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £262 decrease.
Barcelona Ensanche y Gracia, £96 decrease. Barcelona £354 increase.
Brisbane, £1,197 decrease (month of June, £10,187; increase, £1,813).
Buenos Ayres and Belgrano Electric (month of June, receipts £12,229; increase £478), £47 increase.
Calcutta, £246 increase.
Cape Town (month of May), receipts, £16,330; expenditure, £7,205.
Isle of Thanet Electric, £112 decrease
Mexico Electric (month of June), receipts, £20,285; expenditure, £12,275.
Perth Electric, £240 increase.
Port Elizabeth (month of May), receipts, £3,796; expenditure, £1,872.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-⅞
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	⅛-⅛
British Insulated Wire, Ord., 1-70,000	5 ..	7½-8½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6
—— 5 per cent. Mortgage Debentures	100 ..	100-103 xd
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5⅞-6¼
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1¼-1⅜
—— Non. Cum., 6 per cent. Pref.	2 ..	1⅞-2¼
—— 4½ per cent. 1st Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99 xd
Callender's Cable, Debentures	100 ..	109-113 xd
—— Ordinary	5 ..	16-17
—— 5 per cent. Pref.	5 ..	5¼-6 xd
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	100 ..	101-106 p.c. xd
Edison and Swan United, "A" Shares, 1-99,261	3 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	76-81
—— 4 per cent. Deb. Stock, Red.	100 ..	76-78 xd
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9½-10¼ xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17 xd
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22 xd
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15¼-16¼
Telegraph Construction and Maintenance	12 ..	35-38
—— 5 per cent. Bonds	100 ..	101-104 xd
Telegraph Manufacturing, Ordinary	5 ..	—
—— 5 per cent. Cum. Pref.	5 ..	—
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6⅞
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	106-107
Electric Railways.—		
Central London, Ordinary	100 ..	107-110
—— 4 per cent. Pref.	100 ..	107-110
—— ,, ,, deferred	100 ..	104-107
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	117-120
City and South London, Consolidated Ordinary	100 ..	74-76
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	128-131
—— ,, ,, ,, '01	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	93-96

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref.	10 ..	10-11
—— Debenture Stock, Red.	100 ..	101-104 xd
Brompton and Kensington, Ordinary	5 ..	9-9¼
—— 7 per cent. Preference	5 ..	9-9⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8¼-9½
—— Nos. 20,001-30,000	5 ..	8¼-9½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, ,, £10 Ord.	6 ..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-107
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107 xd
Chelsea Electricity Supply	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12½
—— 5 per cent. Debenture Stock	100 ..	121-126 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104 xd
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	11¼-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	108-111 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅝
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	99-102 xd
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¼-10¼
London Electric, Ordinary	3 ..	1¼-1½
—— 6 per cent. Pref.	5 ..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	94-99
Metropolitan, Ordinary	10 ..	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113 xd
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101 xd
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2⅜-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9½
—— 3½ per cent. Deb.	100 ..	97-100 xd
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3¼-3⅜
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130 xd
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	102-105 xd
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9½-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	12-13
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-13¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅛-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105 xd
—— Prov. Cert., all paid	100 ..	95-98
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	4¼-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	5⅜-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	10¼-11 xd
—— ,, ,, ,, ,, ,,	5 ..	8-8¼ xd
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	107-109 xd
—— ,, ,, Prov. Crts.	50 ..	81-83 xd
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98 xd
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103 xd
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8¼-9½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	107-110
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	12s. ..	⅝
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	60 p.c. ..	60 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Preferred, 590,001-790,000	3½ ..	4⅜-4⅞
—— Deferred Stock	100 ..	54-58
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5⅛
—— 3½ per cent. Deb. Stock, Red.	100 ..	93-96 xd
—— 4 per cent. Deb. Stock, Red.	100 ..	102-106 xd
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Franklin Institute.—The current number of the *Journal* of the above institute contains the following, among other papers and articles on scientific matters: "Upon the Structure of Metals and Binary Alloys," by Mr. Wm. Campbell; "Steel Rails," by Mr. R. Job; report of the Committee on Science and the Arts on "Haupt's Reaction Breakwater," and "A Method of Measuring Objects in the Microscope," by Mr. F. E. Ives. A number of notes and comments and current topics of special interest help to make up a very useful issue.

X-Ray Practice.—A remarkable case of the cure of lupus by means of the X-rays has recently been effected at Newcastle-on-Tyne. A woman who had suffered from the disease for over 30 years was subjected for nearly 200 consecutive days to exposures of 15 minutes' duration, and at the end of that time was completely healed. Of 20 cases treated at Newcastle by the Röntgen rays, 15 have been wholly successful—a record which is of great significance in view of the controversy that exists in some quarters as to the relative merits of the treatment by the electric light and by the X-rays.

Books Received.—We have to acknowledge receipt of Mr. Robert M. Neilson's new work on "The Steam-Turbine." The book is published by Messrs. Longmans, Green, and Co. at 7s. 6d.—From the Iron and Steel Institute we have received a copy of its *Journal*, just published by Messrs. E. and F. N. Spon, Limited, containing the general index to vols. xxxvi. to lviii., which cover a period of 10 years, from 1890 to 1900. The book also gives a history of the development of the Iron and Steel Institute, illustrated by portraits of the past-presidents. It is edited by Mr. Bennett H. Brough, the secretary of the institute.

Overland Wireless Telegraphy.—Wiring from Kronstadt under date July 15, Reuter's agency announces that the Italian cruiser "Carlo Alberto" the previous night received messages by wireless telegraphy from Marconi's Poldhu station in Cornwall. This is the first successful experiment in wireless telegraphy over a distance of 1,600 miles in a straight line by land, and the result is reported to be most satisfactory. In the experiment, it is stated, a new receiver, known as the detector magneticum, invented by Mr. Marconi a month or two ago, was tried with success. We understand that Mr. Marconi proposes to erect a station in Italy with a view to establishing wireless communication with Great Britain, Canada, and the United States.

Fire Prevention.—The British Fire Prevention Committee undertook two tests with fire-resisting doors on the 9th inst. at their testing station, Bayswater, when wood doors protected with uralite slabs were under investigation. Among the visitors were the official representatives from the War Office, Admiralty, and other Government departments and the leading insurance, railway, and shipping companies. In the one case the door was protected by uralite slabs alone, and in the other case by uralite slabs and light metal sheeting. The duration of the test was 1½ hours at temperatures rising to 1,800deg. F., and although smoke passed through the joints between the doors and the frame, and the fire side of the doors was badly injured, the fire is reported not to have passed through the doors themselves. The official accounts of the tests will be issued in due course.

Compounding Alternating-Current Machinery. A method of compounding alternating-current dynamo-electric machinery, such as generators and motors, was described by Mr. F. G. Baum at the recent convention of the American Institute of Electrical Engineers. Essentially the system involves the use, besides the ordinary exciter, of another machine, whose field is placed in series with the line of current of the generator. The armature of this second machine has a current-collecting device, which sends impulses of current through a secondary winding on the ordinary exciter's field, thus increasing its potential as the increased load comes upon the main generator. It is reported that the results obtained from the use of this method of regulation are excellent, but it would appear as if the introduction of a second and special exciter would introduce complications, which ought to be avoided wherever possible.

New Radio-Conductor.—Mr. Branly has devised a new radio-conductor to replace the well-known coherer he has been using up to the present. In a note to the Academie des Sciences he attributes the uncertain working of a coherer filled with filings to the large number of contacts caused, and to the modifications which the tappings create in the surfaces of the contents of the tube. After experimenting with various metal contacts, consisting both of polished and of oxidised metal, he has now fixed upon a combination which is described as a polished-oxidised metal contact, and which he says gives a greater regularity, as well as sensitiveness. In his recent experiments, Mr. Branly used pieces of metal which are first cleaned and polished, and subsequently oxidised by being heated in a hot-air oven of ascertained temperature, which enables the metal being heated to be withdrawn at any degree of temperature required, the degree of heating corresponding to the sensitiveness wanted.

A New Element.—Last week Prof. Marckwald announced to a meeting of the Berlin Physical Society that he has discovered a new element, which is radio-active, and of extraordinary energy. According to the Berlin correspondent of the *Standard*, Prof Marckwald has separated the new element from the radio-active bismuth. The so-called polonium, found in uranium ore, consists, as the professor discovered, substantially of ordinary bismuth, and of a new metal, in the proportion of 1,000 to 1. The new metal, it is said, can be separated by electrolytic process. The rays it emits are something like those of the metal radium, but differ in being almost completely absorbed by paper, as well as by glass. Prof. Marckwald has proved that a porcelain tube, heavily charged with electricity by rubbing, immediately lowers its charge when a morsel weighing hardly a milligramme of this metal is brought within a distance of one decimetre. The chemical analysis of the new metal is rendered very difficult by the fact that one ton of ore contains hardly 1 grm. of the metal.

New Submarine Boat.—The sixth submarine boat built to the order of the British Government, and which was launched last week from the yard of Messrs. Vickers, Sons, and Maxim, at Barrow, is the joint invention of Messrs. Vickers and the Admiralty, and marks an entirely new departure in submarines. In many respects she differs from the five boats already attached to the British navy. The length of the new boat is slightly more than 100ft., whereas the other boats measure 63ft. 4in., and her machinery also is more powerful. In consequence, it is expected that she will be able to take up a position as a defensive weapon in the line of battle, thus greatly improving on her predecessors, which are mostly designed for coast defence duties. While on the surface the new boat can be navigated as an ordinary torpedo boat, and she is also described as an under-water diving torpedo boat. It is stated that as a result of her additional mechanical power she can

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dive out of view in a very few seconds, and while in this position she can be navigated by means of Sir Howard Grubb's new instrument.

The Electrostatic Wattmeter.—Mr. Miles Walker contributed a short paper at the annual convention of the American Institute of Electrical Engineers last month, showing the application of the Kelvin quadrant electrometer to electric power measurements. Used as a wattmeter, this instrument reads the power correctly whatever the shape of the wave form, for at any instant the turning moment is proportional to the instantaneous value of the power and the needle takes up a position that corresponds with the average of the instantaneous turning moments. The accuracy of the instrument with low power factors, its wide range and freedom from burning out, make it suitable for general testing purposes, whenever low power factors are likely to be met with. When the power of a three-phase motor is measured in the ordinary way, with two successive readings on a wattmeter, one of these readings will be negative, or of very low power factor, when the motor is lightly loaded. It may be necessary to take the difference between two readings, both of which are inaccurate on account of the effect of the low power factor upon an ordinary wattmeter, and the final results will be very far indeed from accurate. On the other hand, an electrostatic wattmeter can be made to read power supplied at pressures as low as 100 volts.

Arc Lighting.—An instructive paper on the above subject was read by Mr. Green at the recent annual meeting of the Canadian Electrical Association, in which he entirely decides in favour of the enclosed arc lamp as against the open arc. His conclusions are that the enclosed arc is better and cheaper to operate than the open arc; that the direct constant-current, enclosed arc system is best and most economical for plants devoted exclusively to arc lighting; and that the alternating, constant-current, enclosed arc system is best and most economical for plants which use large alternators of from 40 to 125 cycles, the arc lighting alone being but a small part of the total output of the system. It is admitted, however, that direct and alternating-current arc lamps are very extensively used on constant-potential systems of distribution for inside lighting, and somewhat for street lighting, but only when there are special reasons for so doing. The author considers that the open-coil arc generator of the Brush type is superior to arc generators with closed-coil armature, for the reason that the voltage at the terminals of the generators on breaking the circuit will not rise over 20 per cent. above the maximum voltage which the machine will supply at normal current, which is not the case with the machines of the closed-coil type, in which the rise of voltage is much greater. Another advantage is the great reduction in the number of commutator segments in comparison with generators of the closed-coil type.

A Turbo-Generator.—Those who attended the annual convention of the Incorporated Municipal Electrical Association in London the week before last, or who have read the reports of the proceedings which have appeared in this and other scientific journals, will recall that in the discussion of the question of the use of steam-turbines for driving electrical machinery, the complaint was raised by several speakers that up to the present a generator had not been designed which was suitable for use in connection with these prime movers, and to this principally was assigned the reason why steam-turbines have not made greater progress in their application to electrical machinery. While the matter was being debated on this side of the water, it is interesting to note that practically at the same time a patent was granted by the United States Patent Office to Mr. G. B. Lamme for a generator of high speed, which is claimed to fulfil all the conditions required for working in connection with steam-turbines. The machine is of the revolving-field type. The field consists of two end blocks with two intervening blocks, the several sections of the core being fastened together against independent movement by means of dowel pins near the periphery. The winding, which is all in parallel planes, is laid in deep slots continuous over the two ends of the armature. By means of a system of longitudinally bored holes and spaces between the blocks, ventilation is maintained. Each section of the core is exactly balanced independently as it is placed in position on the shaft, and the entire structure is also balanced by means of screws inserted in the ends, the number and position of the screws being regulated to secure the adjustment desired.

The Berlin High-Speed Trials.—The attempts to obtain a hitherto unrivalled speed with electric locomotives are still being made on the Berlin-Zossen military railway with more or less success. Our readers will remember that some months ago it was reported that a speed of between 95 and 100 miles an hour had been obtained as a result of these trials, but the latest accounts do not show that this figure has been improved upon as yet. However, in face of the fact that in the early stages of the trials the speed obtained averaged only 60 English miles, it is satisfactory to learn that at the present time an average speed of 96 miles an hour is maintained at ease with the electric locomotives. Also, the vibration trouble has been considerably modified, and the only serious difficulty now remaining is said to be in connection with the brakes. Three systems of brakes are used on the experimental trains—*i.e.*, electric, pneumatic, and hand brakes—and even when these are applied simultaneously it is found to be impracticable to stop the cars within a distance of less than 1,600 to 2,000 yards, which, from the point of view of safety, is not regarded as quite satisfactory. An interesting point is that when the trains are travelling at the speed of 96 miles the drivers are quite able to read the mile-post indications, but it is considered that in practice it would be necessary to place the semaphores and block signals at a much greater distance from the passenger stations than is at present the case. The rails in use on the experimental line are of the "Goliath" type, and have shown good resistance under the great weight of the electric locomotives. We understand that the Prussian State Railway Administration is so impressed with the undoubtedly successful turn the trials have taken, that it has placed an order for two cars of a similar type to those under test to run at an average speed of 78 miles an hour.

Light-Weight Storage Batteries.—In a recent issue of the *Electrical World*, Prof. A. L. Marsh discusses the possibilities for a light-weight storage battery. For use in vehicles the large quantity of lead employed in the manufacture of the storage battery is a heavy drawback. Prof. Marsh shows that theoretically lead peroxide can yield over 100 ampere-hours per pound. But not only are the conditions of discharge such that only about one-third of the theoretical electric quantity can be realised, but in order to employ lead peroxide a relatively large amount of solid lead has also to be carried in order to support the peroxide. As it is, instead of obtaining 80 watt-hours per pound of battery, which would be the approximate theoretical limit for a lead battery, it is only possible to obtain about 12 to 14 watts per pound for a vehicle battery, with relatively heavy depreciation, and six to seven watt-hours per pound for a stationary battery, where weight is of lesser

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consequence as compared with duration of life. However, heavy as it undoubtedly is, the lead storage battery is the only one which has stood the test of time, and which is used commercially in automobiles. But the weight combined with the depreciation of the battery is such as to restrict the range and capability of electric automobiles within comparatively narrow limits, although there are signs at the present time that the range of possibility of the storage battery is on the increase. According to the author, the oxidation of iron as the negative material, together with the reduction of peroxide of nickel to the oxide as positive material, gives the best available ampere-hour capacity per pound of matter. These are the substances in the Edison cell, although it is a moot point as to whether in that cell the nickel peroxide is reduced to the sesqui-oxide or to the oxide.

High-Potential Direct-Current Dynamos.—Some very interesting dynamos, capable of generating direct current under a pressure of 25,000 volts, have lately been brought into operation on the St. Maurice-Lausanne transmission line in Switzerland. Details of construction recently published in *L'Electricien* indicate that the field magnet is of laminated iron and revolves inside a ring built in two parts, which constitute the armature. The latter is consequently fixed, while the field revolves. The armature has 48 coils wound in slots in a stationary iron ring, the coils being insulated by a specially prepared paper trough. As each coil contains 500 turns of wire 20mm. in diameter, there are thus in all 24,000 turns in the armature, which is capable of a normal output of one ampere; its resistance is about 700 ohms. The commutator, which is also fixed, is formed of 96 segments, air insulated, and two brushes run upon the inner surface of it, turning with the shaft and being connected to collector rings for leading off the current. To avoid the formation of arcs between the segments of the commutator, which have a difference of potential of 500 volts between them, a blower is provided, feeding two jets which turn with the brushes and blow a powerful stream of air upward from the interior of the commutator. The machine is separately excited, the air-pump being attached to a pulley of the exciter. This machine is, of course, very carefully insulated from the earth, as is the rheostat which controls the exciting current. The machine requires eight amperes at eighty volts for excitation, and gives 25,000 volts at its normal speed (600 revolutions per minute). The diameter of the revolving field is 17in., and the output 34 e.h.p. over an ordinary telegraph line of iron wire 148mm. in diameter. It is stated in our contemporary that one of these machines has transmitted 26 effective horse-power for 218 miles, using the ordinary earth return.

Niagara Falls Power Plant.—The American Institute of Electrical Engineers held their annual convention at Great Barrington, Mass., at the end of last month, when a large number of interesting papers were added to the list of current scientific literature. Among these was one by Mr. H. W. Buck on the development of the Niagara Falls power plant, in which he mentioned a number of improvements which are about to be carried out in the machinery. For instance, he stated that the first type of generators, with the external field was to be supplanted by the internal revolving field type, built in accordance with modern methods. According to an abstract of the paper in our New York contemporary, the *Electrical Review*, almost all modern machines of large size in the States employ the latter type, and the Niagara Falls Power Company has felt that it is to its advantage to employ this in the new machines which are to be installed in the new power at Niagara. The figures given as to the efficiency of the external-field generators of the new type are interesting, as showing the small losses that occur in this type of electrical machinery. The guaranteed efficiency at full load is 98 per cent., and from actual test the full-load efficiency is 98·15 per cent. This so closely approaches the efficiency of alternating-current transformers, as to be a very remarkable achievement in electrical engineering design and construction. The author also brought to the attention of the members the use of a 10,000-h.p. three-phase generator, which the Canadian power plant of the company will include. There is to be a number of these machines erected in the Canadian station, and it is interesting to note that they occupy very little more space than the 5,000-h.p. units which are installed on the American side of the Niagara Falls. The larger units will also be of the internal-field type, and are said to be very simple in their construction details.

Technical Instruction in Canada.—By the last mail we received a copy of the annual calendar of the McGill College and University at Montreal, an institute founded so long ago as in 1813 by Andrew McGill, a Scotsman, who emigrated to Canada before the American Revolution, and subsequently became one of the leading merchants of the city of Montreal. Among Canadian colleges and universities the McGill University stands almost alone in that it owes its origin to private endowment. The governing body of the college now includes such notable personages as the Earl of Minto, Governor-General of Canada, and Lord Strathcona. Glancing through the calendar we see that of the five faculties forming the educational work of the university, not the least important is that of applied science. The undergraduate courses of study in this subject extend over four sessions of eight months each, and provide training in civil engineering, mechanical engineering, mining engineering and assaying, electrical engineering, practical chemistry, and architecture. These courses lead to the degrees of B.Sc., M.Sc., and D.Sc. In electrical engineering the students are instructed in the design and use of continuous current, alternating current, and commutating machinery, and also receive instruction in electric lighting and power distribution, electric traction, electrical design ing, telegraphy and telephony, etc. Practical work is carried out in the laboratories, which are equipped with the most modern types of electrical machinery and testing apparatus. These apartments include a standardising laboratory, a dynamo laboratory, a high-tension testing-room, a photometer room, and a laboratory for special investigation. From the above it will be seen that the arrangements made for the teaching of electrical engineering at the McGill College are of a very complete nature. The building itself stands in one of the best parts of the city of Montreal, and from the prints shown in the calendar it has a most picturesque appearance from the outside.

Grounding Secondary Distributing Circuits.—This interesting question is the subject of a short article by Mr. S. B. Hood in the current number of the *Electrical World*. From personal experience with a system of distribution having a connected load of 40,000 lamps, he has reached the conclusion that a grounded secondary is absolutely necessary for the safety and reliability of the system, and he goes so far as to advocate that a station engineer who permits his system to remain ungrounded should be held not only civilly, but criminally liable for any personal or real damage which may result. In a secondary system ungrounded there is to all intents and purposes a three-gap arrester permanently connected

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to the circuit. These gaps are little, if any, longer than those of any good lightning arrester, and equally liable to destruction. Any one of them is apt to become unknowingly short-circuited, increasing the danger of a high-tension discharge, and the only way to eliminate the gaps in order to avoid this risk is by permanently and effectively grounding the secondary circuit. But this does not get rid of the gap between the coils of the transformer, and the author states that it is not only possible, but entirely practicable to eliminate this last gap by grounding the primary distributing system. The greatest problem to solve, however, is what constitutes a "permanent and effective" ground. The writer's experience has been that a driven pipe in ordinary soil is practically useless, the resistance of a 1in. galvanised pipe driven 6ft., varying anywhere from 20 to 80 ohms, depending on the condition of the weather and nature of the soil. Further tests show that pipes of this size, after having been driven about five or six years, have increased in resistance to as high as 200 ohms. A copper plate or coil of wire, buried in coke or charcoal, placed in the bottom of a hole, before a pole is set, is about as good a ground as can be obtained, unless connection can be made directly with a water or metallic drain pipe. The resistance of such a ground seldom is over 10 ohms. Concluding, the author advises that the best policy is to ground the system at every possible chance, as each ground becomes an additional source of prevention.

New Form of Rheostat.—From the *Journal* of the Franklin Institute, received by the last mail, we understand that the Scott award is recommended by the committee on science and the arts to Mr. Chas. Wirt, of Philadelphia, for a new form of rheostat of which he is the inventor. The special novelty of the apparatus in question consists in the use of a continuous strip of resistance material without joints. This strip is a ribbon of metallic alloy coated on one side with an insulating material, such as flake mica, held in place by shellac, so that when the strip is wound in a flat coil there is a layer of insulation between each layer of conducting material. In making these strips into a rheostat they are wound upon a mandrel of flat, oval section, a certain number of turns being wound one on top of the other, when a slight sideways shifting allows another series of turns to be wound upon the mandrel without breaking the continuity of the strip itself. When a sufficient number of these flat coils have been wound upon the mandrel they are slid off, and the coils are arranged in a circle upon a plate which forms the back of the instrument. The necessary contact strips are then placed in position, one on the face of each coil, and extending the full length and width of same. The front plate, with the necessary insulation, etc., is placed upon these, and the whole subjected to heavy compression, while a steel ring is spun over the outer edges of the plates, making the compression permanent and leaving the instrument ready for the placing of the centre spindle and contact arm. The advantages claimed for these rheostats are: small size combined with large capacity; a large subdivision of the resistance without undue expense; small liability to damage owing to the absence of all soldered joints; and long life for the same reason. The investigating body subjected one of these rheostats, suitable for a 5-h.p. motor, to the severe test of a large number of heatings and coolings, which were estimated to be the equivalent of two years' service. On dismantling the instrument it was found, at the conclusion of the tests, that none of the contact strips had been moved or shifted, nor had the resistance strip apparently sustained any damage. The insulation between the layers of the coils seemed in perfect condition, and the metallic contacts between the strip and contact plates showed no deterioration except where the cooling water used in the test had penetrated.

All-British Cables.—The temporary indisposition of Mr. Chamberlain through a cab accident the week before last was the cause of the postponement of the Colonial Conference, which was to have been held during the past fortnight. One of the topics this conference was to have discussed last week as being of the first importance to the Colonies was the subject of all-British cables, which also naturally has great interest for members of the electrical profession. Some idea of the subject as it will be presented to the Colonial Conference when it begins its sittings is to be gathered from a memorandum issued by Sir Sandford Fleming, who has for many years taken an active interest in promoting the project for laying the Pacific cable between Canada and Australia as part of an all-British telegraph service round the world. The conference is asked in this circular to express its opinion in favour of the creation of what is described as "the Imperial telegraph girdle," and to resolve that this "must be absolutely State-controlled," that "the main lines of communication of the Empire be placed beyond the possibility of interference by trusts and combines," and that "they shall remain inviolably British." A few of the main facts of the above proposal may be of interest. The original estimate of expenditure required to establish such a telegraph girdle around the globe was from £5,000,000 to £6,000,000, but this included the Pacific cable, which will cost close on £2,000,000. The Pacific cable will shortly be completed. To provide and lay the remaining cables not far short of £4,000,000 will be necessary. The Imperial telegraph system will embrace in its circuit round the globe three great oceans. Of these the Pacific will have its opposite shore telegraphically united in a few months. Then will remain the Indian and Atlantic Oceans to be traversed by "nationalised" cables. Sir Sandford Fleming recommends that before proceeding to lay a State cable across the Indian Ocean, the companies should be given the option to transfer, at a fair price, the private cable recently laid by them between Australia and South Africa, and arrangements should likewise be made to connect the Cape with the United Kingdom by a State-owned cable. These, with the Pacific cable, will complete the globe-encircling telegraph line.

London Locomotion.—There is some talk of postponing the Bills approved by the House of Lords this session for the construction of a number of tubular railways in the Metropolis, and of appointing a Royal Commission to enquire into the whole subject and report. The probability of such a course being pursued is taken up by Mr. Robert P. Porter as the keynote of a letter to the *Times* of Monday's date, wherein he protests against any further delay in giving the public needed relief in the shape of tube railways. Ten years ago the appointment of a Royal Commission in the matter would possibly have been of great value, but at the present stage it is not only inadvisable, but unnecessary, as the writer shows. Incidentally he refers to the fact that in the recent enquiries into the various tube schemes by the House of Lords Committees proposed for London, four important groups of capitalists were competing for the through Piccadilly and City route, or, rather, the Hammersmith and City route *vid* Piccadilly. There is not much doubt that the powers to take up this route were awarded to the group offering the most attractive scheme, including the cheapest through fares of any yet proposed for London. The railways contemplated by this group—represented by Sir Clinton Dawkins—will form a continuous line from

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Broadway (Hammersmith), *vid* Piccadilly, Charing Cross, Ludgate-circus, and so on, to Tottenham and Palmer's Green—a length of about 16 miles. With this must be considered the route of the City and North-East Suburban Railway, which was originally part of the scheme, and which it is hoped will be authorised by Parliament next year. The route of this railway is through Whitechapel and Bethnal Green, across Hackney Marshes, through Walthamstow, to Waltham Abbey and Epping Forest. In the writer's opinion, it would be difficult for a Royal Commission or any other capable body of experts to plan a more practical route than that sketched above, which, besides being a through line under the most congested thoroughfares of London, connects with the rapidly growing electric tramway system in the West of London. A careful study of these well-worked-out projects, recommended alike by the Joint Committee of 1901, the County Council, and finally passed by the Lords Committee of this session, with the authorised lines which Mr Yerkes and his friends have purchased and are intending to link up in connection with the District Railway, reveals the fact that the two together, with the lines already in operation, make a fairly harmonious beginning in these tubular railways for London, and one which would be difficult to improve upon.

Light of an Incandescent Lamp.—In the current number of the *Wisconsin Engineer*, Mr. H. Seamen gives the results of an investigation into the effect of frequency in alternating-current circuits on the steadiness of light emitted from incandescent lamps. The object in view was to ascertain what the variation in light from a 110-volt incandescent filament is for various frequencies, and to derive curves showing to a certain extent what is the lower limit of frequency for good incandescent lighting. An ingenious method, which the author promises to publish soon together with the curves and data, was used, and the frequencies employed ranges from 17½ up to 80. The experiments showed exactly what the effect of frequency in an incandescent lamp is. The temperature of the filament varies periodically, the range and number of these variations depending upon the frequency. It was found that the maximum change in resistance to these variations was 1,760 ohms, which corresponds to a change of 5·5 volts. This occured at a frequency of 17½. At 80 frequency, the change was only two volts. The fact that light comes to a maximum and minimum twice in 300 electrical degrees, or twice that of the alternating current, was demonstrated very clearly. The following conclusions were also obtained as a result of the investigation: The radiation from an incandescent lamp varies with the variation of the alternating electric current; and this variation is shown by means of a selenium cell for the curves' frequencies, but becomes materially less noticeable when the frequency is raised. Since the photographic plate is more particularly affected by the radiation of waves of shorter wave-length than those affecting the eye as light, and as this is also probably true of the selenium cell, the facts demonstrated perhaps apply more specifically to the radiation of waves of shorter wave-length which belong to the upper spectrum. As the current intensity increases, the proportion which the waves of short wave-lengths bear to the total increases; therefore the diminution of the range of variation in the intensity of radiation will be more marked in case of the visible spectrum. It is reasonable to conclude from the results of the experiments that the light—that is, the physiological effect of the radiation—from an incandescent lamp operated on a current frequency of 60 cycles per second will be very nearly, if not quite, uniform, but at a frequency as low as 25 the light emitted from an incandescent lamp certainly cannot be considered other than as varying between comparatively wide limits, and with a frequency equal to double that of the alternating current. The form of the pressure wave affects the amount of light. Peaked waves cause a maximum variation and flat-topped waves a minimum, consequently the sinusoidal wave used in this thesis would give nearly average results. The higher the temperature of the filament and the smaller its diameter, the greater will be the change in the amount of light for a certain change of energy.

Electric Locomotives for Mine Haulage.—The electric locomotive considered as a machine has many points in its favour for mine use. For a given hauling capacity it is by far the most compact of all forms of motive power; it is simple in construction and convenient in operation. Externally, it consists of a massive cast-iron box without visible mechanism, a construction excellently adapted to the required service, as the frame serves to give the machine the necessary weight and protects the mechanism against injury in case of derailment or otherwise in rough mine service. Writing on the subject in the mining and metallurgical number of *Cassier's Magazine*, Mr. G. Gibbs remarks that the European design of mine locomotive differs considerably from American practice, and its complexity and lack of compactness would make it unsuitable for general mining conditions in the United States. A determination of the proper locomotive equipment for a given time is dependent upon a variety of factors, such as the maximum grade over which it is desired to operate, the condition of the track, character and condition of the wagons, and a general knowledge of the haulage scheme, such as length of haul and output desired per locomotive. The importance of all these considerations will be apparent when it is observed that mining conditions necessitate extremes for grades and curvature, and that the wagon resistance is far greater than that found on surface railways Thus mine grades are frequently as much as 4 to 6 per cent., and curves as short as 15ft. radius. Wagon resistance varies generally between 30lb. and 60lb. per ton weight, never falling below 20lb., and frequently exceeding 60lb. with badly-worn loose wheels. The rails are generally light and in poor condition, so that the adhesion is seldom better than one-sixth of the weight on drivers for tractive effort. When the above conditions have been ascertained, the size and number of locomotives required to handle the mine output can be determined. But it should be understood that the capacity of a given electric locomotive is dependent upon the maximum and the average work required of its motors in a given time. In other words, a certain hauling power can be furnished continuously, but this will be much below the maximum capacity of the locomotive on short, heavy grades. This limitation arises from the heating effect of an electric current upon the motor windings, an effect which is cumulative, and cannot be dissipated faster than at a certain rate. In average mine service the work required of a locomotive is variable, and where no unusual conditions prevail it has been found safe to assume that the full tractive effort will not be required for more than 40 per cent. of the time. The rating of locomotives is based upon this assumption. The actual tonnage of products which can be handled per locomotive per day varies, of course, with the local conditions and size of locomotive. In many mines the same locomotive is employed for collecting, main haulage, and switching, and the work done is subject to much variation on account of time lost in making-up the trains. In large mines the main entry haulage is a distinct operation, and in such cases a 10-ton locomotive will readily handle to the tipple from 800 to 1,000 ton-miles of loading in an eight-hour shift.

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THE DUSSELDORF EXHIBITION.—I.

Less has been heard of the Düsseldorf Art and Industrial Exhibition than, perhaps, its importance merits. This is, no doubt, owing to its strictly non-international character, its scope, indeed, being practically limited to the productions of the Rhine Province and Westphalia. But the latter fact has certainly not prevented a display which does credit to German enterprise and industry, especially in the heavy engineering and electrical sections. One of the most interesting exhibits from an electrical engineer's point of view is an electrically-driven main shaft hoisting machine for mines, constructed by the Aktiengesellschaft Bergwerksverein Friedrich Wilhelmshütte, of Mülheim-a.-d.-Ruhr, in co-operation with Messrs. Siemens and Halske, of Berlin, and described below. This plant is the first of its kind which has been constructed in Germany, and will at the close of the exhibition be erected at the Zollern II. pit of the Gelsenkirchener Bergwerks-Aktiengesellschaft.

The hoisting machine is designed to raise a load of 4,200 kg. of coal, corresponding to six trucks of 700 kg. each, in one lift from a depth of 500m. (at first 280m.), with a maximum speed of 20m. (at first 10m.) per second. With 16 effective hoisting hours per day and a depth of 500m., the daily capacity is 2,700 tons, with a single unloading platform. With a double platform the capacity is increased to 3,200 tons, and with three platforms to 4,000 tons. The Koepe system of driving pulley is used, in which the hoisting rope passes but once around the pulley, and is driven by the friction of the oak lining, with which the groove is provided. The Koepe driving pulley is most suitable in the case of hoisting from one level only, as the mechanical connection between the two cages—viz., the rope—renders a change in the relative position impossible. It has, moreover, the advantage of requiring only a very small constructional width and small moving masses, giving in consequence a quicker acceleration. As by this system the hoisting rope is continued below the cages as tail rope, the total load is perfectly balanced, and the working conditions of the motors are very favourable, especially during the acceleration. The diameter of the Koepe pulley was fixed at 6m., which is as small as is consistent with the durability of the rope and the necessary small specific pressure between rope and pulley, because smaller electric motors can be used if the speed is increased. Electrical energy is transmitted to the motors as continuous current at 500 volts, because, in addition with a buffer storage battery this gives a good storage of power for the very intermittent work, and, moreover, the gradual switching in of the voltage, with increasing speed, allows of accelerating with a minimum loss.

The general arrangement is, as Figs. 1 and 2 show, very simple. On each side of the driving pulley, and keyed directly to the main axle, is an electric motor of 1,400 maximum horse-power. Outside of the motors powerful main bearings are arranged having automatic ring lubrication. Instead of one single driving motor, a set of two was chosen, partly because by series, or parallel, control the maximum hoisting speed could be either 10m. or 20m. per second, and partly because if one motor is stopped from one reason or another the hoisting could be continued with reduced load, in order to bring the miners to bank, etc. By the gradual switching in of the storage battery and alteration of the exciting current of the motor magnets, other speeds can be attained without energy losses, so that the attainable speeds are 2, 4, 5, 6, 8-10, 12, 16-20 metre-seconds. Since the losses by speeds intermediate to these are very small, the machine can practically be run permanently at any speed. For rope examination the speed can be reduced to 30 centimetre-seconds. In front of the hoisting machine, as seen from the driver's position, is fixed the depth indicator, which shows the exact position of the cage in the shaft at any time, and is directly connected with a Baumann's safety device. The latter prevents the maximum speed being exceeded, and ensures a proper diminution of speed as the cage approaches the bank. If the speed exceeds the specified maximum at any point the brake is automatically applied, the current being at the same time cut off. Moreover, below this safety device, and connected directly to it, is a so-called retarding apparatus, which automatically switches off the electric energy by gradually turning back the lever of the starting gear, in case the attendant has neglected to do this, as the cage approaches the bank. The gradual application of the voltage is attained by dividing the storage battery into four groups, and switching these groups in step by step, using small starting resistances between the groups. The order in which the individual groups are switched in varies in alternate trips, first the one terminal of the whole

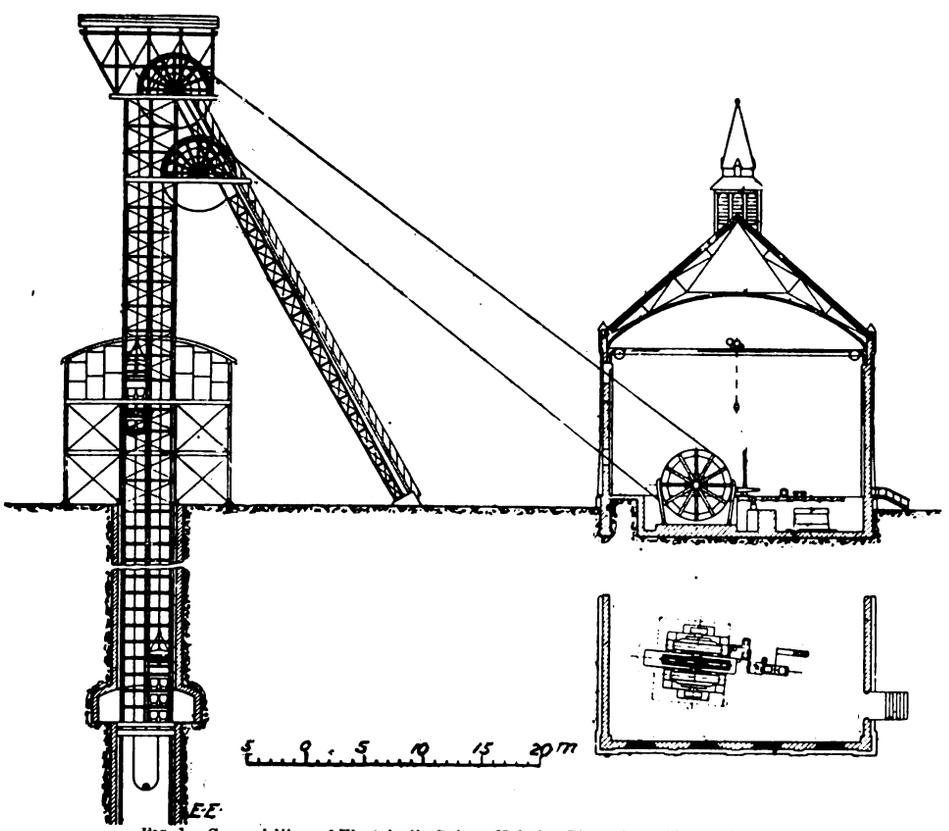

FIG. 1.—General View of Electrically-Driven Hoisting Plant, Dusseldorf Exhibition.

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battery being used as the fixed motor terminal, and then the other, or as we may say, the battery is discharged from right to left, when the one cage is ascending, and from left to right when the other cage ascends. The various groups and cells will be thus subjected to as near as possible the same working conditions. A small number of cells at each end of the battery can be switched in individually. These are used for manœuvring, especially for the small movements necessary to unload the various stages of the cage at a single platform. These cells are charged by means of a special small boosting dynamo. The small and yet liberally-designed starting resistances are combined with the above-mentioned starting switchgear under the motor-driver's position. This starting gear, of cylindrical form, carries on its outer periphery the switch contacts, in front of which the rotating switch arm moves. The starting gear, the connection diagram of which is given in Fig. 3, consists of two perfectly separated starting resistances. At a speed of 20 metre-seconds each motor has its own starting resistance, but at 10 metre-seconds, the two motors being in series, only one starting resistance is used. We have thus a perfect reserve. In addition to this, the starting resistance is so arranged as to allow of various reserve connections being introduced by means of the grouping switch in the room above. These arrangements can be seen from Fig. 3. It is thus possible if one motor breaks down to continue work with the other, and, further, to connect either of the starting resistances with either of the motors. It is provided for that the work can be continued with the battery cut-out, in which case the two starting resistances are connected in series as a common starting resistance for the two motors, which are likewise in series. The vertical axle of the starting gear is continued upwards through the arched foundation, and receives its movement through a rack and pinion from the pneumatic auxiliary regulating gear in the room above. The latter consists in the main of two cylinders, the working cylinder and the dash-pot cylinder, bolted to a common centre block, and in which, connected simply by means of the piston rods, the pistons travel. These are also connected to the driving rod. The working piston is put into motion by means of compressed air, the dash-pot piston serving to damp and arrest the motion. The compressed-air gear is worked on the differential system, in which the movement of the driving piston rod is used to bring the valve back to its centre position. This valve gear is contained in the steering block in front. The pneumatic engine is set in motion by moving the switch lever. The path of the working piston corresponds exactly to that of the lever in the steering-block slot.

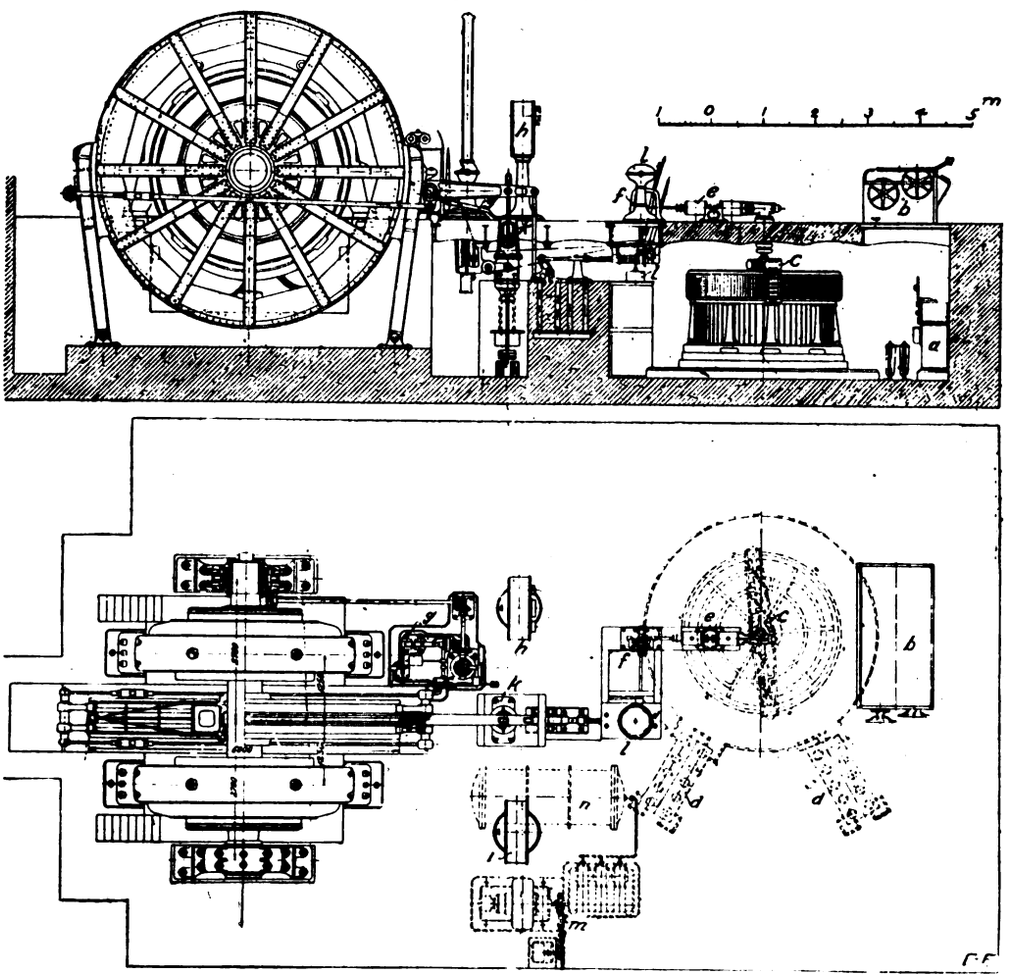

FIG. 2.—Arrangement of Electrically-Driven Hoisting Plant, Dusseldorf Exhibition.

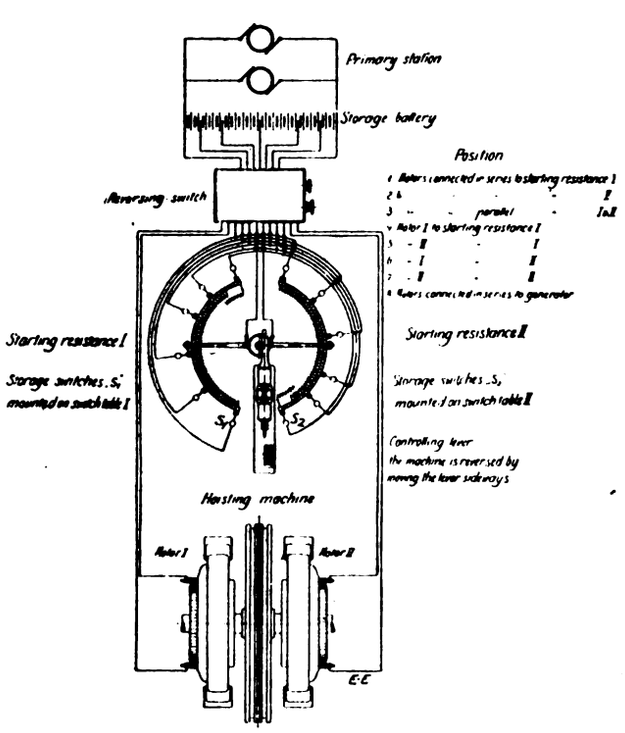

FIG. 3.—Diagram of Connections, Electrically-Driven Hoisting Plant, Dusseldorf Exhibition.

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In the position of rest, the lever leans towards the attendant. From this position it is first moved either to the right or left, thereby actuating through a compressed-air transmission the switchgear in the rear, which determines the direction of rotation of the motors. Thus, when the lever is in the right-hand slot, the right-hand cage ascends, and *vice versâ*. In addition to this switch lever, the steering block has a brake lever actuating the pneumatic brake. This brake lever has a stop, which only allows of its motion when the switch lever is in the no-current position. The pneumatic brake, distinguished by a brake cylinder fixed vertically in front of the hoisting machine, and actuating the four brake blocks by means of simple levers, differs very little from the usual steam brakes used with steam winding engines. As already mentioned, this can be actuated not only by the hand lever, but also by the safety apparatus, which at the same time cuts off the current. In addition to this, the main brake lever can be worked through a gravity screw brake, which is fixed under the floor, the observer above seeing only a cast-iron pillar. This pillar carries the weight-releasing lever, which can be worked by the attendant in the case of the failure of the pneumatic brake. The pillar contains also a winch for winding up the fallen weight.

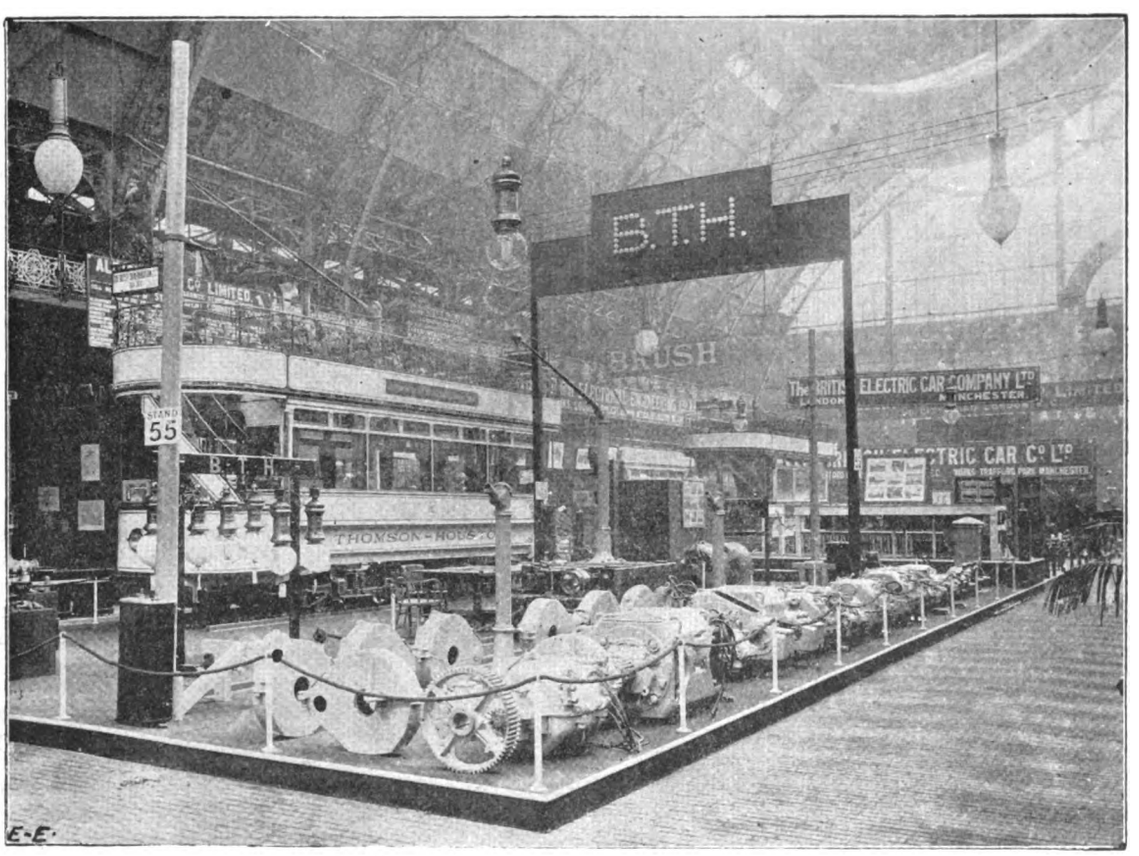

FIG. 18.—The British Thomson-Houston Company's Exhibit.

TRAMWAYS AND LIGHT RAILWAYS EXHIBITION AT THE AGRICULTURAL HALL.

(Continued from page 46.)

The great number and variety, to say nothing of the unusual interest, of the exhibits shown at the Tramways and Light Railways Exhibition opened in the Agricultural Hall, Islington, on June 30 made it impossible to deal, within the limited space at our disposal, with even the principal stands before the close of the exhibition on Saturday last. However, we continue our description of the exhibits with the knowledge that it will be of no less interest, because somewhat belated, to those of our readers who for divers reasons were unable to attend the exhibition.

The accompanying illustration (Fig. 18) will serve to show what a fine collection of traction motors and other apparatus the BRITISH THOMSON-HOUSTON COMPANY, LIMITED, of Rugby, were able to bring together. It was such exhibits as this that contributed so largely to the success of the exhibition, including as it did the latest type of electric traction apparatus for operating light railways, tube railways, and tramways. It is well known that the British Thomson-Houston Company standardise their apparatus as a bicycle, for instance, is standardised—that is to say, care is taken that the standard of the day embodies the latest improvements. In this way the apparatus is kept strictly up to date. But it is in detail rather than in general design that the apparatus is liable to modification from time to time, the uniform excellence of the essential parts of the British Thomson-Houston apparatus having, it may be said, been established universally by practical experience. Now to describe the exhibit.

The car seen in the illustration (Fig. 18) is of the double-deck type, with reversed stairways, the body having been built by Messrs. G. F. Milnes and Co., Limited, of Hadley, Salop. It is mounted on two Brill maximum traction bogie trucks, having driving wheels of 30in. diameter, and 20in. diameter small wheels, with 4ft. wheel-base, and 4ft. 8½in. gauge. The car provides accommodation for 70 passengers—30 inside and 40 outside The traction motors shown included several different types—all of them ironclad—suitable for narrow and standard gauges. Of special interest was a complete working exhibit of the firm's master control system. This system is intended for use on lines dealing with heavy passenger traffic, and where it is necessary to have a rapid and frequent service of trains with a high rate of acceleration; further, where trains must be capable of operation in either direction and from either end. It consists essentially of two parts: (1) a series-parallel controller, consisting of a number of electrically-operated switches, which effect the different combinations of the motors, and vary the starting resistance in circuit with them, and an electrically-operated reverse switch; (2) two master controllers on each motor-car, one situated at each end, which operate the motor-controlling switches and reverse switch.

A cable connected to each master controller, and to the electrically-operated switches, runs the entire length of the train, suitable couplers for connecting the cars being provided. The synchronous action of the motor con-

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trollers on all the cars with the movement of the master controller handle, ensures similar resistance connections and motor combinations on all the cars at all times. The position of the master controller handle indicates to the operator the exact position of the motor controllers on all of the cars, the proper number of points being provided on the cap plate. The rate of movement of the motor controllers, and consequently the amount of current taken by all of the motors, is, therefore, under the driver's immediate control, and he is able at will to instantly utilise the full power of the motors in either direction in an emergency. In case the power circuit is momentarily interrupted for any reason, the system of

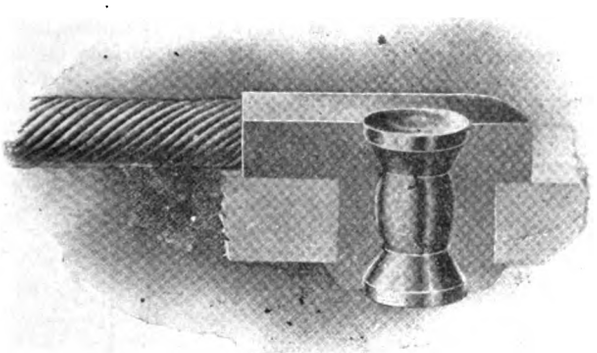

FIG. 19.—Section through Bond Terminal, Steel Core Compressed.

control provides for the immediate restoration of the motor and resistance connections, which were in effect immediately preceding such interruption, being equivalent in this respect to the ordinary hand controller. All current for the operation of the motor controllers on each of the different cars passes through the single master controller under the immediate control of the driver. The interruption of current to the motors in the off position of the motor controller is ensured by providing three separate electrically-operated switches connected in series, any one of which has capacity to open the circuits If the train should break in two, the current would automatically and instantly be cut off from the motors on that part of the train not under the control of the driver,

FIG. 20.—Steel Core before Compression.

while his ability to control the front part of the train would not be affected. When the master controller is thrown off, both "positive" and "negative" connections are cut off from the operating coils of the motor control switches, and none of the train wires or any of the wires in the train-line cables are alive. For reversing the motors the master controller is provided with a separate reversing handle, and a mechanical interlocking device prevents this reversing handle from being thrown unless the main handle is in the off position. Moving this reverse handle either back or forward makes connections for throwing an electrically-operated reverse switch, called the "reverser," to either "forward" or "reverse" position. The reverser is electrically interlocked, so that it cannot be thrown when the motors are taking current. The operating circuit is so arranged that unless the reverse switch is thrown for the direction of car movement, indicated by the master controller reverse handle, it will be impossible to operate the contactors and get current through the motors on that particular car. A cut-out switch is provided on each car, so that in an emergency all of the contactors on that car may be disconnected from the control circuit. The control operating current per car at 550 volts line potential is about 2·5 amperes for an equipment of two 160-h.p. or four 80-h.p. motors, the total weight of the control apparatus for this equipment being approximately 2,200lb. The system, it may be mentioned, has been applied with satisfactory results to two trains on the Central London Railway, while the Great Northern and City Railway Company have decided to adopt it.

On the same stand was also exhibited in operation an electric locomotive of the firm's standard L. M. 103 A-1 type. This locomotive seems particularly adapted for the local haulage of materials. It weighs 9,500lb., and is capable of exerting a draw-bar pull on the level of 1,000lb. at eight miles per hour. The gauge is 2ft. 6in, while the

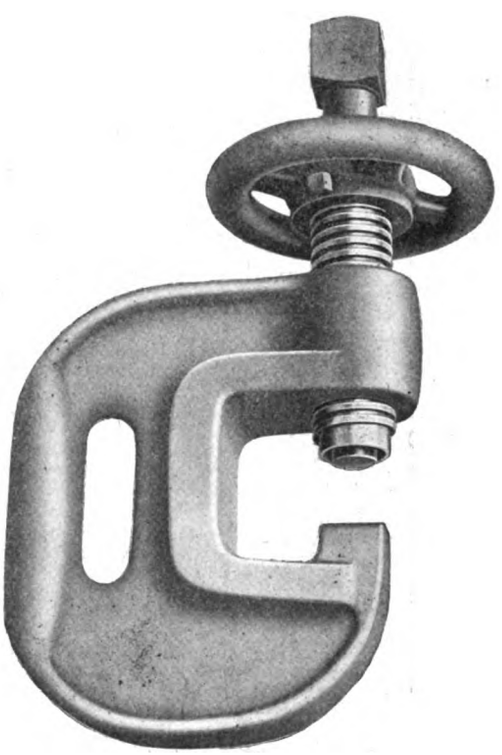

FIG. 21.—Rail Bond Compressor.

driving motors are wound for 200 to 210 volts terminal pressure. The firm's type F.K high-tension oil-break switch was also shown. This switch is enclosed in an iron box mounted in a brick chamber behind the switchboard panel, and operated by an insulated lever, as shown, to which it is connected by means of link motion. Each pole has a double break, which takes place under oil When opened on full load, the arc will only follow the blade a small fraction of an inch. Connecting pieces are brought out of the cover of the box through insulating bushes. The switch is fitted with an overload tripping device, and is capable of opening a dead short-circuit of the whole plant up to 6,000 kw. with a maximum voltage of 15,000.

Of the various other British Thomson-Houston apparatus shown mention should be made of a rail bond (Fig. 19) constructed upon a new principle, and which is claimed to absolutely ensure perfect and permanent contact with the rail. As in some other types of rail bonds, a steel core is used for expanding the terminal into a hole drilled for its reception in the rail, but in a new manner. In the process of manufacture this core (Fig. 20), in the form of a double-headed rivet, is cast in the terminal with its head protruding $\frac{1}{8}$in. beyond the copper. At this stage the steel core is nearly cylindrical between its flanges. The shank, however, is slightly expanded in the centre, the most effective form having been determined by experiment. After the terminal

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is inserted in the hole in the rail, the steel core is upset by compressing it lengthwise until its protruding ends are flush with the copper surrounding it. The heads, which are hardened, and the shank, which is very soft in the centre, expand in inverse proportion to the hardness of their various portions. By this process the copper terminal is forced with great pressure against the walls of the hole, and so perfect a contact with the rail is effected, it is claimed, as to preclude any possibility of electrolytic action, or of loosening under vibration in service. The form of compressor used for compressing the steel core is shown in Fig. 21. The British Thomson-Houston exhibit included other apparatus equally worthy of notice, with which, however, pressure on our space prevents us from dealing now.

Messrs. CROSSLEY BROS., LIMITED, of Openshaw, Manchester, had an interesting exhibit, including a double-cylinder, inverted, vertical gas-engine of 56 b.h.p., the first of its kind which they have exhibited, and one of their smallest gas-engines—namely, of ¾ actual horse-power—also an oil-engine of 23 actual horse-power. With regard to the first-mentioned engine, this has two cylinders, with both connecting rods leading on to the same crank-pin. The cylinders are 11½in. diameter by 15in. stroke. The engine is fitted with an efficient high-speed governor, by means of which the speed can be adjusted at pleasure, and which automatically regulates the consumption of gas in proportion to the load on the engine. In addition, each cylinder is provided with an automatic cut-off valve under control of the governor, which regulates the power given out by the working strokes, and enables the engine to run without cutting out ignitions down to, or below, half load; also with timed ignition valves, which ensure economical working under varying conditions, and prevent waste of gas. Patent safety gear to prevent the engine turning the wrong way at starting is further provided. The ignition tubes are in duplicate, which prevents stoppage in the event of one tube breaking. The engine is built for giving off about 55 b.h.p. when working with producer gas at a speed of 250 revolutions per minute. Its mechanical efficiency is guaranteed to be not less than 85 per cent., and the variation in speed, including both cyclical and governing, when running at a load between half power and full power, will not exceed 1 per cent. The engine exhibited was combined, by means of one of Raffard's patent elastic couplings, with a Mather and Platt multipolar shunt-wound dynamo. The ¾ actual horse-power engine referred to above is a comparatively recent addition to Messrs. Crossley's list of sizes, and is designed with a view to meeting the demand for an engine of very small power. It is capable of giving a maximum of 1 h.p. actual. Its consumption of gas is only in proportion to the work required, and it occupies a very small space, 3ft. in length by 2ft. 5in. in width.

Messrs. JOHN I. THORNYCROFT AND CO., LIMITED, Church Wharf, Chiswick, of torpedo-boat destroyer and boiler fame, also signalised an addition to their list of productions by exhibiting an engine of their own design and make coupled to a Crompton dynamo. This engine is of the enclosed, double-acting, two-cylinder, compound type, with forced lubrication. The high-pressure and low-pressure pistons drive the cranks, set at 180deg., of a shaft without a centre bearing. This omission reduces friction, and gives room for a shaft bent from a bar with easy corners and long crank-pins, in which all surface metal is well hammered. The separate high-pressure and low-pressure piston valves are driven from opposite ends of a lever rocking between the guides and actuated directly from the high-pressure big end. Their great lap minimises leakage, while their inertia, balanced as regards foundations, greatly improves the turning moment. The high-pressure cylinder and valve chest is separate from the low pressure, but connected by a breeches receiver. These, together with a throttle and stop valve, are surrounded by a cylindrical lagging case, on removing the covers of which all covers are exposed. Steam economy is promoted by the flat cylinder ends and ports, by the deep pistons, and by the separator action of the receiver. Close speed regulation is promoted by the small volume of the high-pressure and low-pressure steam-chests, and by the ease with which the low-pressure steam can be throttled. On a sudden fall of load the abnormal rise in speed is hereby so reduced that the normal rim speed of the flywheel can be increased proportionately. By a new system the high-pressure cut-off can be made late for overloads without alteration of the valve gear. Ample water relief is provided by three relief valves in each end of each cylinder. Instead of mounting the crank chamber and dynamo on an under-bed, the dynamo bed is bolted to the end of the deep crank chamber. This arrangement gives a good connection under the ring of a multipolar dynamo without side wings, and utilises the full depth of the crank chamber as an oil-settling tank. The trials and experiments with this engine not having been completed by the makers, no figures are yet available as to its efficiency.

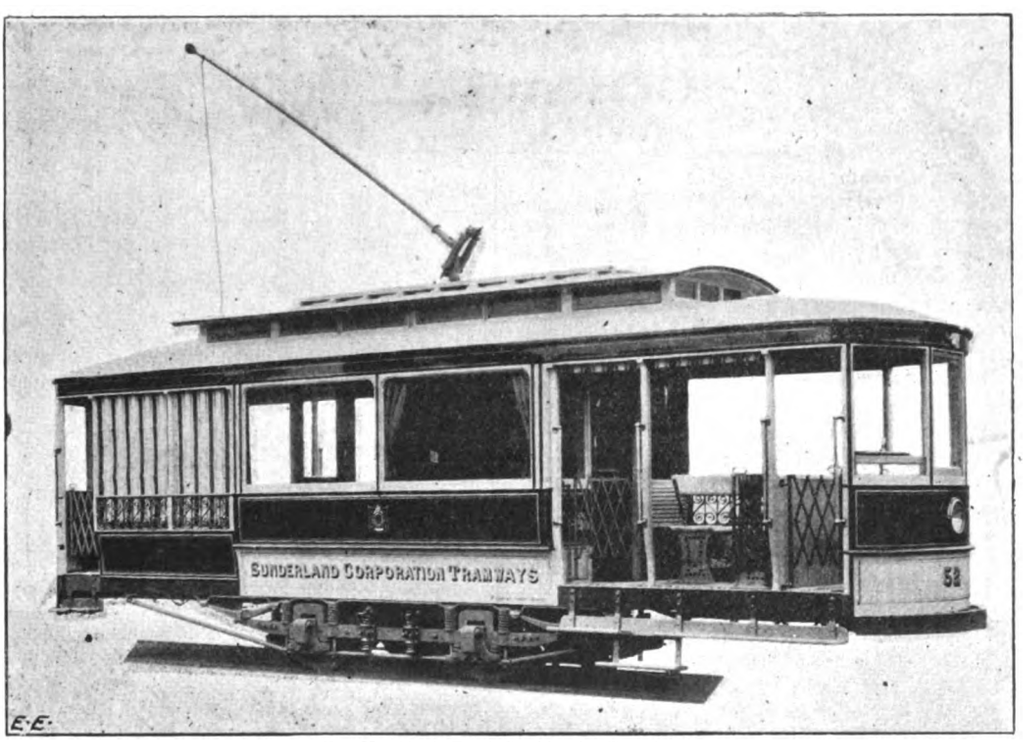

FIG. 22.—Single Truck Combination Type Car.

Messrs. E. GREEN AND SON, 2, Exchange-street, Man-

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chester, were showing one of their small size fuel economisers. This economiser had 96 tubes, representing nearly 1,000 square feet of heating surface. It was, moreover, of the high-pressure type, fitted with internal lids in the top boxes, the scraper gearing being driven in the usual way by means of an electric motor. According to a recent testimonial received by the firm, the saving in fuel effected by this type of economiser is equal to at least 20 per cent. Further recommendation is needless.

The combined exhibit of Messrs. DICK, KERR, AND CO., LIMITED, 110, Cannon-street, London; the ENGLISH ELECTRIC MANUFACTURING COMPANY, LIMITED, Preston; and the ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS, LIMITED, Preston, was well calculated to set at rest the minds of those who, through ignorance, are concerned about the supposed decadence of British industry. The exhibit in question was, indeed, only what one acquainted with the extent and perfect equipment of the works in which the apparatus shown was produced might have expected; but in the excellent workmanship of apparatus manufactured to order, and not especially for exhibition purposes, one had actual proof that one's trust in the British working-man has not been misplaced. Included in the exhibit were two fully-equipped tramcars. One of these (of which Fig. 22 is an illustration) was of the single-truck combination type. It was built to the order of the Sunderland Corporation. The main feature in the design is the provision of both outside and inside seats upon a single deck, giving also ample room for passengers alighting from or boarding the car. This car is built to accommodate 34 passengers—16 inside and 18 outside—and has an over-all length of 30ft. 10in. over the buffer irons, and a width of 6ft. over the side sills. With regard to the other car shown, it may be mentioned that this was one of a number built to the order of the London County Council for their conduit line in South London. In general appearance it is very similar to the well-known "Preston" type of car with Bellamy reversed stairways. It provides seating accommodation for 66 passengers—28 inside and 38 outside. The over-all length of the car is 33ft. 6in. A new feature in the interior of the car is a glazed partition dividing the seats on each side. The plough attached is similar to that employed on the Paris conduit system.

Among the other exhibits by the above firms calling for special mention was a motor-alternator (Fig. 23), built to the order of the Portsmouth Corporation, and consisting of a continuous-current shunt-wound motor direct-coupled to an eight-pole three-phase alternating-current generator, the two machines being carried on the same bed-plate. The output of the generating side is 200 kw. when supplying current at 5,500 volts, and running at 375 revolutions per minute, and 25 cycles per second. The motor is a four-pole shunt-wound machine, running at 550 volts. The field yoke is of high-permeability cast iron, the pole-pieces consisting of laminated steet cast into the frame. The armature is of the slotted-drum type, the core being built up of laminated discs securely carried on a special form of spider. The alternating-current generator is of the revolving-field type, with external stationary armature. The armature consists of laminated segments built up in and dovetailed into a cast-iron frame, the windings being star connected. The field magnets are of laminated steel, firmly keyed and bolted to the revolving hub, which is itself keyed to the shaft. The field-magnet spools are firmly fixed to the pole-pieces, but are readily removable.

Several types of controllers were also included in the exhibit, in which connection it may be mentioned that Messrs. Dick, Kerr, and Co., Limited, have introduced an improvement in the form of a new magnetic shield blow-out, by means of which the arc is drawn on to the shield instead of on to the contacts. Consequently no carbonising of the contacts takes place, while there is a saving in the cost of maintenance and a reduction in the size of the controllers.

Standard types of traction motors, trolleys, and rheostats, etc., completed the exhibit.

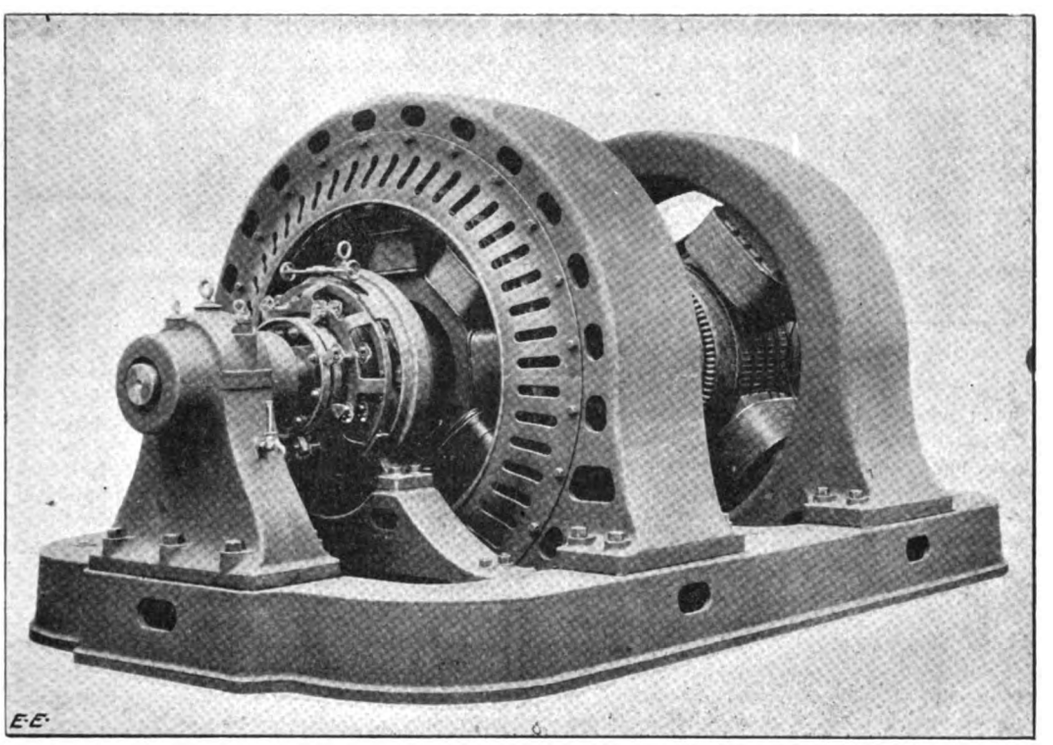

FIG. 23.—Motor-Alternator.

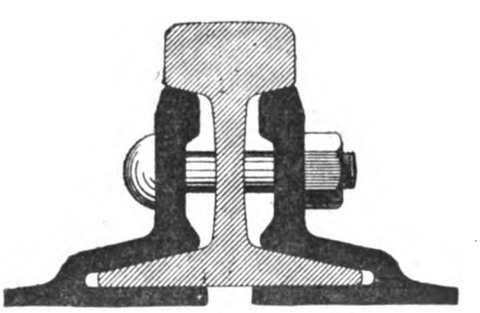

FIG. 24.—Section of Continuous Rail Joint.

THE CONTINUOUS RAIL JOINT COMPANY, 26, Victoria-street, Westminster, S.W., were showing samples of their special rail joint, the principle of which is shown in the section (Fig. 24). Among the claims put forward for the continuous rail joint are the following: It has the fewest possible parts; the base-plate being an integral part of the

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joint gives great horizontal and vertical rigidity, prevents any play between surfaces, and holds the rail ends in perfect line and surface, and, lastly, it produces a perfect riding track.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, Loughborough, were exhibiting two fully-equipped tramcars, besides detached trucks, motor equipments, etc. One of the cars (Fig. 25) was a specimen of a large number built to the order of the Manchester Corporation. This car is mounted on a pair of Brush maximum traction trucks, the easy running of which is claimed to be a distinctive feature. The following are the leading dimensions of the car: length of body, 21ft. 10½in.; extreme length, 33ft. 4½in.; width of roof, 6ft. 10in.; width over pillars, 6ft. 6in.; gauge, 4ft. 8½in.; number of inside passengers, 28; outside, 39. The second car was of the double-deck type, mounted on a Brush single truck of the design shown in Fig. 26. We were agreeably impressed by the excellent finish of these cars, the interiors being neat and effective without being too elaborate. We noticed that the lamps serving to illuminate the destination indicators were made to serve also for the lighting of the upper decks, thereby effecting a slight economy. The special features of the Brush single truck (Fig. 26) may be indicated: The frame is of solid steel, supported on journal boxes by eight laminated springs. The car body is carried on eight long-movement coil springs, and four three-quarter extension elliptic springs, and the motor is supported on an independent spring base. The entire load is thus live weight. The oscillation of the car body is effectually prevented by the spring distribution. The four-coil springs nearest the ends and the three-quarter elliptic springs support the car body when empty. In addition to this, a spiral check spring is placed at each corner of the truck, to take the back-lash. The backs are supported on coil springs, which effectually prevent their communicating any shock to the car body.

Mention may also be made of a recent addition to the list of Brush manufactures, which was given a prominent place in the exhibit. This was a 10-h.p. light petrol motor carriage, geared up to 30 miles per hour, and weighing completely equipped for service 15cwt.

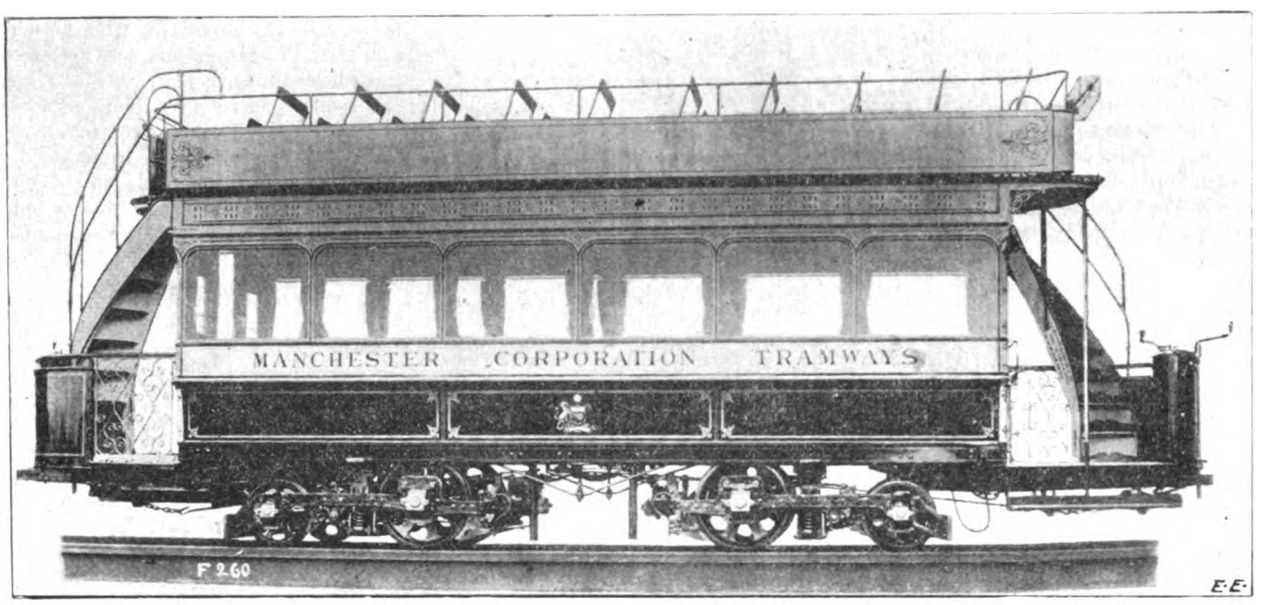

FIG. 25.—Brush Car, built for Manchester Corporation.

Messrs. ELLIOTT BROS., Century Works, Lewisham, S.E., had an interesting exhibit of their apparatus, including several devices which could lay claim to distinct novelty. Of the latter, Partridge's Sparklet fuse calls for prior notice. This fuse has been designed by Mr. Partridge, chief engineer of the London Electric Supply Corporation, to avoid the necessity of having fuses of great length in circuits using pressures of 5,000 or 10,000 volts, and the disadvantages thereby entailed, as likewise the troubles involved by the use of oil fuses. The principle of the Partridge sparklet fuse consists in the employment of one or two ordinary sparklets, such as are used for the making of aerated waters, these sparklets being so arranged that if the fuse melts and an arc is formed, this arc burns away part of the metal case of the sparklet and allows a blast of the gas contained in it to escape, and so extinguish the arc. Added to the fact that the liberated gas is carbonic dioxide, the sudden release of the pressure causes a great decrease in the temperature, the pressure in the sparklet itself being somewhere about 600lb. per square inch. It should be noted that in the case of the fuse being sufficient of itself to open the circuit without an arc being formed, then the sparklets do not come into use at all. The fuses are arranged to carry two sparklets, one at each end. One is sufficient to extinguish the arc, but the second is provided in case by any chance one sparklet might fail to act. This chance is a very unlikely one, and has never occurred, we are told, during the whole series of experiments and trials, which have now extended over 18 months. The apparatus has been in practical use on circuits of 10,000 volts pressure for over a year, and during that time has come into action on many occasions and never once failed to act in a completely successful manner. The action of the arc on the metal of the sparklet ensures the blast of gas taking place at exactly the right place, that is to say, where the metal is burnt through, and the greater the amount of current through the arc the more quickly the metal is burnt away, and the greater, consequently, is the initial rush of gas. The accompanying illustration (Fig. 27) represents some of the sparklets used in their natural size. A working model of the fuse was shown in action at the exhibition. The fuse employed consisted of a small piece of

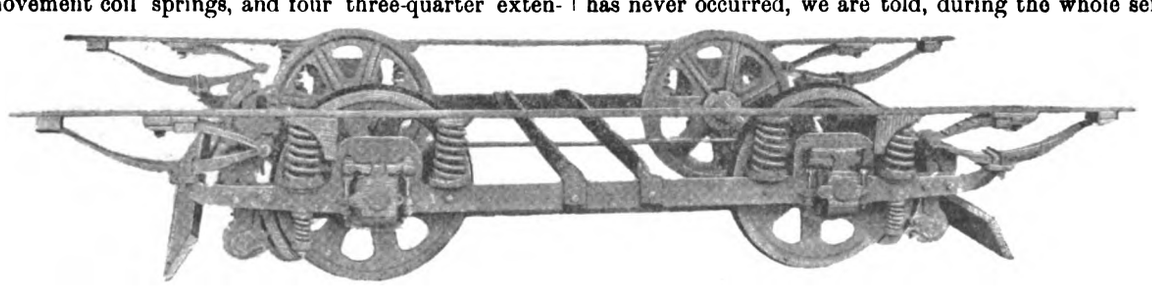

FIG. 26.—Brush Single Truck.

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copper wire, No. 40 S.W.G. and about §in. in length, between the terminals. This fuse was connected directly across the high-tension side of a transformer having a difference of potential of 2,500 volts between its terminals. The low-tension side of the transformer was connected through a double-pole switch, an indicating ammeter, and a small amount of resistance (in order to prevent trouble on the rest of the circuit) to the 100 volt alternating mains of the Islington Vestry. This model fuse was actually dealing with about 20 kw. at 2,500 volts. Its action was interesting to watch, the sparklets being infallible in their action either way up. We understand that several types of the fuse are being put on the market by Messrs. Elliott Bros. The "Century Test Set" (Fig. 28) was shown by the same firm. This set of standard

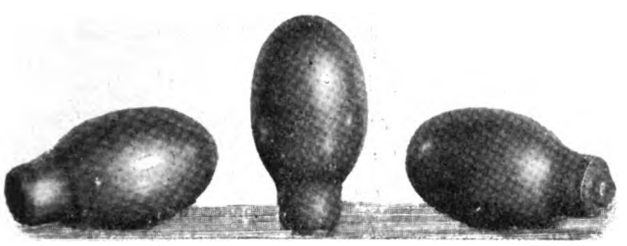

FIG. 27.—Sparklets, natural size.

instruments has been specially designed to afford a convenient means of making accurate measurements of current and pressure over large ranges, and also measurements over a considerable range of resistances. In Fig. 28 the instrument is shown with the 600-ampere shunt coupled up to two leads, and the switch on the instrument opened. The apparatus is supplied in two portable cases. One contains an indicating instrument in the form of a Weston low-reading voltmeter, a switch for changing over the instrument terminals for the measurement of either current or pressure, the necessary series resistances for the pressure measurements, and the two smallest shunts which are employed in the measurement of current, while the second case contains the two larger shunts.

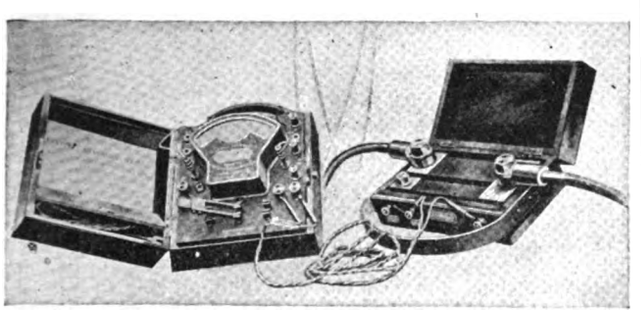

FIG. 28.—Century Test Set.

HIGHFIELD AND BEETON'S patent speed indicator for electric tramcar work also deserves mention. This apparatus consists essentially of a small magneto generator attached directly to the motor frame, and two indicating instruments, one on each platform, the scales of which are calibrated to read in miles per hour. These instruments can be fixed in the most convenient position, so that the motorman can see the speed at which the car is travelling without altering his position.

(To be concluded.)

THE CONVERSION OF SINGLE-PHASE INTO MULTIPHASE STATIONS.

BY STAINER HUTCHINS.

Owing to the increased demand for power, and the fact that the small power users are at last realising the advantages of electricity over steam, gas, or oil, the engineer of the single-phase station is in an awkward position. He finds he is unable to supply single-phase motors that will satisfy the wants of the power users. Although it is contrary to the statement made by some engineers, single-phase motors leave much to be desired when they have to be frequently started and stopped. Proof of this will be found in the great number of small power users installing their own engines, generators, and motors. If it is not the fault of the single-phase motor, then it is the high price of current, but if the user can generate his current cheaper than can be supplied from the central station, then the centralising of generation is a myth—which is ridiculous. It is only fair to add in defence of the single-phase that for lighting and continuously-running motors it will compare very favourably with any other system.

If a motor load is to be captured, the engineer must guarantee to supply the current at the same price as the power user can generate it, and supply motors or current

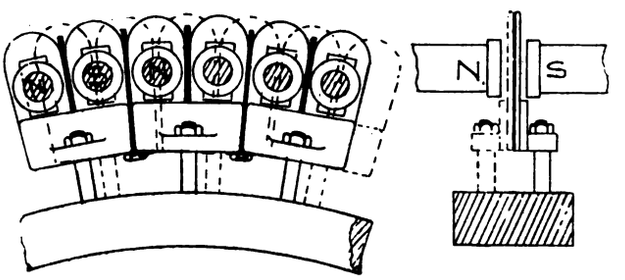

FIG. 1.

that will drive motors, the behaviour of which must equal a continuous-current motor. If this is to be done, it is evident the station must be converted from single-phase into multiphase or continuous, as multiphase is equal, if not superior, to continuous; and converting to continuous would mean the scrapping of the single-phase generator. Continuous may be counted out of the running.

It has been stated that a single-phase copper armature may not be converted into a multiphase one. This statement is wrong. A copper armature may be as readily converted as an iron one. This will be seen on referring to Fig. 1, which shows a method of converting a Ferranti single-phase into a two-phase, the dotted lines showing the coils of the second phase. Fig. 2 shows an iron armature converted.

It is not, however, necessary to convert the whole of the plant to transform the station into a multiphase one. All that is necessary is to instal a multiphase set or convert an old set and allow the existing single-phase machines to run on each phase when the load demands it, the multiphase

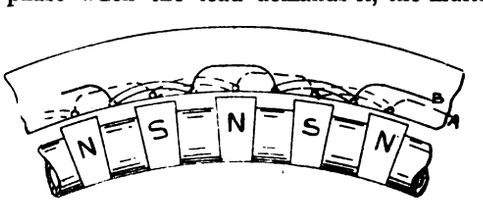

FIG. 2

machines acting as a coupling, and so keeping the phase angle constant. If the two-phase system is adopted, the switchboard may be split, one-half on each phase, with an extra switch for each machine converted. The switches need not be linked, as each phase may be taken out of parallel separately. To convert the transformers would mean rebuilding, and in most cases new coils in place of the old ones, also an additional coil for the second phase, and the iron is probably aged; therefore it would be better to instal new ones, considering their comparative low cost.

The next consideration is the conversion of the cables. If the two-phase single-return system is adopted, and the existing system is high-tension feeders with low-tension network, then, where there are two feeders feeding the one point or chamber, one of these may be used on each phase, the low-tension network being treated in a like manner. Where there is only one feeder per chamber, one phase may be fed at one chamber, the second phase at another, and so on; this would mean the lacing of the low-tension network—*i.e.*, one phase circuit running with the other phase circuit—which would be a great disadvantage in case of a fault. The best method, where there is but one feeder per chamber, is to lay another especially as the load is always rising. The second cable will be a bi-con

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ductor concentric, the outer of the new and the old being coupled together and acting as a common return.

To convert the machines into three phase would mean the addition of two sets of coils, one set per phase, and placing them 120deg. in advance of each other; also new high-tension feeders; on the low-tension side, the addition of one wire where two separate wires are used. If the outer of a concentric cable is used for one phase, it must be remembered the insulation will have to stand the pressure of one phase to earth. By installing converters or motor-generators in the sub-stations, the single-phase may be converted to continuous or multiphase for distribution on the low-tension network. This system is not to be recommended, considering the low cost for converting the station into a multiphase one.

GYROSTATIC ACTION AND ITS BEARING ON CERTAIN POINTS OF ENGINEERING DESIGN.

BY W. R. KELSEY, B.SC.

The gyrostat in its most usual form consists of a disc, the axis of which is carried by gymbals (Fig. 1), which permit rotation of the disc about its axis in any plane. As thus made it possesses the remarkable property of apparently

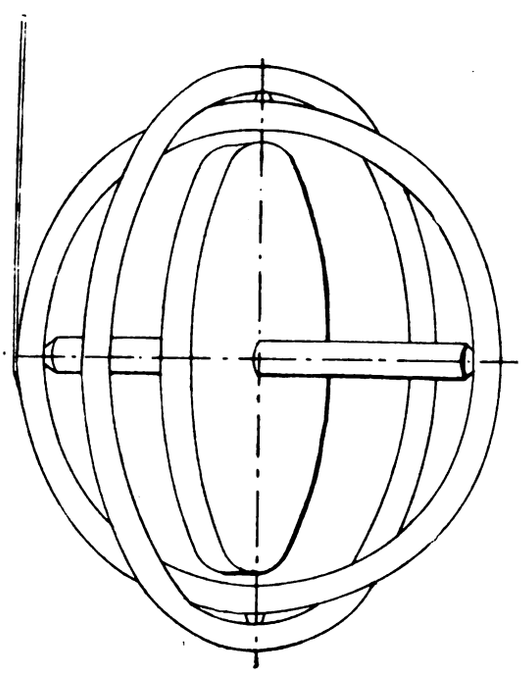

FIG. 1.

defying the force of gravity and contradicting Newton's law as to the equality and opposition of action and reaction. For if the disc be set swiftly rotating in a vertical plane, and the whole contrivance be suspended from a point on the inner ring, as in Fig. 1, the centre of mass does not, as in ordinary cases, fall to a position vertically below this point. On the contrary, the axis remains almost horizontal, but the whole thing rotates slowly in a nearly horizontal plane, moving more rapidly and sinking only when the disc slows down. Again, when the disc is rotating, if either ring be turned, a force rotating the other in a perpendicular direction is the general result.

Though these actions are widely known, elementary explanations of their cause have not been often published; indeed, the fact of the gyrostat affording an excellent example of the application of Lagrangian equations and cyclic co-ordinates appears to have usually protected it from meaner methods of attack, though quite susceptible of simpler treatment. Reduced to its simplest form, the point to be investigated is the nature and magnitude of the forces called into action when the plane of rotation of a revolving mass is turned through any angle. Considering, then, a body rotating about an axis, $o\,o$ (Fig. 2), with velocity $\theta - \theta'$ and θ'', denoting respectively angular velocity and acceleration, with similar symbols for other angles, let A A′ represent the circular path of any point in it. If the axis be rotated with a velocity ϕ', the plane of the body's rotation at the end of a short time dt will have turned, through an angle $\phi' dt$, and the path of the point may be represented as A B, the angle $\phi' dt$ being shown large for clearness, but in reality being infinitesimally small. But by the ordinary rule for resolving vector quantities a rotation θ' in the plane A B is equivalent to a rotation $\theta' \cos(\phi' dt)$ in the original plane, A A′, and another $\theta' \sin(\phi dt)$ in the perpendicular plane, A C. This, indeed, is obvious when ϕ' is less than θ' for the intersections of projected points on A A′ and A C reached simultaneously when the respective velocities, as stated, lie upon A B. (The motion is equivalent to these components, not actually their resultant. The actual path traversed by a point performing rotations in perpendicular planes with velocities ω and ω' is given by an equation of the form

$$x = R(\cos \omega t + \cos \omega - t),$$
$$y = R \sin \omega t,$$
$$z = R \sin \omega' t,$$

a screw-like kind of curve on a circular pitch line). During the interval dt, therefore, the body has acquired a velocity $\theta' \sin(\phi' dt)$ in the plane A C—that is, an angular acceleration Ψ'' equal to $\frac{\theta' \sin(\phi' dt)}{dt}$ has been in operation. It is simpler to consider the angular momentum impressed on it in this plane; and this, if its moment of inertia about the centre of rotation be denoted by I, is $I\,\theta' \sin(\theta' dt)$. But angular momentum equals the product of the torque and time, hence the

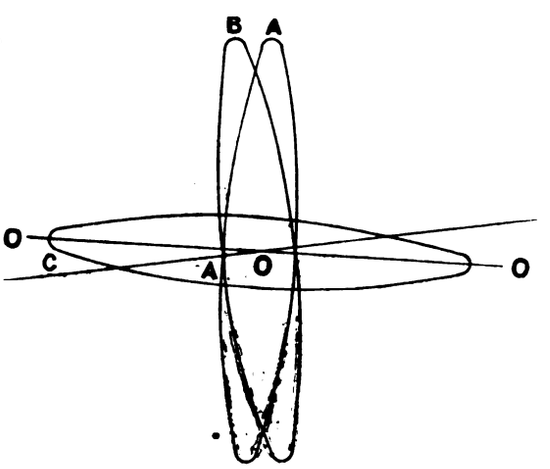

FIG. 2.

corresponding torque is equal to $\frac{I\,\theta' \sin(\phi' dt)}{dt}$; or, since dt is a very short time, to $I\,\theta'\,\phi'$. Though this torque is indirectly impressed, the body exerts a direct reaction, and produces an equal torque on the axis in a counter-clockwise direction in the plane A C perpendicular to that in which the axis is rotated. If motion under this torque is prevented, the torque applied to the axis originally to produce the velocity ϕ' is precisely the same as if the body were at rest in the plane of θ; or, excepting the initial acceleration, is simply equal to the frictional resistance opposing ϕ'.

If the axis $o\,o$ is free to rotate under the torque $I\,\theta'\,\phi'$, let the moment of inertia of the body about the new axis of rotation be I′, and let Ψ' denote angular velocity in the plane A D. Then

$$I\,\theta'\,\phi'\,dt = I\,\Psi''\,dt,$$

and at the end of the period dt

$$\Psi'' = \frac{I}{I'}\,\theta'\,\phi',$$

but, reciprocally, this rotation of the axis gives rise to a torque, $I\,\theta'\,\Psi'$, in the plane of θ and opposing θ'. Hence the torque necessary to produce the rotation θ' is now, neglecting friction, $I'\,\theta'' + I\,\theta'\,\Psi'$, or substituting for Ψ', $I'\,\theta'' + \frac{(I\,\theta')^2\,\phi'}{I'}$. If the axis $o\,o$, instead of rotating in a plane, be constrained to do so about the axis o A′ under

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the component of the torque $I\,\theta'\,\phi'$, the torque impressed on it in the plane of θ is now

$$I'\,\theta'' - I'\left(\frac{I}{I'}\theta'\,\phi'\right)^2 \sin\theta\cos\theta + \frac{(I\,\theta')^2\,\phi'}{I'},$$

and the small effect of gravitation when the body is suspended, as in Fig. 1, becomes intelligible.

It is evident that the torque $I\,\theta'\,\phi'$ may become extremely great, if I or θ' be sufficiently large, for even small values of ϕ'; and in the case of high-speed machinery on ship-board the stresses so produced are by no means always negligible. In the main engines, as also in those driving fans, pumps, and refrigerators, either the speed or the moments of inertia are relatively small, but in the electric plant the speed is generally high and the moment of inertia of the armature considerable. If, for example, the armature and outer bearing of a dynamo be as in Fig. 3, and the former be rotating at 400 revolutions per minute, θ' is $\frac{2\pi\,400}{60}$, or 420, and I is approximately 32·5 pound-feet. The value of the moment of inertia, I, may be approximately found by multiplying the mass of the core and winding—*i.e.*, its weight in pounds divided by 32, by the square of the mean radius from the centre line of the spindle.

In estimating ϕ', which must be taken here as the maximum angular velocity which may be impressed on the vessel, some experience of the class of ship is necessary; the natural period of its motion would give only a small value, but as the dynamo shaft usually runs fore and aft, the greatest angular velocity and stress would arise if the head or stern were struck to starboard or port by an

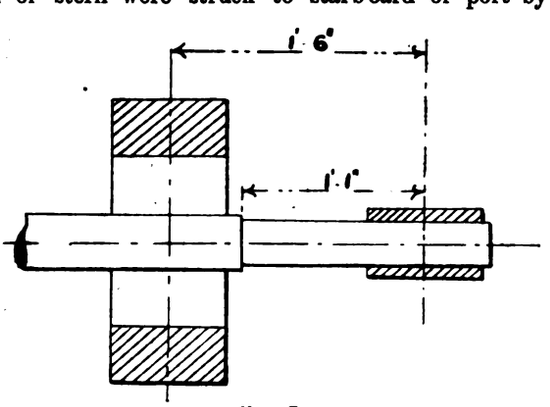

FIG. 3.

oblique sea. The value of ϕ' due to this cause would probably on occasions be considerable. Taking ϕ' as ·09 per second, the torque tending to rotate the shaft in a vertical plane round the centre of the armature is

$$32{\cdot}5 \times 420 \times {\cdot}09 = 1{,}230 \text{ pound-feet.}$$

Regarding this as opposed by equal forces on each end of the shaft, the increase of pressure on the bearing is $\frac{615}{1{\cdot}5}$, or 410lb., and the increase of bending stress at the shoulder between commutator and armature is 410 × 13 = 5,300lb.

An example coming under the writer's notice was that of a flywheel 4ft. in diameter, 8in. wide, 5in. deep in the rim, rotating at 300 revolutions per minute. Here θ' is 31·5 and I about 100,000 inch-pounds. Taking ϕ' at ·09, as before, the torque is 100,000 × 31 5 × ·09 = 234,000 inch-pounds. In this case the armature spindle was restrained from longitudinal movement only by the coupling bolts, and the wheel was driven from a web between the coupling flanges. The average distance of the coupling bolts from the axis of gyrostatic rotation was 4·5in., and consequently the tension on them would be 21,000lb. were it not for the resistance to crushing of the metal of the boss into which the flanges were recessed about an inch; as this, however, was an easy fit, the relief afforded by it is uncertain.

It thus appears that, apart from its curious action and theoretical interest, gyrostatic forces may attain magnitudes not unworthy of attention by the designers of machinery subject to its influence.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

499. Describe the best means for testing the resistance of rail return of an electric tramway where the earth leakage is considerable. Also the method of bond test, with description of instrument for same.—J. C.

500. A road six miles long, and along the entire length of which an electric tramway is laid, is to be lighted by means of incandescent lamps attached to the tramway poles. Current is supplied to the tramways in the usual way at a mean voltage of 500 volts from a distributing sub-station situate midway between the ends of the tramway. One 16-c.p. lamp is to be attached to each pole, and penalties will be inflicted if the lamps are not maintained alight according to contract. Consider the relative advantages from the tramway company's point of view—they having to supply current free and supply and lay and maintain all cables, fittings, and lamps—of the following methods: (*a*) two lamps in series between trolley wire and earth; (*b*) two lamps in series between tramway feeder and earth; (*c*) five lamps in series off separate lighting distributors run direct from the sub-station; (*d*) five lamps in series run off separate distributors laid in three sections, each of two miles, and each section fed at its centre point with boosted current direct from sub-station. By "earth" in (*a*) and (*b*) is meant the rail return.—C. J.

ANSWERS.

Question No. 493.—Since the speed of an induction motor depends upon the periodicity and the number of poles, what advantage is obtained by increasing the field flux?

Best Answer to No. 493 (*awarded* 10*s.*).—The flux of an induction motor running at a given periodicity can be increased either by raising the supply voltage or by reducing the number of stator conductors per phase, for

$$\text{Total flux per pole} = \frac{\text{E.M.F. per phase} \times 10^8}{\text{stator conductors per phase} \times \text{periods per second} \times \text{constant}},$$

The effects of increasing the flux in either of these ways are: (1) to increase the magnetising current approximately in proportion to the flux, and consequently lower the power factor of the motor at all loads, but more especially at light loads: (2) to increase the maximum torque which the motor will stand before stopping, roughly, as the square of the flux; (3) to reduce the slip, for a given load, approximately in proportion to the increased flux, since the rotor conductors need not cut the increased flux so often per second in order to have the same current induced in them; (4) owing to the increased stator iron loss at the higher flux, the efficiency of the motor is reduced at all loads.

On the whole, therefore, an increase in flux would be an advantage if the motor were intended to start with large torque and to run safely at considerable overloads, whilst if the motor is not likely to be subjected to heavy overloads it would be advantageous, on the score of efficiency and power factor, to keep the flux down. At the same time this reduction must not be carried too far, or the power factor will begin to fall off again owing to the increased magnetic leakage set up by the larger number of stator turns, or by the large current carried by the existing stator turns. Manufacturers of induction motors usually have several standard stator windings for each size of motor carcase for a given voltage and periodicity. These windings give different amounts of flux, and enable the motor to be arranged for different conditions of work, ranging from crane or traction work, with its heavy overloads, to ordinary machine tool or factory driving, in which good efficiency is of more importance than a specially large overload capacity.—Q.

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Answer to No. 493 (*awarded* 5*s.*).—The advantage gained by increasing the field flux of an induction motor is to increase the torque at starting. This can easily be seen from the following mathematical results:

Let Ω = angular velocity of the magnetic field (radians per second);
ω = angular velocity of rotor (radians per second);
then slip = $(\Omega - \omega)$ radians per second.

$\therefore$ induced E.M.F. in the rotor at any speed
$$= E_2 = N(\Omega - \omega),$$
where N = field flux.

$$\therefore \text{ current in rotor} = C_2 = \frac{N(\Omega - \omega)}{\sqrt{R^2 + L^2 p^2}},$$
where R = resistance of rotor;
L = self-induction of rotor;
$$p = \frac{(\Omega - \omega)}{\Omega} \times \text{periodicity of supply.}$$

Also, torque exerted on rotor conductors $= C_2 \times N \times \cos\phi$,
where $$\tan\phi = \frac{pL}{R}.$$

At starting we have
$$\text{torque} = N^2 \cdot \frac{\Omega}{\sqrt{R^2 + L^2 p^2}} \cdot \cos\phi.$$

Thus it can be seen that the starting torque is proportional to the square of the field flux. If the field flux is doubled, the starting torque is increased fourfold.

Due to the large value of p at starting, ϕ, the angle of lag of rotor current, is very large, $\cos\phi$ is very small, and therefore the torque at starting works out to a very small quantity. It is therefore necessary that this should be increased It could be done either by increasing the field flux as shown, or (as is usually done in practice) by diminishing ϕ, by putting additional resistance in the rotor circuit at starting, and cutting it out as the rotor runs up to speed.—A. P. YOUNG.

Answer to No. 493 (*awarded* 5*s.*).—In induction motors the torque is proportional to the product of the magnetic flux through the rotor and the rotor current, and also to the cosine of the angle of lag of the rotor current, which is small at all loads between maximum and no load when once the motor has started.

Let N = the magnetic flux through rotor;
C = the rotor current;
ϕ = the angle of lag of the rotor current;
T = torque of motor;
V_1 = angular velocity of rotating magnetic field of stator;
V_2 = angular velocity of rotating magnetic field of rotor;
$V_1 - V_2$ = the slip;
$\frac{V_1 - V_2}{V_1}$ = the slippage;
then $$T = N \times C \times \phi.$$

Hence it follows that by *increasing* the *magnetic flux* in the *stator*, we *increase* the *torque*. For the same load, increasing the flux will decrease the rotor current, C, as the torque is constant for a constant load if the speed is the same.

Going back to the formula $T = N \times C \times \phi$, if N is increased, C must be decreased to keep the equation equal. If C is decreased, the slip $(V_1 - V_2)$ cannot be the same, because the voltage of the rotor current depends upon the slip, and the current is proportional to the voltage. Therefore, as the slip decreases the motor would run more nearly in synchronism with the rotating magnetic field of the stator—*i.e.*, there would be a slight *increase* in the *speed* for the same load if the *field flux* is *increased*

The main advantages are: (1) a smaller motor can be used to supply the same power; (2) increase of power for the same current in the rotor; (3) the speed is more constant on low loads.—A. J. M.

Answer to No. 493 (*awarded* 5*s.*).—By increasing the field flux we increase the power that can be got from the rotor for a given drop in the speed, and hence increase the rating of the motor. With a weak field, for example, we might only be able to get 10 b.h.p. from the motor for a 10 per cent. drop in the speed of the rotor, whilst if we doubled the flux we would be able to get nearly 40 b.h.p. from the motor for the same percentage drop in its speed. The algebraical equations giving the torque and power for an induction motor running at a given speed are very instructive. The following formulæ are proved in Hospitalier's "Formulaire Pratique de l'Electricien, 1902," for an induction motor with a squirrel-cage rotor:

$$P = T\omega_2 \quad \ldots\ldots \quad (1)$$

$$T = \frac{n F^2 r}{2} \cdot \frac{\omega}{r^2 + \omega^2 l^2} \quad \ldots\ldots \quad (2)$$

The field is supposed to turn with angular velocity ω_1, and the rotor with velocity ω_2, and
$$\omega = \omega_1 - \omega_2.$$
P is the "brake" power got from the machine in ergs per second, T is the torque in dyne-centimetres, n the number of rotor bars, r the resistance of a turn, l its self-inductance, and F the maximum value of the flux of induction through the turn. It will be seen from (2) that the torque is directly proportional to the square of the flux density, and hence from (1) for a given drop of speed the rating of the motor depends on the square of the flux density. Therefore, if we wish to design a cheap and efficient machine, it is of the greatest importance to have a high flux density.—J. C. R.

Answer to No. 493 (*awarded* 5*s.*).—It is not absolutely correct to say that the speed of an induction motor is directly dependent upon periodicity and number of poles alone. As a matter of fact, the torque the motor is exerting is also a matter of considerable importance. The speed decreases as the torque increases. In fact, the case of an induction motor is somewhat analogous to that of a direct-current shunt motor. This decrease in speed—in the case of an induction motor—beyond that given by the number of poles and the frequency is termed the "slip."

Now, the action of an induction motor may be stated thus: Alternating current is put into a stator. This produces an alternating or rotary flux as the motor is single or multiphase. The motor having coils wound on it is, therefore, practically the secondary of a transformer, of which the stator is the primary. The amount of the induced E.M.F. in the rotor coils is dependent, firstly, on the speed of rotation of the field, and, secondly, on the field flux. The effect, then, that ultimately obtains (as will be seen from a consideration of Lenz's law) is that the rotor rotates in the same direction as the stator field. The difference in linear velocity of the stator field and the rotor is, therefore, a measure of the lines cut in unit time. This, then, is also a measure of the E.M.F. induced in the rotor coils and of the current circulating in them. The watts used in this way in the rotor, neglecting C^2R, eddy-current, frictional, and other losses, appear at the pulley of the motor. Hence it will be seen that the effect of loading the machine is to make the rotor lag behind the field in order that *its conductors may cut the field to a sufficient extent to generate the necessary watts for the load put on.*

Now, from the foregoing it will be seen that if the field is strong, the decrease in speed of the rotor will not be as great as if the field were weak. Therefore, the advantage, as regards the speed question, is that the "slip" will not be as great in the case of a strong field as in that of a weak field. Also, to quote Jackson's "Alternating Currents and Alternating-Current Machinery," "a reasonably large value of N, with a proportionate iron section, increases the no-load losses, but increases the full-load efficiency as in the case of a transformer."—T. T.

Question No. 494.—What are the benefits of carbon breaks on switchgear? Is the resistance of the carbon of any practical value? What principles should guide one in designing such "breaks," and how would you determine the necessary size of carbons for breaking a given load?

Best Answer to No. 494 (*awarded* 10*s.*).—The sole object of carbon breaks on switchgear is to protect the main switch contacts from the very destructive effects of the temporary arc formed when opening a circuit on heavy load. The effect of the arc on carbon contacts is found to be less destructive than on metal, as the carbon does not fuse and become mis-shapen to the same extent. In design-

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ing switchgear it is not sufficient to consider the full-load current only, but the fact that in emergency the circuit may have to be broken many times, the usual load must also be taken into account and a good margin left. The resistance of the carbon blocks would at first sight appear to be advantageous, as tending to reduce the current before the final break. In actual practice, however, this resistance is found to be a serious drawback.

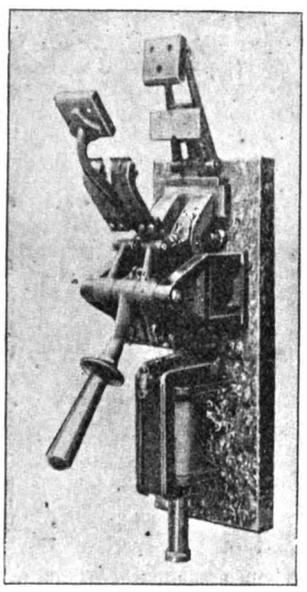


FIG. 1

Consider the case of a switch carrying a heavy current, the first motion of the switch opens the main contacts, but owing to resistance there is an appreciable potential difference between the carbons, and consequently a serious tendency to arc across the main contacts. This has led engineers to incorporate in their designs an intermediate contact, constructed of strips of metal, easily and cheaply renewed. This intermediate contact is sometimes distinct and sometimes forms part of the carbon break, in which latter case it is often only the man who designed the switch who is really aware of the importance of this feature, or even of its existence. There is no fixed rule

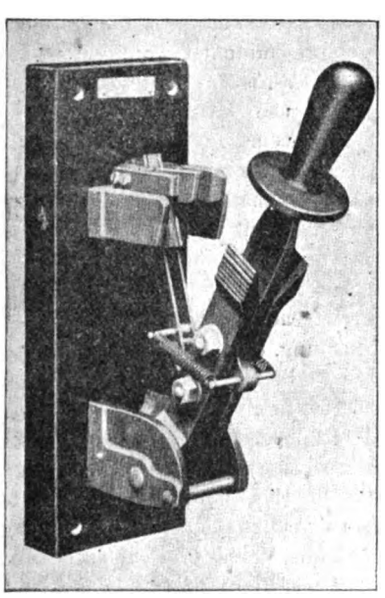
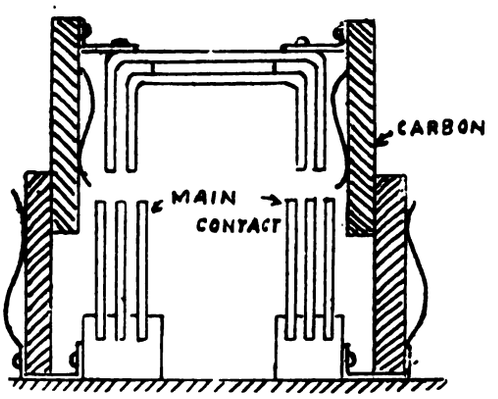


FIG. 2.

with regard to the area of carbon breaks, but bearing in mind the fact that resistance is a serious defect, this area should be as large as can be conveniently worked in with the general design. Good practice is to make it something over half the area of the main contacts. The carbon blocks should not be thicker than is consistent with strength, and must be carefully fitted so as to avoid risk of fracture through setting up unequal stresses. The figures show two types of switches with carbon breaks as manufactured by Messrs. Cowans, Limited, of Salford.

Fig. 1 shows an automatic cut-out, and is a good example of the class in which three distinct contacts are used; in Fig. 2 the intermediate break forms part of the carbon break, and is not so prominent.—GEO. D. LEYS.

Answer to No. 494 (*awarded* 5*s.*).—Carbon breaks are placed on switches to preserve the main contacts from the destructive effects of the arcs on breaking circuit. The main contacts are arranged to break before the auxiliary carbon breaks, as shown in sketch, and by this means the arc takes place between these easily replaceable and less costly portions of the switches, and the main contacts are



thereby kept clean and free from pits, etc. The auxiliary breaks on switches are always made of carbon or a metal with a high fusing point, so that they will not be so easily destroyed by the arc on breaking circuit.

These contacts are often put on switches for breaking inductive circuits (where non-inductive breaking resistances are not used), such as a series of arc lamps, dynamos, and motor fields, etc., and the arc can then be drawn out on these contacts, which is equivalent to inserting a resistance and prevent excessive pressure due to self-induction.

The resistance of the carbon is of very little importance as compared with the resistance of the arc on breaking circuit.

The chief principle to be observed in designing carbon breaks is stability, as the switches will usually be closed rapidly and the carbon is so liable to fracture, and if this happened the main contacts would be damaged; therefore, they should never be made flimsy, but have plenty of material in them, and be as well supported as possible. They should be easily renewable, and a slight pressure obtained by means of springs to keep them in contact. As the carbon only remains in circuit for a moment, the current density may be carried very high, say 500 amperes to the square inch on large switches, but stability determines the size on small ones.—C. HERBERT.

Answer to No. 494 (*awarded* 5*s.*).—On switchgear the main contacts, which consist of copper or some other suitable material, are separated before the carbon contacts leave one another, so that the arc takes place between the two carbon blocks. By this means the main contact surfaces remain unburnt. The carbon blocks burn, but do not melt like metal contacts, so that lumps are not formed on them, and there is no tendency for them to fuse together in the operation of the switchgear. The cost of replacing the carbon blocks is nothing compared with the cost of having to replace the main copper contacts. The resistance of the carbon is of value in motor-starting switches, by having a carbon brush a little in advance of the main brush, on a separate path. When cutting the resistance out of circuit, the main brush is saved from being burnt. Also the carbon brush having a greater resistance per square inch of contact surface than the metal brush, practically two steps are obtained for each step of resistance in the switch; by this means the motor gets the increase in voltage more gradually than if there was only a metal brush on the switch. Suitable sizes for the carbon can only be found from practical experience. The point at which the carbons leave one another should be as wide as possible, so that a wide surface is exposed to the arc. Carbons 2½in. wide and ½in. thick have been used on a switch breaking 1,300 amperes, and found satisfactory.—C. G.

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CONTENTS.

Notes	73	Gloucester Accounts	96
The Dusseldorf Exhibition.—I.	78	Stepney Accounts	96
Tramways and Light Railways Exhibition at the Agricultural Hall	80	Barking Town Accounts	96
The Conversion of Single-Phase into Multiphase Stations	85	Eccles Accounts	97
Cyrostatic Action and its Bearing on Certain Points of Engineering Design	86	Tube Bills in Parliament	97
Questions and Answers	87	Legal Intelligence	97
Honour to Whom Honour is Due	90	Companies' Meetings and Reports	98
Correspondence	91	Appointments Vacant	98
Carnarvonshire Power Scheme	91	New Companies' Registered	99
Power Station Signalling Apparatus	92	Contracts for Electrical Supplies	99
Incorporated Municipal Electrical Association	92	Traction Notes	100
Production of Calcium Carbide	95	Lighting Notes	103
Forthcoming Events	95	Provisional Patents, 1902	106
Lancaster Accounts	95	Specifications Accepted	107
Bury St. Edmunds Accounts	95	Traffic Returns	108
		Companies' Stock and Share List	108
		Supplement:	
		The Union Internationale Permanente de Tramways	1
		Municipal Trading	4
		Questions and Answers	7

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HONOUR TO WHOM HONOUR IS DUE.

It is a great pity that many eminent men fail to recognise the sphere of life in which they are eminent, and are always seeking to shine in spheres they do not adorn. Mr. Henniker Heaton has done exceedingly valuable work in one direction, but that experience has not fitted him to become a judge in questions relating to wireless telegraphy. His interposition in the correspondence between Prof. S. Thompson and Lieutenant Solari does not redound to his credit; rather the contrary, showing most conclusively to those familiar with the question his want of familiarity with it. It is not our wish, nor is it necessary that we should attempt to decide the questions in dispute. The exact position of Mr. Marconi in relation to wireless telegraphy is not a question which can at present be solved, nor is it necessary that it should be solved. The misfortune attending the introduction of all improvements is that the credit should be almost equally divided between two parties, and this is exactly what the friend of either party fails to see. On the one hand we have the inventor to whose labours the germ of success is undoubtedly due, and we are fain to believe that to him the thanks of the world are due in a greater measure than to his successor or contemporary who utilises the germs he has discovered. Hertz, Lodge, and others were, or are, devotees to what may be termed pure science. Their work is laboratory work. Their proofs can go no further, and need go no further, than to show successful experiments. Mr. Henniker Heaton seems to place no value upon this, and to give all credit to the man who successfully applies on a larger scale the apparatus these men proved successful in the laboratory. On the contrary, we prefer to give and to demand for the man who searches the recesses of nature and grasps some secret from these recesses the greater share of praise than we should give to the man who, once the secret has been placed in his hands, devotes money, time, and attention to the moulding of nature's process to the welfare of humanity. The latter deserves great credit, the former deserves the greater credit. To maintain that the work of the one is pre-eminently valuable and the work of the other valueless, is to maintain what is nonsensical. The worker in the laboratory places weapons in the hands of the worker in the field of applied science which enables the latter to develop from the crude form an apparatus which shall be more or less perfect, but it is not too much to say that were not the crude idea put into the hands of the worker, the successful apparatus would never by him be given to the world. Prof. Silvanus Thompson, so far as we can read his letters, or so far as we can understand his reasoning, does not attempt to detract from the credit which is to be given to Mr. Marconi for the latter's wonderful success in all the practical work appertaining to wireless telegraphy. All that Prof. Thompson does is to claim credit for those workers who have placed the germs of success in the hands of the practical man. It must never be forgotten that so far as the world's pecuniary reward goes, the practical man receives of it, if successful, an abundant share, while the student of the laboratory gains nothing but scientific fame and a seat in the ranks of the Royal Society. Why Lieutenant Solari, why Mr. Henniker Heaton, should be so rabid in detracting from the claims of the pure scientists it is difficult to see; but history is simply repeating itself. Time and again similar claims have been made in other directions, and in a similar most uncalled-for manner. Take the case of a professor who delegates a certain research to one or more of his students. The students do the investigation, they obtain the results, but we think the professor justly claims the credit. Not

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one of the students would have entered upon the investigation of his own accord, and, therefore, the credit which is due to him is purely the credit which is due to a workman, or, rather. to a draughtsman who has designed a machine to fulfil the suggestions of an employer. Again we say the greater credit is due to him who initiates, and this need not lessen or stint the praise to him who makes practical. Herein, therefore, seems to us to be the whole pith of the controversy which ought never to have arisen. The friends of Marconi claim too much and disparage the original work of others, while a little consideration would show that the work of both parties was necessary to bring the matter to a successful issue. What does Mr. Marconi suffer if in his experimental researches to make wireless telegraphy practical he utilises in combination the suggestions or the detail apparatus designed and suggested by others? It is perfectly evident he grasps the value of the detail, and he utilises it for the benefit of humanity. There is is no necessity, then, for him to suffer, nor is there necessity that he should disparage those who suggested the detail, and, therefore, assisted in the consummation of the great work. He has done more by his energy and perseverance to make this system of telegraphy known to the world than most or even than all other investigators combined. Let him, therefore, have the credit which is due to him for that perseverance and success, while at the same time let us give those who have suggested modifications in details the credit which is due to them for their discoveries.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

UTILISATION OF PEAT BEDS.

SIR,—I observe that you quote from a letter of Sir R. Sankey to the *Times* on a new era for Ireland, to be brought about by the utilisation of her peat beds for the production and distribution of electricity. This identical project was first set forth (and originated) by me in an article in the *Nineteenth Century* for December, 1894, where I pointed out that the highlands would benefit in the same way. The project attracted notice in Ireland, etc., at the time, and I believe the idea has not been lost sight of there or elsewhere. Plans of the kind have since been mooted for the peat beds of Sweden and Canada. Such an idea, once planted, does not perish, and soon or late bears fruit. Sir R Sankey was chairman of Public Works in Ireland for 12 years, and probably either saw the article or had his attention called to it by the Irish journals or in conversation.—Yours, etc.,

Croydon. JOHN MUNRO.

CARNARVONSHIRE POWER SCHEME.

ADDRESS BY SIR WILLIAM H. PREECE AT CARNARVON.

On Monday Sir W. H. Preece, K.C.B., delivered an interesting address at Carnarvon at a largely-attended meeting of the magistrates, county councillors, and other public men interested in the installing throughout the county of electricity for lighting purposes, traction, and power. Mr. W. A. Darbishire, J.P., presided.

Sir Wm. Preece explained that the meeting was the outcome of an interview he had a fortnight ago with Mr. Charles H. Rees, of Carnarvon, who called upon him to seek his co-operation in connection with a small tramway scheme. He (Sir William) then pointed out that he did not think it worth while spending much time on a small undertaking of the kind, and that if the practical application of electrical energy to useful purposes was to be extended in Carnarvonshire, those who were interested in the matter throughout the county should be called together, so that some really practical and useful step might be taken. He wished particularly to point out to the people of his native county that we were now in a state of transition as regards the application of electrical industry. They had been going on for many years under great restrictions—not legislative restrictions, but restrictions of another kind, but now they were emerging from the infantile stage, and were really reaching a very practical commercial life of electrical industry. The electric current was so cheap, so convenient, and so safe, and the apparatus generating it occupied such small space, that one might say that of all the forms of energy there was nothing so convenient as electricity. He did not know whether anybody knew the exact quantity of energy used in that county, but, from the estimates he had been able to form, it represented at least 20,000 h.p. It was only when there were large stations and large engines that great economy in fuel could be secured. He wished to impress upon them that to get up electrical energy as cheap as it can be got they must have large stations. If they frittered away their capital and their fuel in small stations, they showed a great want of what he might call commercial economy. Wallsend produced its electrical power at $\frac{1}{3}$d. per unit; Llandudno was one of the next lowest, being a little over $1\frac{3}{4}$d. per unit. If Llandudno, Conway, Bangor, Carnarvon, and their other borough towns amalgamated to generate their own electrical energy in one spot, they would save a third of their capital, and they would get their electricity generated at one-third of the price. In that county there was a great deal of water running to waste, and much had been said about the utilisation of their waterfalls. In all such cases it was a question of pounds, shillings, and pence, and when the value of water power was considered they had to take into account the capital expended in hydraulic works to render it possible to obtain the water power. Two years ago there was a scheme brought before Parliament called the West Highland water scheme, it being proposed to distribute 40,000 h.p. from the head of a Scotch lock. It was shown, however, that the cost of carrying out the works—the payment for the rights, the dams to be built, and so on—would absorb two millions of money, and the interest on the money would be much greater than the total cost of the coal required to produce the power. Of course, that upset the scheme, and it would upset any scheme if it was not carefully considered. There were not many water sources in the county large enough to secure the water power they wanted, and they had to consider how far the generation of power, either by water or by coal, could be carried on on commercial grounds. This was a matter he had very thoroughly gone into. They could not carry their electricity through a wire without losing on each mile a certain percentage of it; for every horse-power that was carried through they lost 5 per cent. The 5 per cent. on the capital of the mains should balance the cost of carriage of the coal. When that became less than the carriage of coal, it was economical to transmit energy by wire; but when greater, it became the reverse. He had found that it was not economical to go to a distance of more than 15 miles from the generating station with coal at its present price. The next question was that of market. When they dealt with a generating station either worked by steam or water, it was a question whether the producer ought to go to the customer or the customer to the producer. In the case of Niagara—one of the greatest generators of electricity at present in the world—the first concession asked for was for the purpose of transmitting energy to Albany, on the Hudson, about 150 miles, and to New York, about 400 miles away. The scheme was brought to London, which in those days—he was speaking of 20 or 25 years ago—was the spring whence all financial support emanated for carrying out these undertakings. The matter was referred to him, and he had to report upon it, and he pointed out that it was perfectly impossible that the power at Niagara could compete with coal at Albany, and certainly, of course, at New York. In fact, in these days he made the economic distance 30 miles, but now he made it 15. The result was that the Niagara scheme was not carried out by that particular concessionaire, but a scheme had since been carried out, and had become a gigantic success, not because anything he said was wrong, but because it was right—that the customers would have to go to Niagara before it would pay. That was what had happened. Niagara was now an enormous city, supplied almost entirely by electric power; Buffalo was a great city of 150,000 inhabitants 18 miles away, but at that distance they could not compete with coal and with oil. One of the greatest needs of the present day was improved traction on our roads—light railways, tramways, and automotors. A light railway implied that it should be carried out as a feeder on a big line of railway, but there had been a great many constructed which were only tramways. As to the automotor, it was his deliberate opinion that it had come to stay. Its advantages over other cars were apparent: it had no vibration, no smell, and no delicate machinery to get out of order. In referring to the slate industry, Sir William pointed out that but a very small fraction, indeed, of the slate blown down by explosion ever reached the market. The chair-

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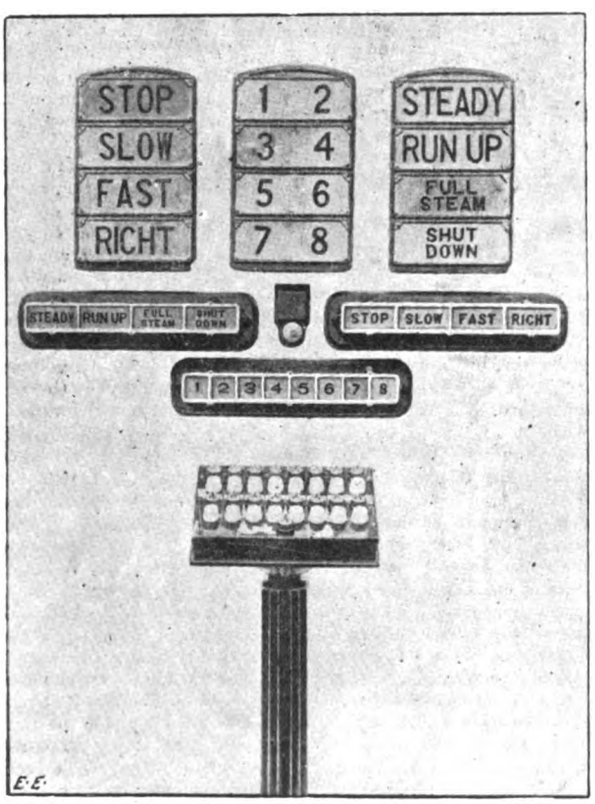
man assured him that the marketable slate only represented 2½ per cent., and he could not help thinking that there was something barbarous in the mode of blowing down the face of the rock. In the Pyrenees the French cut the slate by means of wire saws worked by electric motors, but how far such machines were applicable to the Welsh slate rocks he could not say. For making school slates, pencils, and so on, electrical machinery was the very thing. The electric motor was displacing all shafting and belting, which caused a loss of 75 per cent. in the power. It was also used by brewers, in sawmills, by shirt manufacturers in Ireland, and for corn and cake mills, etc.; in fact, the market for electrical energy was at their very doors. His object in addressing them was to excite the interest of his fellow-countrymen. He was prepared to join them in working out any scheme, and would plank down his money and help them to the best of his ability.

On the motion of Mr. C. A. Jones, chairman of the County Council, seconded by Dr. John Williams, J.P., a hearty vote of thanks was passed to Sir Wm. Preece for his address, and a committee was afterwards appointed to consider the question of forming a syndicate.

POWER STATION SIGNALLING APPARATUS.

We illustrate herewith the parts of a power station signalling apparatus similar to that installed by Messrs. John Fowler and



Parts of Power Station Signalling Apparatus.

Co., Limited, of Leeds, in the Cardiff tramways power station, and recently referred to in these columns. The vertical column shown in the illustration is equipped with a number of switches, each of which controls a lamp in one of the various cubicles of the indicators. It also carries the fuses which protect the lamp circuits. Each of the indicators, also shown in the illustration, consists of a number of cast-iron cubicles fitted with windows of frosted glass, on which numbers or instructions are painted. In each of these cubicles is fixed an incandescent lamp, which serves to illumine the number or instruction on the glass of its particular cubicle. The three top indicators and the electric bell shown in the illustration are fixed in the engine-room in any convenient position, the remaining parts being placed in the switchroom, so that when the switchboard attendant wishes to signal to the engine driver he has simply to ring the electric bell to attract attention, and then operate the switch corresponding to the number of the engine which requires attending. This operation will illuminate a number on the indicators in the engine-room, and a similar number as a check in the switchroom. The other switches, by means of which the instructions on the engine-room indicators are illuminated, can be used in a similar manner, and the driver so instructed how to operate. We understand that the arrangement is an unqualified success.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

(Continued from page 53.)

Notes re Earthing.

BY H. FARADAY PROCTOR, CITY ELECTRICAL ENGINEER, BRISTOL.

To avoid the constant repetition of somewhat extended phrases, it may be stated that in these notes the following expressions have been used with the somewhat limited application set opposite to them respectively:

Installation.—Consumer's wiring.

Distributing System.—The distributing system external to consumer's premises belonging to the suppliers of energy, and from which several consumers are supplied direct.

An Earthed Conductor. — Any conductor which is itself earthed or is joined to another conductor which is earthed.

An Uninsulated Conductor.—A conductor which is not intentionally insulated from earth at any point.

An Unearthed Conductor.—A conductor which is itself insulated, and is nowhere joined metallically to an earthed conductor.

Return Conductor.—The uninsulated or earthed conductor.

It is with a certain amount of diffidence that this paper is written and presented to the members of the Incorporated Municipal Electrical Association. The consideration of earths intentional and earths accidental bring out some problems of very great interest—(1) to suppliers of electrical energy, who probably think they know all about it; (2) to consumers, if they were to know all about it; and (3) to the insurance companies, who, of course, do know all about it. The writer has given a considerable amount of time to the consideration of the different problems, more especially in connection with the work of the Wiring Rules Committee of the Institution of Electrical Engineers, and he has come to the conclusion that he knows little or nothing about the matter at all, since on that committee (it is probably no breach of confidence to admit) he was quite alone in his views touching this question. His complete ignorance and thirst for enlightenment must, therefore, be pleaded as the extenuating circumstances under which a subject on which all the engineering members of this association have already been circularised is brought to your notice. The following notes are intended to apply only to risks or inconveniences that may arise from work carried out on a consumer's premises, as affecting other work, on the same or other premises, supplied with electrical energy from the same generating system. As so many here have already considered the points in a certain order, perhaps the wishes of those present will be best served by that arrangement being now adhered to.

1. Where one conductor of a two-wire installation is uninsulated throughout its length, and is joined to a similarly uninsulated conductor of a two-wire supply system, it is obviously advisable to have the uninsulated conductor so arranged that it cannot be accidentally interrupted, and, therefore, all switches and fuses should be inserted in the insulated conductor only. Were the uninsulated conductor severed at any place, at a time when there would be a tendency for a current to flow, such current would take any path left open to it, and there would be a risk of electrolysis at gas or water pipes, either on or off the premises containing the installation, and also of earth currents possibly causing other electrical disturbance. If the distributing system were to be earthed at one place only, instead of having one uninsulated conductor, the connection of installations with one pole uninsulated would not be permissible, since the fall of potential between the single earth on the distributing system, and the multiplicity of earths on consumer's premises, would lead to troubles. The use of an uninsulated conductor buried in the ground is probably out of the question, owing to the difficulties that would arise due to rust and corrosion. If, however, a sufficient number of good earth-plates were well distributed and connected up, no ill results should arise from the connections of installations with only one pole uninsulated. The greater the number of earths the less would be the risk of troubles from earth currents. As regards the risk of interruption to supply on consumer's premises when one conductor is uninsulated from earth, the points for and against appear to be as follows: (1) There is only one half the length of conductor to be kept insulated. (2) If an earth develops on the otherwise insulated conductor something is sure to happen, whereas if the same occur and the other conductor is insulated something is not "sure to happen," although in all probability it will, since it is likely that a friendly neighbour who also has "the supply" will provide the earth on the other pole. (3) If there be any fault it probably develops at once, whereas if both conductors are supposed to be insulated, the fault may only develop when an earth occurs on the other pole at some different part of the system. Since most irregularities on installations are caused at

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times when some alteration is being made, it is distinctly desirable that a fault should show itself at once rather than await some inopportune moment, as is too often the case under existing conditions. (4) Economy as regards first cost of installation.

2. Where the neutral conductor of a three-wire installation is uninsulated throughout its length the arguments set out above all apply. Reverting to two-wire installation (as in No. 1) consideration must also be given to the question of a change-over from one side of a three-wire distributing system to the other. If a two-conductor installation be connected to a three-wire distributing system where the neutral is connected to earth at one or more points (presumably the earthed conductor will be intermediate to the other two as regards electrical potential), and it is desired to change over such installation to the other side of the system, say for the purposes of balancing, the following points arise: if one conductor of the installation be earthed or uninsulated, the change-over must be so arranged that that conductor shall continue to be joined to the neural or earthed conductor of the distributing system, but if the supply be continuous current this means a reversal of polarity on the premises, necessitating a change-over of each arc lamp, Nernst lamp, and any other selective apparatus there may happen to be on the premises, and where arc lamps have one pole to frame, and the frame has been earthed, the frame under the new conditions must be carefully insulated. These troubles do not appear if alternating current is used. To ensure criticism and afford the members as much amusement as possible, the writer ventures to express the opinion that where a distributing system can be properly equipped with a sufficient number of earths, it is admissible from every point of view (with the exception of that allowing for the inconvenience of a change-over from one side to the other of a continuous-current system), and desirable from reasons of economy, to allow the connection thereto of installations having one conductor uninsulated from earth throughout its length, and that on such a conductor there should be no switches or fuses. It is only under such conditions as these that the use of a complete three-wire system should be permitted.

3*a*. Where on a two-wire system one conductor is earthed at one place only, say at the generating station, it is, as previously pointed out (see No. 1), inadmissible to allow any earth or uninsulated conductor on a consumer's premises, for if an earth fault occur on the earthed conductor the two earth connections will shunt the return current, not only of the particular installation on which it exists, but of all other installations on the same distributing system; and if this conductor is not protected by fuses on the supply side as well as the lamp side, a dangerous amount of current may be carried through it in the vicinity of the earth fault, and for this reason it appears desirable that fuses be used. Suppose, however, that fuses are used, and that the fuse on the supply side of the earth fault were to operate, the flow of current to earth at this fault would cease, except from that portion of the installation *away* from the supply side of the fault. This portion of the installation would, however, have to pass the whole of its return current through the earth fault; it is, however, improbable that the fault should have so low a resistance that there would not be some conspicuous fall in the voltage, consequently the fault would soon be observed and remedied, whereas if there were no fuse there would be no result to indicate the irregularity until an actual burn-out on the conductor had occurred. Let us suppose that an earth having a resistance of five ohms develops on a conductor of a five-ampere circuit of an installation. This earth fault, and the earth at the generating station, will shunt the cables lying between them, current will flow to earth at the fault, not only from the installation on which it occurs, but also from all other installations in the neighbourhood if the circuit be fused for 10 amperes, and the resistance between other connections in the vicinity and this fault be one-tenth of an ohm less than the resistance between such connections and the generating station earth, then the shunt current from the flow of 600 amperes would sever the fuse. If the resistance back to the station earth were higher, say one ohm, then the shunt current from a correspondingly less flow—viz., 60 amperes—would suffice to blow the fuse. Suppose, however, that the fuse were non-existent, a greater flow would cause a dangerously large current at the earth fault, and, possibly, even the melting of the small conductors leading up to it. Consider now the behaviour of the current from the particular five-ampere circuit on which the fault exists, the leakage to earth will be comparatively small so long as the return circuit is unbroken. Should it become interrupted, due to a large flow from other portions of the system, or from any other cause, then the whole of the return current from this small circuit must pass through the fault. It is, however, contended that this evil is less in extent than that of passing the much larger current to earth from other installations, especially having regard to the fact that such is as likely to occur when the faulty circuit is switched off at the non-earthed main as at any other time, and that the leakage to earth under these conditions will not be noticeable until a burn-out takes place. A fault having a resistance of five ohms has been taken as an example in the endeavour to show that with even so high a resistance fault, the current from neighbouring sections of a system may be expected to burn out either the fuse or conductor of a five-ampere circuit. With a lower resistance fault the probabilities would be correspondingly greater.

3*b*. The whole of the remarks made above with reference to 3*a* apply also to 3*b*, where the system of supply being a three-wire one with the neutral conductor earthed at one place only, the installation is carried out on a two-wire system.

3*c*. Where an installation is carried out partially or wholly on a three-wire system it is preferable to avoid the risk of burning out lamps by not employing fuses on the neutral conductor which will be *likely* to give way and sever the circuit, but to avoid the more serious risks above referred to (see 3*a*) it still becomes desirable to insert fuses, and these, as before, should be of such size that they will protect the smallest conductor between them and the source of supply. If, however, the amount of three-wire distribution is very small in proportion to the two-wire work—for instance, if three conductors be taken from the supply mains direct to a board from which the distribution is carried out on a two-wire system—then it is better not to insert fuses on the earthed conductor until after it is split up into two-wire systems. These fuses, if inserted where the splitting-up takes place, will protect the neutral conductor, right back to the supply service, from any heavy return current arising from an earth, as they will be placed practically on the ends of this neutral or third wire at the distributing board.

4. Where a conductor is joined to the neutral conductor of a supply system which is not intentionally earthed, it should always be borne in mind that such conductor may become earthed at any time, either at some point of the distributing system or on any consumer's installation, and under such conditions it should be treated as though the earth existed.

4*a*. On two-wire installations fuses should therefore be used on both conductors.

4*b*. Where only a small portion of the work is carried out on the three-wire system, as mentioned under Clause 3*c*, fuses should not be used on the intermediate conductor except beyond the point where it is split up into two-wire circuits. Where the whole is carried out on a three-wire system fuses should be used on all conductors, those on the neutral being proportioned as before described. Should, however, a person be nervous as to the burning-out of lamps, or should the pressure across the outers of the three-wire system be such as would be dangerous when applied across the terminals of any apparatus used on one side alone of the system, then three-wire work should not be entertained.

Since the chief advantage of a three-wire system arises in connection with the use of pressures across the outers higher than it is permissible or desirable to give to the ordinary lighting consumer, one of the chief advantages disappears if the neutral conductor is not earthed, for under such conditions the public may become "shocked" to an extent that would surprise them; but the earthing of a continuous-current system in a manner that will obviate all forms of obnoxious earth current, both external to and within consumers' premises, is a problem which requires a certain amount of consideration. Mr. Snell may have a solution, but the writer is disposed towards the the view that: (1) three-wire distributing systems are chiefly useful when the neutral conductor may be earthed; (2) the neutral conductor of a distributing system to be earthed in the safest of all manners, from the consumer's and fire office point of view, should be at as many points as possible; (3) where a distributing system is earthed at many points it is probably much to the advantage of all parties concerned that the current be alternating, as although troubles might then be experienced if earth-return telephones were used, a state of equi-potential can be most easily arranged for from a transformer-fed system, when no troubles from electrolysis can exist.

Discussion.

The president, Mr. J. H. Rider, having opened the discussion with the remark that the paper was of great interest to those who had to deal with lighting circuits,

Mr. Raphael expressed the opinion that there was less heat generated, and consequently less risk of faults, if one of the mains be at earth. He thought Mr. Proctor was risking a great deal by suggesting that there should be earths all over the system. The difficulty of locating faults was thereby greatly increased. As to the question of fusing the middle wire of a three-wire system, when the middle wire was earthed at any point, he was sure it would tend to increase the fire risk.

Mr. J. S. Highfield, of St. Helens, thought that for safety of supply with the three-wire system, it was more satisfactory to have the middle conductor earthed at only one point.

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With regard to fusing the circuits connected to such a system, it appeared to him that the main fuses should be only on the two outer conductors, and not on the neutral conductor, but beyond that point he liked to have double-pole fuses in the ordinary way. He did not agree with having the three-wire system in the consumer's premises. The work inside the consumer's premises should be on the two-wire system. On the general question of earthing, he thought that the negative conductor ought to be earthed the whole time. It gave a great many advantages. First of all, a tramway negative was always earthed, and, therefore, one could work such a system from the tramway 'bus bars. Excellent results were obtained in the North with the system used for supplying the collieries with power. Supply was made at, say, 500 volts with the negative absolutely earthed, using concentric conductors, and having the outer conductor grounded. As to the danger of electrolysis, he was not in accord with the author's statement that with an alternating system no such troubles could arise. He believed himself that there was very great question about it.

Mr. F. A. NEWINGTON, of Edinburgh, agreed with nearly all Mr. Highfield had said with reference to its being necessary to have fuses on the middle wire. There was one very good reason for this. Wiring contractors were very often not as careful as they might be, and the chances were they might fix up the house connections wrongly, so that there would not be any fuse either on the positive or the negative conductor, as the case might be.

Mr. L. ANDREWS, of Hastings, thought they ought to keep in mind the risk attending the fusing of the middle wire of the three-wire system. The risk he referred to was that if the fuse blew, then all the current from the installation returned to earth in the event of a fault. It seemed to him that for alternating-current work at least, the simplest way out of the difficulty was to earth the system throughout. He, however, saw no very great prospect of being able to do that. In tramway work the system was earthed throughout, and apparently the only objection to that was the danger of electrolysis. With alternating currents they did not appear to be getting electrolysis.

Mr. V. A. H. MCCOWEN, of Belfast, was afraid of putting a number of earths on a system. With the system earthed at the station, it was much easier to locate faults. He had found that by making intermittent make and break, and following up faults by means of a compass, they were very easily discovered; but with earths all over the system, there were numberless difficulties in the way. He did not think that the middle wire of the three-wire system should be brought beyond the consumer's terminals.

Mr. A. P. TROTTER, electrical adviser to the Board of Trade, observed that the paper did not exactly tell them what Mr. Proctor's idea was, but was rather more for discussion than anything else. The whole question of the continuous earthing or continuous insulation of the middle wire was a matter which was creating a good deal of interest just now. The practice in this country, with the exception of only one town, was to earth the middle wire at one point only—that was to say, of any three-wire system. The exception was Guildford, but there the mains were laid in bitumen in such a way that there was a very tolerable insulation. The question was recently brought to his mind by some German engineers; up to that time he had only looked at the matter from the point of view of house-wiring with concentric wires, the outer being earthed. This was excellent practice, no doubt, for isolated jobs, but he could find no engineer of large practice who would connect such a system to his mains. A short time ago he was shown a most surprising list of towns on the Continent in whose systems there was said to be no insulation at all on the middle wire, and this list went further to induce him to carefully consider the question than anything else. Showing the list to Mr. Kapp the other day when he was in London, that gentleman told him that it did not represent the whole of the more important towns on the Continent. In Berlin, for instance, mains were very largely laid in dry clean sand, and it did not matter whether they were insulated or not. One of the objections strongly urged against no insulation on the middle wire was that in the event of a fault the fuse blew at once. That question, however, greatly depended on where the fuses were going to be, and he had not been convinced that abandoning the insulation on the middle wire was going to cause fuses to blow quickly. The whole question of the drop upon the middle wire was mixed up in the consideration of this matter. There used to be some conditions of the Board of Trade by which approval was given for connecting a circuit to earth. One of these conditions was that there should be no fuses on branches from the intermitting conductor, and this led to a number of enquiries from engineers as to where there were to be no fuses put. As he was not quite clear upon the point, that condition was dropped. A condition had now been inserted providing that the network should be cut up and connected by fuses, so that in case of a bad leak the particular section affected could be cut out. The option between fuses and links for this purpose was given, but he was not quite sure whether he should not have to knock out these links and come back to fuses again. On the question of insulation, his own opinion was that it would be a great waste of material to insulate the middle conductor throughout its length as well as the outers. He was often being asked what regulations the Board of Trade had with regard to the earthing of the middle wire, and in such cases he usually explained how it was done. To begin with, there was the question whether you should have low-resistance dead earth. The first thing was to put a small resistance in the middle wire. He might say that he should be very glad when he saw a recording ammeter on the middle wire; it gave very useful information, and was of very great assistance in tracing a leak. There was one large job he knew of where low resistance dead earth was not used; the old-fashioned method of coupling two lamps in series had been adopted. He thought in this case they must have uncommonly good mains, and he was told they did not get any very great troubles, and managed to hunt down their faults easily enough. There was one more thing to be put in the circuit, and that obviously was a circuit breaker. As to taking a three-wire system into the consumers' houses, electrically he did not see the difficulty, but the fire insurance people were very adverse to such a practice. In conclusion, Mr. Trotter referred to some experiments on alternating-current electrolysis. In one experiment two lengths of pipe and also some plates buried in earth showed distinct signs of electrolysis. Mr. Mordey had stated before the Institution of Electrical Engineers that one ampere per square inch would not be harmful, but as a matter of fact Mr. Trotter's experiments showed signs of electrolysis at current densities considerably less than $\frac{1}{10}$ ampere per square inch.

Mr. S. F. WALKER said he was going to take the bold course of challenging universal practice in this matter. His view was that one should keep earth out of one's system altogether. Earth, for practical purposes, consisted of the metals and the moisture which were bottled up in the earth's crust. In the case of a mine, earth was the whole of the mine. His feeling in the matter was that if one allowed earth in the system, a series of conductors was introduced over which one had absolutely no control. Mr. Highfield had said that for mining work the uninsulated return gave absolute security. Unfortunately, that was not so. There had been two deaths lately, one of which was undoubtedly due to the uninsulated return. The victim would be living now but for the fact that practically the whole of the mine formed part of the return circuit. The remedy which appealed to him was to raise the whole standard of insulation, and particularly to increase the mechanical strength of the insulating envelope. He understood that it was the practice of some engineers to burn out their circuits. This could hardly be too strongly condemned as leading to numberless earth troubles. Summarising his remarks, he suggested that the whole of the earth troubles usually met with could be got rid of by keeping earth out of the system altogether, by increasing the mechanical strength of insulation, and by revising, if necessary, the present arrangement of switches.

Mr. F. BATHURST remarked that if they could introduce

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earth return into the consumers' premises, they could greatly reduce the cost of wiring.

Mr. W. B. Esson said that the question really depended upon whether they could get an efficient method of making the earth connection all through the system. They could not earth the houses unless the complete system were earthed. There was no objection, he understood, to the principle of earthing; the only objections had been as to the efficacy with which it could be carried out. What they wanted to do was to completely earth the middle wire of a three-wire system or the single of a two-wire system, so that practically the earth would become a plate of copper. He contended that if they allowed earthing throughout, it would require considerably more copper in the middle wire than was used at present. He believed that the basis upon which Mr. Proctor made his proposition was economy, and what they had to consider was how much more copper would have to be provided for obtaining complete and efficient earthing throughout—whether the extra cost involved would not overbalance the advantages of the method.

The author reserved his reply to the discussion for the columns of the association's *Journal*.

(To be continued.)

PRODUCTION OF CALCIUM CARBIDE.

A novel method for the production of calcium carbide is suggested by Messrs. Vulitch and D'Orlowsky, of Paris. As an alternative to the usual practice of heating a suitable mixture of lime with carbon, it is proposed to first fuse the lime in an arc furnace and then discharge the molten mass into an excess of heavy hydrocarbon—such as "masud" or other residue of petroleum distillation. According to Mr. C. P. Townsend in the *Electrical World*, the formation of the carbide occurs within the body of the hydrocarbon, and the product possesses, as would be expected, some distinctive properties. It is loose and non-coherent, and is saturated throughout its mass with the hydrocarbon, which modifies its relations with water, rendering it practically non-hygroscopic. It is peculiarly adapted for the intermittent generation of acetylene, since it is not penetrable by water and the evolution of gas continues only during the period of actual immersion. It is asserted, also, that it is free from phosphorus, which is eliminated by forming with the hydrocarbon volatile hydrides.

FORTHCOMING EVENTS.

Saturday, July 19.

Institution of Civil Engineers.—Birmingham students' visit to Paris

Devon and Exeter Architectural Society.—Visit to Truro.

Tuesday, July 22.

Waterworks Engineers.—Annual meeting at Leicester.

Friday, July 25.

Waterworks Engineers.—Annual meeting closes.

The following fixtures for meetings have also been made:

Sanitary Institute.—Sept. 9-13, congress, Manchester. Sept. 9-27, health exhibition.

Sanitary Inspectors' Association.—Aug. 7-9, autumn meeting, Middlesbrough.

Waterworks Engineers.—Winter meeting, December, London.

Iron and Steel Institute.—Sept. 2-6, Dusseldorf.

Institution of Civil Engineers.—Birmingham students' visit: Sept. 25, Crewe.

Institution of Junior Engineers.—Aug. 9 to 16, summer meeting.

British Association.—Meeting at Belfast commences Sept. 10.

LANCASTER ELECTRICITY ACCOUNTS.

The accounts of the Lancaster Corporation electricity department to March 25, 1902, show a total expenditure on capital account of £39,346. Abstracts of the revenue account, balance sheet, and statement of electricity generated, sold, etc., are given herewith.

Revenue Account.

Dr. Expenditure.	£	s.	d.
Generation of electricity	2,105	1	10
Distribution of electricity	838	8	2
Attending and repairs to public lamps	129	2	10
Rent, rates, and taxes	320	14	1
Management expenses, salaries, etc.	535	12	6
Insurances	14	9	5
Allowances and bad debts	95	11	3
Balance to net revenue account	2,536	14	6
	£6,575	14	7

Cr. Income.	£	s.	d.
Sale of current and rent of meters, less discounts	5,549	7	7
Public lighting	649	6	9
Sale and repairs of lamps and apparatus	364	8	0
Proportion of apprentices' premiums	12	10	0
Cost of summonses, repaid	0	2	3
	£6,575	14	7

Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Mortgages	8,950	0	0
Lancaster Corporation 3 per cent. redeemable stock	24,680	2	4
Reserve fund account	2,131	6	2
Amount set aside for redemption of stock	2,123	13	7
Floating liabilities	5,100	15	5
Balance, being amount of debt extinguished	847	15	5
	£43,833	12	11

Cr. Assets.	£	s.	d.
Capital expenditure on works	39,346	5	8
Deduct premiums obtained on stock, less compensation	319	17	8
	39,026	8	0
Changing over account	58	6	0
Debt redemption	2,123	13	7
Floating assets	2,625	5	4
	£43,833	12	11

Statement of Electricity Generated, Sold, etc.

Current generated during year (B.T.U.)		384,000
Supplied to public lamps (estimated)	52,674	341,536
Supplied by meter	288,862	
Quantity used at works		10,539
Total quantity accounted for		352,075
Quantity not accounted for		31,925
Number of public lamps of 2,000 c.p. each		22
Number of public lamps of 1,500 c.p. each		8
Number of private lamps of 8 c.p. each		28,547
Maximum supply demanded (kilowatts)		410

Capacity of generating plant: 14,000 8-c.p. lamps = 620 kw.

BURY ST. EDMUNDS ELECTRICITY ACCOUNTS.

From the accounts of the above electricity works to March 31, 1902, it appears that the total expenditure on capital account amounts to £20,376. An abstract of the revenue account and balance-sheet, together with the statement of electricity generated, sold, etc., for the past year is appended:

Dr. Revenue Account.	£	s.	d.
Generating—coal and cartage	369	7	6
Distributing—wages, etc.	101	3	7
General stores, etc.	157	7	7
Repairs, etc.	4	10	0
Rates and taxes	73	16	6
Insurance	16	16	3
Printing and stationery	13	9	10
Sundries and carriage	50	3	11
Engineer's salary	102	13	7
Interest	486	9	5
Sinking fund	454	16	3
	£1,830	14	4

Cr.	£	s.	d.
Sale of current	966	6	1
Public lighting	200	15	1
Works executed	27	2	6
	1,194	3	8
Deficit	636	10	8
	£1,830	14	4

Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account and loans	20,250	5	4
Sundry creditors	311	0	4
Account for net payment of revenue	2,565	12	9
Bank on capital account	126	3	7
Sinking fund	454	16	3
	£24,057	4	11

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Cr. Assets.	£	s.	d.
Capital account—amount expended for works	20,376	8	11
Stores in hand	700	0	0
Sundry debtors	618	1	1
Sinking fund investments	804	2	11
Petty cash	0	14	10
Deficit to March 31, 1900	1,557	17	2
	£24,057	4	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		101,719
Quantity sold { Public lamps 33,107 / Private consumers by meter 39,935 }		73,042
Quantity used on works		24,196
Total quantity accounted for		97,238
Quantity not accounted for		4,481
Total maximum supply demanded (kilowatts)		65

Number of public lamps, 8 arcs, 238 incandescents.

GLOUCESTER ELECTRICITY ACCOUNTS.

The accounts of the Gloucester city electricity works for the year ended March 31, 1902, show a total expenditure on capital account of £57,688. We give herewith abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	1,220	18	3
Repairs and maintenance of buildings and plant	141	0	11
Repairs and maintenance of mains and meters	129	5	0
Repairs and maintenance of public lamps	203	1	8
Rates and taxes	262	12	10
Management expenses	448	5	3
Insurance	46	12	6
Free wiring rental	15	14	2
Total expenditure	2,467	10	7
Balance of revenue account	2,065	12	3
	£4,533	2	10

Cr.	£	s.	d.
Sale of current, less discounts	4,305	18	9
Rental of meters	107	17	4
Free wiring rental	15	14	2
Hire of plant for testing machinery	81	0	0
Miscellaneous receipts	22	12	7
	£4,533	2	10

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	52,586	0	8
Sundry creditors and interest on loans	1,732	14	1
Due to treasurer	5,206	11	4
Surplus, being amount of loan repaid	574	11	11
	£60,099	18	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	57,688	18	3
Stores in hand	200	15	4
Sundry debtors for current, less discounts	1,026	6	3
Public street lamps	291	5	0
Debtors and cash in hands of engineer	23	6	3
Balance at debit of net revenue account	242	5	7
Suspense account	627	1	4
	£60,099	18	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		286,580
Quantity sold { Public lamps 78,465 / Private consumers by meters 192,248 }		270,713
Quantity used on works		15,867
Total quantity accounted for		286,580
Number of public lamps		52
Total maximum supply demanded (kilowatts)		287

STEPNEY ELECTRICITY ACCOUNTS.

The accounts of the metropolitan borough of Stepney electricity department for the year ended March 31, 1902, show a total expenditure on capital account of £114,890.

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation—Coal or other fuel	2,074	19	9
Oil, waste, water, and engine-room stores	181	16	2
Wages at generating station	724	19	2
Repairs and maintenance	210	5	1
Distribution of electricity	220	0	2
Attending and repairs to public lamps	854	1	5
Rates and taxes	306	14	6
Management expenses	1,096	12	9
Stationery, printing, and establishment charges	320	16	3
Law and parliamentary and special charges	22	1	7
	6,012	6	10
Balance of revenue	5,210	11	7
	£11,222	18	5

Cr. Income.	£	s.	d.
Sale of current per meter, less allowances	8,230	10	10
Public lighting	1,908	5	9
Rental of meters	181	14	0
Sale of lamps—profit	1	8	6
Work done for customers, less cost of same	6	17	11
Public lamps, attending and repairs	854	1	5
Rent receivable	40	0	0
	£11,222	18	5

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Balance of loans borrowed	108,713	9	7
Cash account	3,797	5	8
Sundry creditors	10,219	7	7
	£122,730	2	10

Cr. Assets.	£	s.	d.
Amounts expended for works	114,890	7	1
Stores on hand	2,836	14	1
Sundry debtors for current supplied, etc.	4,580	11	3
	122,307	12	5
Deficiency of assets at this date	422	10	5
	£122,730	2	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		1,149,114
Quantity sold { Public lamps 283,500 / Private consumers by meter 724,537 }		1,008,037
Quantity used on works		13,901
Total quantity accounted for		1,021,938
Quantity not accounted for		127,176
Total maximum supply demanded (kilowatts)		506

Number of public lamps: 13 incandescent, 95 arc.

BARKING TOWN ELECTRICITY ACCOUNTS.

In these accounts for the year ended March 31, 1902, the total expenditure on capital account is given as £39,000. Abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., are appended:

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	2,408	19	10
Distribution of electricity	75	14	3
Attending and repairs of public lamps	545	15	10
Rents, rates, and taxes	211	15	10
Management expenses	315	15	9
Special charges—insurances, etc.	14	6	0
Total expenditure	3,572	7	6
Amount carried to net revenue account	1,078	0	0
	£4,650	7	6

Cr.	£	s.	d.
Sale of current per meter	2,342	9	3
Public lighting	1,983	2	8
Lighting outside lamps at hospital	15	0	0
Rental of meters and other apparatus	60	5	4
Sale and repairs of lamps, etc.	48	1	3
Heating water for public baths	140	0	0
Interest on service main to outfall works	10	0	0
Ditto East London Waterworks	18	0	0
Miscellaneous items	0	18	0
Stores on hand	32	11	0
	£4,650	7	6

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	39,019	15	0
Sundry creditors	663	2	9
Consumers' deposits	2	0	0
Cash due to treasurer	2,536	2	1
	£42,220	19	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	38,941	10	8
Stores on hand	122	7	3
Sundry debtors for current, etc., supplied	841	6	6
Cash with treasurer and engineer	92	8	9
Suspense account	2,223	6	8
	£42,220	19	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		352,647
Quantity sold { Public lighting (estimated) 157,121 / Private lighting by meter 128,795 }		285,916
Quantity used on works and batteries		28,520
Total quantity accounted for		314,436
Quantity used in distribution		38,211
Maximum demand (kilowatts)		204

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ECCLES ELECTRICITY ACCOUNTS.

The total expenditure on capital account of the Eccles electricity department to March 31, 1902, amounted to £21,707. Abstracts of the revenue account and balance-sheet are given below:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,655	1	10
Distribution of electricity	95	18	9
Public lamps	84	3	7
Rent, rates, and taxes	86	16	0
Salaries	225	5	6
Establishment charges	53	0	10
Insurances	22	11	0
Interest and repayment of loans	909	10	1
Interest and commission	232	2	9
	£3,364	10	4

Cr. Income.	£	s.	d.
Sale of electrical energy	2,347	2	0
Meter rents	68	15	9
Sale of cinders, scrap iron, and compensation	34	8	9
Fittings and repairs on consumers' premises	46	12	6
Balance—being deficit on revenue account	867	11	4
	£3,364	10	4

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans on mortgage	16,361	4	5
Sundry creditors—tradesmen's accounts owing	71	15	9
Loan repayment account	1,060	15	7
Balance due to treasurer	7,665	11	4
Sinking fund—contribution for the year	93	15	0
	£25 253	2	1

Cr. Assets.	£	s.	d.
Capital outlay account	20,164	6	3
Suspense accounts	1,542	16	8
Sundry debtors	956	12	2
Stock on hand	16	19	0
Cash in hands of electrical engineer	5	0	0
Sinking fund investments	93	15	0
Revenue account	2,473	13	0
	£25,253	2	1

TUBE BILLS IN PARLIAMENT.

Eight Bills authorising the construction of tubular railways in the Metropolis passed the second reading in the House of Commons on Wednesday. Contrary to general expectation, the subject did not give rise to much discussion, and the opposition was comparatively small. On the motion for the second reading of the Baker-street and Waterloo Railway Bill, Mr. Claude Hay moved the rejection of the measure, commenting on the fact that the scheme had hung fire for a long time, and was one of many "paper railways" of which they had heard much. The line, he contended, would be used to limit competition and divert traffic to the District Railway. This was practically the only opposition, and the Bill was read a second time by 174 votes to 10. Mr. Hay also moved the rejection of the Brompton and Piccadilly-circus Railway (New Lines) Bill, complaining that the finance of the company was mysteriously connected with the finance of Mr. Yerkes. The Bill, however, was read a second time without a division, as was also the Charing Cross, Euston, and Hampstead Railway No. 1 and No. 3) Bill, Mr. Hay again opposing. The second reading of the Charing Cross, Euston, and Hampstead Railway (No. 2) Bill was next carried, Mr. Perks, on behalf of the promoters, stating that they were in sympathy with the representations which had been made in favour of the running of workmen's trains. He further remarked that the Metropolitan District Railway, with which these tubular railways would have interchange stations, was at present hedged about by various agreements with neighbouring companies. They would be obliged next session to go for a complete revision of their rates over their whole system. The probability was that they would have one uniform rate. In view of next year's enquiry the promoters of these Bills had not thought it necessary to go in for a general notification of interchange rates in connection with the various tubes. The Great Northern and Strand Railway Bill was also read a second time.

On the motion for the second reading of the London United Electric Railways Bill, Mr. Banbury moved the rejection of the measure on the ground that it would set up illegitimate competition, and that the financial arrangements were unsatisfactory, the capital of 16 millions being higher than would allow of the payment of a reasonable interest, especially having regard to the competitive conditions that must prevail. Mr. Burns was in favour of competition. It was, however, possible to have too much competition, and he suggested that in this case time should be given to see what use the Metropolitan and the District Railways made of their powers to electrify their lines. They would give these enterprises a better chance if there was not too much duplication. This railway was financed by Mr. Pierpont Morgan and his syndicate, and he very much suspected that if they got the line sanctioned the British investor might be made to suffer, or there might be an attempt to combine with the Yerkes enterprises to the advantage of American capitalists and to the public injury. Ultimately the second reading was carried by 250 to 69. An instruction that the committee should take security from the undertakers for the completion of the whole scheme of railways comprised in the Bill was agreed to. The two other Bills, the North-West London Railway and the Piccadilly, City, and North-East London Railway Bills, were also read a second time.

The *Times* on Tuesday published a number of letters which have passed within the last week or so between Mr. Perks, Sir Clinton Dawkins, K.C.B., and Mr. Claude Hay regarding the various Tube Railway Bills now before Parliament The matter discussed in this correspondence is with reference to Mr. Hay's opposition to the second readings of the Tube Bills. In the first letter, dated July 8, from Mr. Hay to Mr. Perks, the former places on record the conditions upon which he is prepared to withdraw his opposition to what are known as the Morgan and Yerkes's tubes. He states that whilst eager to assist in the creation of tubes which will secure rapid, cheap, and frequent communication between the various parts of the Metropolis, he cannot waive his opposition to any scheme which does not conform with the principle laid down by the joint committee of 1901 that one of the main objects of underground railways should be to relieve traffic in congested places. The rival schemes, known as those of Messrs. Morgan and friends, do at least, to a certain tangible extent, comply with this criterion in their proposal to run through from Hammersmith to Tottenham at rates lower than any at present obtaining, and their plan at the same time provides a valuable connection with a widely extended tramway system. Nothing, however, can really meet the gravity of the situation in the East, but a line which will traverse the East London districts, which no railway, tube or other, at present taps, the nearest now involving a long walk to its stations from all the more crowded parts, followed by gross overcrowding in the trains when reached. Finally, Mr. Hay urges there is a very natural feeling abroad that ultimately Mr. Perks and his American partners may combine with rival American interests now seeking parliamentary powers for London tubes, and thus get the London public within the grip of a foreign monopoly. In a letter to Mr. Hay Sir Clinton Dawkins admits that at the present time the Morgan syndicate have made no proposals to Parliament to cover the areas contemplated in the abandoned City and North-East Suburban Bill. Both the Walthamstow and North-East Suburban lines have very unfortunately disappeared, and it is impossible to revive either of them or to present new Bills in their place this year. But they do not the least contemplate, therefore, abandoning the idea. Sir Clinton Dawkins goes on to say that if their through main route receives parliamentary sanction they are perfectly willing to assure the promoters of the City and North-East Suburban line of the same financial support, which is what they asked for, as they assured them of this year, provided their Bill is modified so as to overcome the engineering difficulty which proved fatal this year. They should consider such a line as as an essential and integral part of their tube railway system. The correspondence is closed by a letter from Mr. Hay to Mr. Perks on July 11, in which he asserts his object to be to secure a service of tube railways for all London, and to prevent the creation of a patchwork of such means of communication, or the handing over of the most profitable routes to those who will not serve the poorer districts, which, by-the-by, properly worked as part of a greater scheme, should be advantageous to the undertakers. He concludes: "Whilst indifferent to the conflicting interests of rival groups of financiers, I can only regret that you have been unable to help those who want to help London owing to your inability to devise or promise anything approaching to a complete system."

A letter appeared in yesterday's *Times* from Messrs. Walter Webb and Co., who, as solicitors for the City and North-East Suburban Electric Railway Bills, 1901 and 1902, write to confirm the statement made by Sir Clinton Dawkins in the above correspondence with regard to the financial support of these Bills. Messrs. Webb assert that Sir Clinton Dawkins's firm will support the Bill to be introduced next year, "as they consider the railway to Walthamstow, Epping Forest, and Waltham Abbey an essential and integral part of the Morgan tube railway system." The letter concludes as follows: "It was unfortunate that, in consequence of adopting Mr. Perks's suggestion to deposit the City end of the line under the District Railway from the Mansion House to Whitechapel, our engineers placed in his hands a weapon which was used with fatal effect against this section of the scheme and rendered it expedient to withdraw the Bill, with the view to its amendment in this particular and redeposit next session. The support received from Sir Clinton Dawkins stands out in marked contrast to that of Mr. Perks's clients, who deserted our railway after having given us every reason to expect their support."

LEGAL INTELLIGENCE.

DUDLEY TRAMWAY REGULATIONS.

On Wednesday last week at Dudley Police Court the Dudley and Stourbridge District Electric Traction Company appeared to answer two summonses charging them with having no speed indicators on the cars, two further summonses respecting the absence of copies of the Board of Trade regulations, and a third couple of summonses charging the company with carrying passengers on the roofs of cars on a light railway.

Sergeant W. Lane stated that on June 11 he saw three cars in the Birmingham-road on neither of which was a speed indicator or a copy

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of the Board of Trade regulations. The same day he saw a double-decked car being used on the Pensnett light railway.

Police-Constables Gardner and **Tolley** deposed to seeing passengers on the roofs of cars used on the Pensnett light railway on June 25 and on July 14.

Mr. Waldron, who appeared for the defence, submitted that the failure to post the regulations on the cars arose from the negligence of the car cleaners and would not occur again. The company were unable to provide the cars with speed indicators, there being, as he stated, no suitable apparatus of the kind in existence, and he read a report showing that the Board of Trade did not at present insist on compliance with that particular regulation. The light railways order, he further pointed out, while by one clause prohibiting double-deck carriages, specified in another clause what precautions should be taken for the protection of passengers on the tops of such cars.

In the result for failure to post the Board of Trade regulations the company were fined 2s. 6d. in each case, and for carrying passengers on the roofs of the cars on the light railway fines of 20s. and costs were imposed in each case. The charge of failing to provide speed indicators was adjourned *sine die*.

LEAMINGTON AND WARWICK ELECTRICAL COMPANY.

On the 13th inst., in the Chancery Division of the High Court, Mr. Justice Farwell had before him a petition *in re* the Leamington and Warwick Electrical Company, Limited, originally known as the Leamington and Warwick Tramways and Omnibus Company, asking that the scope of the memorandum of association of the company be enlarged under the Memorandum of Association Act, 1890, so as to enable the company to substitute electric traction for horse power on their system, to supply the town of Warwick with electrical energy for certain purposes, including light, heat, and telephones, to increase their capital from £25,000 to £100,000, and to take over the rights, powers, and obligations of the British Electric Traction Company. There was no opposition, and the petition was granted.

COMPANIES' MEETINGS AND REPORTS

ELECTRIC CONSTRUCTION.

The annual general meeting of the shareholders in this Company was held on the 10th inst. at Winchester House.

Mr. James William Barclay, who presided, moved the adoption of the report, which appeared in our last issue. Having referred to the loss the Company had sustained in the death of their chairman, Sir Daniel Cooper, he observed that the general result of the year's business was similar to that of last year, and, coupled with the figures of previous years, it went to show that they had a steady-going business. Their general reserve was now £32,000, while the depreciation fund, made up exclusively from revenue, amounted to £43,000. He had much satisfaction in referring to the handsome increase in the net receipts from the Madras Tramways. It was no less than 33 per cent. over that of last year, and the gross receipts for 1902 so far showed every promise of even a larger increase in the current year. Referring to the Electrical Power Storage Company, the subsidiary company formed to take over the accumulator branch of the old company's business, he stated that that concern had, under the present able management, proved a success, for it held the premier position among electric storage companies. The profits of the Storage Company showed a large increase in the year just ended. The relations between the management and all classes of the employés continued to be thoroughly cordial, and the directors had much satisfaction in recommending the distribution among them of the usual bonus in token of their appreciation of steady and zealous service. The Company's works, plant, and tools were all modern and of the best, and in size capable of turning out the largest machines that may be required. In every respect they had reason to have confidence in the future of the Company.

Sir Henry C. Mance seconded the motion, which was adopted.

ELECTRICAL POWER STORAGE.

The thirteenth ordinary general meeting of the shareholders in this Company was held on 10th inst. at 4, Great Winchester-street, E.C., Mr. J. I. Courtenay, chairman and managing director, presiding.

In moving the adoption of the report, the **Chairman** said the net profit for the past year was £10,913, making with the balance brought forward £11,346. They had transferred £5,000 to reserve and £1,000 to contingent fund, and they recommended a dividend of 5 per cent. on the ordinary shares, leaving £854 to be carried forward. The reserve would now stand at £15,000 and the contingent fund at £5,000. This policy would greatly strengthen the position of the Company. The past year had been an exceptionally prosperous one for the Company. There had been a general increase of business in all directions—orders for lighting and power stations for private installations and for traction purposes all showing an increase over previous years. Their turnover during the past year had been larger than ever before, and they were starting the new financial year with orders ahead to an amount considerably in excess of that of any previous year. Among the contracts at present on hand was one for the Underground Electric Railway Company, of London, Limited, the company which was carrying out the change to electric power on the Underground Railway. They were still continuing their experiments in batteries for electric traction, and although their laboratory had tested a very large number of cells manufactured in this country, on the Continent, and also in America, they had not found anything superior to the cell they were now manufacturing and selling in large quantities to the City and Suburban Electric Carriage Company. For the last two or three years there had been more or less persistent rumours of an accumulator invented by Mr. Edison which would, they were told, revolutionise electric traction. Mr. Edison's own figures, however, did not show that his battery was more than 10 per cent. lighter than the latest type of traction cell manufactured by this Company, while its cost was from two to three times as great. The Company's technical staff thought it would probably be found that Mr. Edison was yet far from making a commercial article of his invention, as the 20 years' experience of the Electrical Power Storage Company showed that there had been no great commercial success resulting from a radical alteration in principle since Faure introduced what was known as the pasted plate.

The report was unanimously adopted.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The half-yearly meeting of the shareholders in this Company was held on Tuesday at the offices, Old Broad-street, Sir Robert G. W. Herbert presiding.

The **Chairman** stated that the interim dividend at the rate of 5 per cent. was available and would be paid. The affairs of the Company and general business were progressing in the usual satisfactory manner. They had had a busy six months, and a great amount of cable had been constructed and shipped. On Saturday last their new ship "Colonia" sailed for Vancouver with 3,500 knots—which was a long stretch of cable—to connect Vancouver and Fanning Island. The "Colonia" was the largest cable ship in the world. The "Anglia" had returned to England, having laid the shorter portions of the line connecting Vancouver with Australia and New Zealand. The Company were hard at work, and were still constructing some portion of the Pacific cable. The entire work would be completed before the expiration of the period in which they undertook to finish it. The whole of the cable connecting Canada with Australia and New Zealand had to be completed before the end of the year, and they would be more than ready with the work when that period arrived. The Company had smaller labours on hand also, such as providing lengths of cable by way of repairs and occasional breakdowns for various companies, and the directors expected that the Company would be well employed until the annual meeting.

CHELMSFORD ELECTRIC LIGHTING.

The report of the directors for the year ending Dec. 31, 1901, states that the net result of the year's working is a profit of £2,890. 8s. 11d., and after adding thereto the balance from 1900, and providing for debenture interest and other charges, there remains an available balance of £2,564. 19s. 8d. At Dec. 31, 1901, the number of lamps connected to the Company's mains was equivalent to 15,417 8-c.p. lamps, an increase of 1,138 lamps during the year. The supply of electricity has been well maintained, and there has been a satisfactory increase in the revenue from the sale of current. The working costs have at the same time been considerably reduced, the principal item of reduction being in coal. Additional shares to the number of 25,122 have been applied for and allotted, and with the proceeds from the same the loan account has been paid off and trade creditors' account has been reduced. Messrs. Crompton and Co., Limited, have removed from the old Arc Works adjoining the Company's generating station at Chelmsford, but the premises have been taken by a firm of motorcar manufacturers, who are driving their machinery by electric power supplied by this Company. The directors propose to set aside a sum of £800 towards the establishment of a renewals fund account, to pay a dividend at the rate of 4 per cent. per annum on the share capital, and to carry the balance (£365. 5s. 8d.) forward.

CITY AND SOUTH LONDON RAILWAY.

The accounts of this Company for the half-year ended June 30 last show a balance, after providing for the debenture stock interest, payment of the dividend on the preference stocks and the transfer to the renewal fund of £2,000, sufficient to allow the payment of a dividend on the consolidated ordinary stock for the half-year at the rate of 3 per cent. per annum, carrying forward a balance of £1,750. The dividend for the corresponding period last year was at the rate of 1¾ per cent. per annum, carrying forward a balance of £733.

APPOINTMENTS VACANT.

Engineer-in-Charge, Willesden Board of Guardians, July 19. See advertisement.

Electrical Engineer, Cleckheaton Urban District Council, £200 per annum. Particulars may be obtained from the chairman, Mr. F. W. Birkett. July 21.

Fitters, Ferranti Limited, Switchworks, Hollinwood, Oldham. See advertisement.

Improver, Stockton-on-Tees Electricity Works. See advertisement.

Assistant Engineer, Portsmouth Corporation Electricity Works, £100, rising by annual increments of £5 to £125, July 23. See advertisement.

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NEW COMPANIES REGISTERED.

British Railway Traffic and Electric Company, Limited.—Capital, £100,000. Objects: to construct and equip light and narrow-gauge railways, etc.

Force Motor Syndicate, Limited.—Capital, £5,000. Objects: to carry on the business of W. A. Taylor and C. E. Warren, motorcar and engine manufacturers, whether propelled by steam, electricity, oil, or other power, builders of rolling-stock, electrical, and general engineers, etc.

English Power Company, Limited.—Capital, £100. Objects: to establish and carry on in the United Kingdom or elsewhere the business of manufacturers of and dealers in all kinds of plant, and in particular plant and machinery used in the creation or application of any motive power, especially compressed heated air, electricity, and heated water, etc.

Bath Electric Tramways, Limited.—Capital, £230,000. Objects: to acquire and turn to account any tramways in or near Bath, to work the same by electricity, steam, or other power; to manufacture and deal in carriages, motorcars, vans, locomotives, accumulators, and dynamos; to adopt an agreement with the E. C. Syndicate, Limited; to manufacture, lay down, and maintain any cables, wires, and lines; and to carry on the business of a tramway, telephone, telegraph, and electric light, heat, and supply company.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Calarasi-Stirbey (Roumania).—The Municipality require tenders for public electric lighting. Tenders by Sept. 3.

Trujillo (Spain).—The Municipality require tenders for public electric lighting for 20 years. Tenders by Aug. 10.

Pontypridd.—The Urban District Council invite tenders for cables and dust destructors. Tenders by July 31. See advertisement.

Barking Town.—The Council invite tenders for construction of tramways in their district. Tenders by July 31. See advertisement.

Rochdale.—The Corporation invite tenders for the supply and delivery at the car depot, Rochdale, Lancs., of three tramcars, complete with trucks, motors, and equipment. Tenders by Aug. 4. See advertisement.

Accrington.—The Electricity Committee invite tenders for one steel Lancashire boiler, and steam and other piping. Specifications, etc., can be obtained from Mr. H. Gray, borough electrical engineer. Tenders by July 21.

Bradford.—The Corporation invite tenders for an installation for electric lighting at the new conditioning house, Canal-road. Specification, etc., may be obtained at the Electricity Department, Town Hall, Bradford. Tenders by 24th inst.

Hendon.—The Urban District Council invite tenders from companies and others for the sale or lease of their provisional order authorising the supply of electricity in the urban district of Hendon. Tenders by July 28. See advertisement.

Anzuaga (Spain).—The Municipality require tenders for lighting the town by electricity for 25 years; 3,500 10-c.p. lamps are required for public lighting. The town authorities will contribute 9,975 pesetas per annum. Tenders by July 27.

Nisch (Servia).—The Municipality invite tenders for electric lighting of the town estimated at 202,132·47 dinars, and for plant estimated at 366,841·75 dinars. Tenders by Aug. 13. Particulars may be obtained on application to above.

Finchley.—The Urban District Council invite tenders for the construction of an electricity generating station. Specifications, etc., can be obtained from Mr. Edward Calvert, chief electrical engineer, 2, Broadway, Finchley, N. Tenders by July 21.

Hapton (Lancs.).—Tenders are invited for lighting Hapton township with electricity from Sept. 1, 1902, to April 30, 1903. Full particulars on application to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, 16, Hammond-terrace, Padiham. Tenders by July 31.

Malvern.—The Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work); engines, alternators, exciters, and switchboard; high and low tension concentric cables; and transformers. Tenders by Aug. 23. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1. The Government also propose to lay a cable between Punta-Arenas and Puerto-Montt.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Stratton St. Margaret (Wilts).—The Swindon and Highworth Board of Guardians invite tenders for a complete installation of electric lighting at their workhouse and infirmary at Stratton St. Margaret, Swindon, Wilts. Tenders by 9 a.m. on 29th inst. See advertisement.

Dublin.—The Lighting Committee invite tenders for the construction of a cast-iron subway under the Grand Canal Dock, near the Victoria Bridge, in connection with the municipal electricity supply undertaking. Specification, etc., may be obtained from the City Engineer. Tenders by July 20.

Farnworth (Lancs.).—The Urban District Council invite tenders for supply of a 400-h.p. enclosed high-speed engine, direct coupled to a 250-kw. lighting and traction generator, together with the necessary extensions to switchboards, pipework, foundations, condensing plant, etc. Tenders by July 31. See advertisement.

Bishop's Stortford.—The Urban District Council invite tenders for lighting such of the public streets as are at present lighted by electricity or otherwise. Tenders, endorsed "Tender for Lighting," to be sent to Mr. Thos. Swatheridge, clerk, Council Offices, North-street, Bishop's Stortford, by 4 p.m. on 22nd inst.

Epsom.—The Urban District Council invite tenders for the supply and erection of semi-marine dry-back boiler, with fittings, etc.; ejector condensers, circulating pumps, and pipework; spray cooling pond; steam, feed, and drain pipes, etc.; and one 150-kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, etc. Tenders by July 18. See advertisement.

Devon.—The Visiting Committee of the Devon County Asylum, Exminster, invite tenders for wiring alterations and additions, 2,000 lamps, booster, dynamo, motors, switchboard, and replacing of a battery of 120 700-ampere-hour cells, etc. Specification, etc., can be obtained from Messrs. O'Gorman and Cozens-Hardy 82, Victoria-street, Westminster. Tenders by July 23.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street works of condensing water pumps, pipe work, tanks; storage feed-water tanks and circulating pipes over workshop. Specifications, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by July 22.

Madrid.—The Public Works Department invite tenders for the extension of electric tramways in the east of Madrid, and also for a new line and working of the same for not more than 60 years. A preliminary deposit of 3,368 pesetas and a final deposit of 16,844 pesetas is required, also the repayment of 3,189 pesetas and interest to the Sociedad del Tranvia del Este for preparation of the scheme. Particulars may be obtained from the above. Tenders by Aug 26.

King William's Town (South Africa).—The King Electric Lighting and Cold Storage Company invite tenders for supply of plant, boilers, wrought-iron smokestack, high speed enclosed engines, single-phase alternator, direct-driven exciters, surface condenser, main switchboard, transformers, copper mains, etc. Specifications, etc., can be obtained from the London agents, Messrs. A. E. Booth and Co., 16, New Union-street, Moorfields, London, E.C. Tenders by Aug. 7.

Selangor (Malay States).—The Crown Agents for the Colonies invite tenders for certain plant and materials in connection with the electricity supply scheme for the town of Koala Lumpur, in the protected native state of Selangor, Federated Malay States: (Contract A, Section 1) supply, delivery, and erection of a generating station, consisting of two 600-h.p. high-pressure turbines, with pipes, two 400-kw. three-phase alternators, switchboard, and sundries. (Section 2) The supply, delivery, and erection of a sub-station plant, consisting of three 150-kw. motor-generators, two balancers, switchboards, and sundries. (Contract B, Section 3) The supply and delivery f.o.b. at a European port of steel poles, cross-arms, insulators, copper wire, &c., for the high-pressure transmission line. (Contract C, Section 4) The supply and delivery f.o.b. at a European port of arc lamps, iron posts, controlling apparatus, incandescent lamps and fittings. Tenders may be sent in for any or all of above three contracts. Specifications, drawings, general conditions, and forms of tender may be obtained from the Crown Agents for the Colonies, Downing-street, London, S.W., on and after 7th inst., on payment of £2 for Contract A, £1 for Contract B, and £1 for Contract C. Sealed tenders, endorsed "Selangor Electric Lighting Contract," and addressed to the Crown Agents for the Colonies, are to be delivered at Downing-street, London, S.W., by 12 noon on Aug. 21. All information regarding above contracts is to be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

RESULTS OF TENDERS.

Morley.—The Town Council have decided to purchase a 12-h.p. motor from Witting Bros.

Cables.—The St. Helens Cable Company, Limited, Warrington, have received an order for their dialite bitumen cables from Maidstone.

Motherwell.—The burgh have given their contract for an 800-h.p. steam set, with Willans engine, to the Lancashire Dynamo and Motor Company.

Tynemouth.—The Corporation have accepted the tender of the Lancashire Dynamo and Motor Company, Limited, for motor for driving condenser.

Premier Incandescent Lamps.—In the new Baltic Sale Rooms there will be an installation of about 3,000 incandescent lamps, all to be of Premier make.

Ealing.—The Town Council have accepted the tender of Siemens Bros. and Co. for jute mains, and that of the British Electric Transformer Company for transformers.

Hawick.—The Town Council have given the contract to the Urban Electric Supply Company to transform the gas into electric lighting in the streets of the town, at £1,070.

Greenwich.—The Borough Council have accepted the tender of Rawlings Bros., of Blackheath, at £282, for wiring and fitting the lecture hall premises for electric light.

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South America.—The Rosario Electric Lighting Company have placed an order for three 360-h.p. Willans engines combined with dynamos by the Allgemeine Elektricitäts-Gesellschaft.

Burton-on-Trent.—Willans and Robinson, Limited, have received an order through the British Thomson-Houston Company for three 180-h.p. engines for supplying power to the tramways.

West Ham.—The Council have accepted the following tenders for two steel chimneys, four fans and engine for induced draught, all brickwork in connection with the flues, and economisers: W. H. Allen, Son, and Co., Bedford, fans and engines, £2,200; Babcock and Wilcox, Oriel House, Farringdon-street, E.C., steel chimneys £1,648, economisers £2,480, brickwork £3,425.

Nuneaton.—The Urban District Council have accepted the following tenders: Callender's Cable and Construction Company, cables for private lighting extension, £818. 7s. 11d.; the same company for joint-boxes and compounds for private and street-lighting cables, £83. 10s; St. Helens Cable Company, cable for street-lighting, £70. 0s. 8d.; British Westinghouse Electric Company, arc lamps, columns, and accessories, £558. 18s.

West Ham.—The Corporation have received the following tenders for the supply of 50 tramcars:

	Reversed staircase.	Ordinary staircase.
Hurst, Nelson, and Co.	£500 10 0	£490 10 0
Witting Bros.	518 0 0	518 0 0
British Westinghouse Company	523 10 0	518 10 0
Dick, Kerr, and Co.	530 0 0	525 0 0
Brush Company	532 0 0	527 0 0
British Westinghouse Company	542 10 0	537 10 0
British Electric Car Company	548 10 0	553 10 0
British Thomson-Houston Company	565 15 0	565 15 0
F. Suter and Co.	605 0 0	605 0 0

Hackney.—The Borough Council have received the following tenders for supply of electric motor for laundry machinery at disinfecting station:

	Direct coupled.	Belt geared.
British Westinghouse Electric Manufacturing Company, Norfolk-street, Strand, W.C. (accepted)	£76 5 0	£72 6 0
Electric Construction Co., Wolverhampton	122 10 0	112 0 0
Electromotors, Limited, 35, Queen Victoria-street, E.C.	76 10 0	87 7 0
J. H. Holmes and Co., Newcastle-on-Tyne	94 0 0	71 0 0
G. N. C. Mann and Co., Norwich	110 5 0	103 5 0
D. Bruce Peebles and Co., Edinburgh	125 0 0	110 0 0
Crompton and Co., Salisbury House, London-wall, E.C.	123 0 0	—
Siemens Bros. and Co., Woolwich	124 0 0	—
Greenwood and Batley, Leeds	97 0 0	86 0 0
Ward Bros., 28A, Basinghall-street, E.C.	83 17 0	84 17 0

London County Council.—The County Council have received the following tenders for the supply, delivery, and erection of steam, exhaust, feed, and other piping, valves, etc., for the temporary electricity generating station to be established by the Council on land adjoining the station of the South London Electric Supply Corporation, near Loughborough Junction:

W. Waterhouse, Limited, Newport†	£2,035 9 4
Sir Hiram Maxim Electrical and Engineering Company, Limited, 65-67, Gracechurch-street (accepted)	2,268 7 0
British Mannesmann Tube Company, Limited, Landore, South Wales	2,473 12 6
Aiton and Co., Willesden Junction	2,500 17 0
Ashton, Frost, and Co., Limited, Blackburn*†	2,600 0 0
Babcock and Wilcox, Limited, Farringdon-street	2,605 10 0
Mechan and Sons, Victoria-street	2,700 0 0
Wenham and Waters, Limited, Croydon*	2,885 12 6
Cowlishaw, Walker, and Co., Limited, Etruria†	2,910 0 0
D. Stewart and Co., Limited, Glasgow	2,945 0 0
Refuse Destructors, Limited, Queen Victoria-street	3,106 10 0
Light and Power Fittings Company, Birmingham	3,421 15 6

*Tenders incomplete. †Not to specification. The accepted firm proposed as sub-contractors A. J. Stewart and Menzies for the steam pipes; Clay, Henriques, and Co., Limited, for the exhaust pipes: J. Hopkinson and Co., Limited, for the steam and feed valves; Hamilton, Woods, and Co., Limited, for the exhaust valves; Suffield and Brown for the expansion joint; Newton and Nicholson for joint rings; Jones and Horsfield for the non-conducting coverings. This arrangement has been agreed to.

BUSINESS NOTES.

TRACTION.

Lowestoft.—The estimate of cost for the main line of tramways proposed is between £60,000 and £70,000.

Auckland (N.Z.).—We learn that the Auckland electric tramways are expected to be open for traffic by August next.

Rothesay.—The Tramways (Extensions) Order Confirmation Bill was read a third time in the House of Lords on Monday.

Newcastle.—In view of the additional car accommodation required, it is decided to erect car-sheds at the west end of the city.

Richmond.—The Town Council have sealed a petition against the Bill of the London United Tramways Company in the House of Lords.

British Electric Traction Co.—An addition has just been made to the Board of the above Company in the person of Mr. W. L. Madgen.

Stalybridge.—During the past month the Stalybridge, Hyde, Mossley, and Dukinfield Tramways Board have obtained loans amounting to £6,000.

Batley.—Mr. F. O. Kirby has been appointed to assist Mr. O. J. Kirby, the borough surveyor, in superintending the work of laying the electric tramways.

Yarmouth.—The Tramways Committee have decided to adjourn until September the question of possible extensions of the electric tramways systems.

Folkestone.—The assent of the Board of Trade to an extension of time for commencing the construction of the proposed tramways until 1903 has been received.

Hindley.—The South Lancashire Tramways Company are in communication with the District Council with reference to the leasing of the tramways to the company.

Smethwick.—The Birmingham and Midland Tramway Company expect to be able to commence the working of the trams by electricity early in the spring of next year.

Bury.—A valuer has been appointed for all the local authorities interested in the acquisition of the undertaking of the Bury, Rochdale, and Oldham Tramways Committee.

Hartlepool.—At Durham Assizes a hairdresser has recovered £250 from the Hartlepools Tramways Company for personal injuries sustained by him through a tramcar accident.

Leeds.—The authorities are making experiments with a view to providing a better tramway service for working-men in the early morning and a better all-round service.

Hove.—At the instance of the Hove Corporation a conference of representatives of the authorities west of Hove interested in the tramways question was held on Wednesday.

Heckmondwike.—The terms of the supply of electric power by the Corporation to the British Electric Traction Company for working their tramways have been provisionally agreed upon.

Birmingham.—The Tramways Committee at a meeting on Tuesday had before them designs of new cars for the electric route on the Dudley-road. No decision was definitely agreed upon.

Douglas.—The revenue from the borough tramways from April 1 to 2nd inst. shows a decrease of £5 on last year, which is considered satisfactory. The expenditure shows a still larger decrease.

Barrow.—The directors of the British Electric Traction Company have decided not to run any 'buses or other means of conveyance on the tramway routes prior to the laying of the electric system.

Newport (Mon.).—We have great pleasure in noting the appointment of Mr. H. Collings Bishop, of Wigan, as borough electrical engineer and tramways manager at Newport at a salary of £500 a year.

Broomhill.—The people of Broomhill have started an agitation in regard to tram fares, stopping places, and other matters affecting the Broomhill and Ranmoor section of the Sheffield Corporation tramways.

Bilston.—Though the Board of Trade order has not yet been received, the British Electric Traction Company have commenced running the electric cars on the new tramways. The Willenhall section also is now open for traffic.

Longton.—A letter has been received by the Town Council from the Potteries Electric Traction Company stating that they hope soon to be in a position to finally decide upon which is the most suitable lifeguard to adopt upon their cars.

Rhondda.—The estimated cost of the construction of the proposed tramways is £170,000, and of the generating station and electrical equipment £135,000. Purchase of land and construction of works will be responsible for another £51,000.

Middlesex.—The County Council will shortly commence the construction of the proposed electric tramway system. Their Finance Committee are providing £1,000,000 for the first part of the scheme. This is exclusive of the cost of generating stations and equipment.

Bath.—Sir Frederick Bramwell has issued his award in the arbitration to decide the price to be paid by the Corporation for the tramway company's undertaking. The award is that the Corporation shall pay the tramway company £5,210 for the existing tramways, and also all costs.

Walsall.—The contractors for the permanent way of the new tramways (Messrs. Wm. Griffiths and Co.) will commence work in a day or two. The Tramways Committee propose to visit Manchester and Liverpool in September next to inspect the tramway systems in those towns.

Bristol.—On Monday evening a well-attended meeting of Longwell Green residents was held, with a view to inducing the Bristol Tramways Company to extend their lines from the Hanham terminus to Longwell Green. A resolution urging the company to do this was carried unanimously.

Hipperholme.—An interview was arranged to take place yesterday between a committee of the District Council and the Halifax Tramways Committee to urge the immediate extension of the tramways from Stump Cross to Hipperholme, and the introduction of electric light into the district.

Southport.—On the ground that the trams on Sundays are used "purely for secular purposes, and fail to render any assistance to the congregations of the churches and chapels in attending Divine service," the directors of the company have decided to considerably curtail the tramway service in Southport on the Sabbath.

Torquay.—The Light Railway Commissioners opened an enquiry on Wednesday into an application by a private company for powers to institute an electric tramway system at Torquay. The application was opposed by the Corporation, who at the present moment are themselves anxious to introduce tramways into the town.

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Greenock.—The new depôt and office of the tramway company are so far completed that these will be occupied this week. The company have at present 34 cars, but there is accommodation in the new depôt for 54 cars, and ample space for the housing of the new motor-cars which may be introduced in Greenock towards the end of the year.

Cardiff.—The Board of Trade have appointed Sir Frederick Bramwell, Bart., F.R.S., referee in the matter of the proposed purchase by the Corporation of the Cardiff District and Penarth Harbour tramways. The Town Council have resolved to secure for trial a single-decked car with smoking compartment at a cost of £600, and also a number of dry seats.

Wolverhampton.—The Examiners of Standing Orders in the House of Commons have had before them a Bill to confirm a provisional order authorising the Corporation to construct a number of new tramways inside the borough. The measure was ordered to be reported to the House for second reading, the promoters having complied with the Standing Orders. The Bill has already passed the House of Lords.

Heywood.—The examiners of Standing Orders in the House of Commons on Friday had before them a Bill confirming a provisional order granted by the Board of Trade to the Heywood Corporation authorising them to construct additional tramways in the borough. The Bill was ordered to be reported to the House for second reading, having complied with Standing Orders and passed all stages in the Lords.

Aberdeen.—The Corporation have obtained the permission of the Board of Trade to run trailers behind the tramcars during this week, when a good deal of extra traffic is expected in consequence of the Highland and Agricultural Society's show. Twelve new cars constructed for the Corporation tramways have been rejected by the Tramways Committee on the ground that they do not satisfy the specifications.

Halifax.—The Tramways Committee have visited Hipperholme, Brighouse, and Greetland districts to consider the applications made to them to extend the Corporation electric tramways to those places. They have decided to defer consideration of the whole question to the next ordinary meeting of the committee. Meanwhile, estimates as to the cost of making these extensions, with calculations as to the probable traffic, are to be prepared.

West Ham.—The Borough Council are reported to have just placed a tender, amounting to £108,900, for the construction and equipment of a system of electric trams for the borough. The southern districts, Plaistow and Canning Town, will be chiefly benefited by the enterprise of the Council. The rails are to be made in England, and it is hoped as far as possible to employ men in the constructional works who reside in the borough.

Tube Breakdown.—On Saturday a breakdown occurred on the Central London Railway. Passengers who arrived at Shepherd's Bush Station after half-past seven found that traffic had been suspended, and thousands had to make the remainder of their journey to the City by omnibus or the Underground Railway. An official statement issued gave the failure of the electric current as the cause of the breakdown. About four hours later traffic was resumed.

Sheffield.—A long discussion took place at the last meeting of the Town Council on the question of depreciation in the tramway accounts. The committee are not in favour of a depreciation fund, being of opinion that it is sufficient to make provision for the payment of interest and sinking fund out of revenue. Ultimately this view was upheld by the Town Council, an amendment in favour of the establishment of a depreciation fund being rejected by 25 to 34 votes.

Glossop.—A letter received by the Town Council from Edmundson's Electricity Corporation, Limited, states that plans for the proposed building of the generating station will be forwarded next week, and when passed by the Corporation the work will be proceeded with at once. The construction of the track will follow very shortly afterwards. The whole of the plant has been ordered some time, and will be ready for delivery when the buildings are completed.

Perth.—A special meeting of the Town Council was summoned for Friday night to consider a resolution to acquire the Perth and District Tramways Committee to sell their undertaking to the Corporation. The meeting was fixed for seven o'clock, but as only 17 members put in an appearance after waiting 15 minutes, being one less than the necessary quorum of two-thirds of the Council, the chairman intimated that he had no alternative but to declare the meeting at an end.

Brockley.—A meeting of the Brockley and District Improvement Committee was held last week to consider the subject of tramways in the district. After a long debate a resolution was passed authorising the preparation of a memorial to the Borough Councils of Deptford and Lewisham, and to the London County Council, in support of the most practicable scheme to be approved by the County Council for the connection by electric trams of New Cross with Sydenham, *vid* the Brockley railway station.

Presentation.—Some of the employés of the Co-operative Wholesale Society, Limited, Longsight, have presented Mr. A. A. Blackburn with a handsome meerschaum pipe in case, together with a framed letter of thanks and photo of his staff, on his leaving the position of electrical engineer at the society's printing works to take up the post of general foreman at the Queen's-road depôt of the Manchester Corporation tramways. The manager, foremen of departments, and office staff have also made him a presentation of a walnut writing table suitably inscribed.

Southampton.—The Tramways Committee on Monday inspected some new apparatus on one of the electric cars with a view to its possible adoption. The first device was an arrangement by which the rope attached to the trolley arm is kept clear of the stairways to the top of the car. The second patent was one which cleans the dirt out of the rails as the car goes along. An iron projection from the bottom of the car goes down between the rails and throws out the accumulated dirt. The third patent was an ingenious contrivance for distributing sand on the rails on steep declines, and so enabling the wheels to bite.

Calcutta.—After a very successful experiment on their Kidderpore section, the Calcutta Tramways Company have extended their electric service to the line running from Kalighat to the corner of Clive-street. This is an important artery, and serves some of the busiest parts of the city. According to *Indian Engineering*, the popularity of the new cars is evidenced by the way in which they are being used by the people, who find their smooth and rapid transit a relief after the spasmodic progress of the old horse traction. A peculiar feature of the Calcutta tramways is that the cars are made up into trains, first and second class cars being attached to each train.

Tramways in Yorkshire.—A Bill confirming provisional orders made by the Board of Trade under the Tramways Act, 1870, has come before the examiner for proof of Standing Orders. The orders authorise the Corporation of Leeds to construct additional tramways, and they empower the West Riding Tramways and Electricity Supply Company, Limited, to construct tramways in the borough of Pontefract, the rural district of Pontefract, and the urban district of Knottingley. The Bill was found to have complied with the further Standing Orders of the House of Commons, and was sent for second reading. It has already passed the House of Lords.

Sunderland.—The returns of the Corporation tramways for the month of June are as follows: receipts from passengers, £5,569. 8s. 8½d.; total mileage, 105,660; total passengers carried, 1,307 828; average number of cars in use, 40. Three of the consignment of new electric cars have been delivered by the contractors. They are of the double-deck type with an enclosed canopy for the protection of the drivers in bad weather, and are built to accommodate 56 passengers. The first annual report of the Tramways Committee shows that the total receipts of the tramways undertaking for the past year amounted to £57,307, and the expenditure £49,565, leaving a net profit of £7,742. Of this, £7,000 has been applied to the relief of the rates.

Exeter.—The City Council have before them a motion that application be made to the Board of Trade for permission to serve upon the Exeter Tramways Company notice of the intention of the Council to purchase their undertaking. The deputation which recently visited several of the large towns in the country and on the Continent where tramways are in operation, have now issued their report. They recommend as a result of their investigation (1) that in the system of tramways to be introduced into Exeter and suburbs, the overhead trolley, because of its economy and greater simplicity, be adopted for all the tramways, with the exception of High-street and Fore-street; (2) that the system of tramways to be adopted in High-street and Fore-street be left an open question for the present.

Liverpool.—The Town Council have decided that the earliest arrangements be made to apply for powers to lay a single line, with crossing places, to connect the "outer belt" line at the corner of Croxteth-road and Lodge-lane with the Aigburth line at the point in Aigburth-road where the old omnibus terminus used to be; or, as an alternative, that powers be applied for to run a double line from Lodge-lane down Aigburth-drive to the Aigburth-road terminus. We understand that the Corporation have agreed to send the general manager of the tramways (Mr. Bellamy), the chairman and deputy-chairman of the Tramways Committee and the chairman of the sub-committee to the United States and Canada for the purpose of inspecting the various tramway systems in operation there.

Shields.—In the House of Commons on Tuesday the North and South Shields Electric Railway Bill was laid on the table for consideration. Notice of motion has been given for the insertion of the following clause: "The company shall provide accommodation for the conveyance of bicycles by all trains, but the company shall not be required to convey a greater number of bicycles than six in any train." When the Bill was before the Committee of the House of Lords the Cyclists' Touring Club endeavoured to get similar provisions inserted in the Bill, but were refused a hearing, and the Court of Referees refused to give the club a *locus standi* to appear before the Committee of the House of Commons which considered the Bill. The consideration of the amendment was postponed until next week.

Dunedin (N.Z.).—The city tramways engineer (Mr. W. R. Wright) has considered the question of tramway extension to Wadestown and the neighbourhood, and sent a report to the Onslow Borough Council on the subject. Mr. Wright suggests that the best way of serving the district will be to have a cable way meeting the city trams at the boundary and hauling them up the steepest grades, and then along the highway when necessary, doing away with the necessity of transhipping passengers, who could thus be carried direct from Wadestown and district to any part of the city. The engineer indicates three possible routes, but recommends the adoption of one proceeding to the junction of the Porirua-road, deviating this a little so as to meet the main road on the city side of the Grange House in the Rhodes Estate.—*New Zealand Mining Journal.*

Plymouth.—On the past year's working of the tramways there was a loss of about £1,000. At the last meeting of the Town Council the chairman of the committee gave some explanation of this. There had been an increase in the cost of current from 2·3d. per unit to 3d.; for the permanent way and overhead equipment there had been an increase of £1,100; rent had increased £136; and proportion of salaries of corporate officers £92. These were only some of the items. The receipts, however, for the week ending July 12 were more than £100 over the corresponding week last year, and the receipts for the 13 weeks from March to July showed a total increase of £131. 17s. 6d. The bad weather in May and June was responsible for a great deal of loss. It was hoped that the remainder of the summer would be very fine that there would be a tolerable autumn, and that as a result the receipts would considerably increase.

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Darlington.—The Board of Trade have forwarded to the town clerk the completed order authorising the construction of electric tramways by the Corporation, and a special meeting of the Town Council is summoned to deal with the matter and to take steps towards the obtaining of tenders for the construction of the lines, etc. It will be remembered that out of several schemes placed before them by Prof. Kennedy, the Tramways Committee decided upon one comprising rather more than 5½ miles of tramways—part single and part double—the estimated cost of which is a little over £90,000. They also recommended, and the Council agreed, to borrow £100,000 for this purpose. The order as now granted contains a clause deferring the commencement of the repayment of the loan for a period of two years from the date of the order.

Tooting.—The Wandsworth Borough Council have resolved that the attention of the London County Council should be called to the very dilatory way in which the work of reconstructing the tramways from Clapham to Tooting was being carried on. It was decided to inform the County Council that serious loss and inconvenience was caused to ratepayers in the borough and other users of the road owing to the manner in which the work was being proceeded with, and that the County Council should be urged to considerably expedite the work by arranging for the employment of at least double shifts of men. It was also decided that the County Council should be informed that the present method of running the tramcars on temporary lines was a source of danger and injury to the horses and vehicles of the public using the road, and required immediate improvement.

Barcelona.—The Barcelona Tramways Company, Limited are offering for subscription at 93 per cent. £51,900 4½ per cent. redeemable debenture stock, being the unissued balance of the £200,000 authorised issue. During the year there have been negotiations with a view to the purchase of the company's undertaking, but as there is no immediate prospect of the negotiations coming to a speedy conclusion, the directors have decided to make the present issue. A sale may take place, and one result of a sale would be the redemption of the whole of the debenture stock at £105, or a difference of £6,228 between the issue and redemption price upon the £51,900 now offered. This difference would represent a loss of 6s. 2¾d. per share to the ordinary shareholders when the assets of the company came to be distributed. To compensate for this contingency a preference on allotment of the above issue will be given to the ordinary shareholders.

Battersea.—The Borough Council have received a letter from the London County Council stating that the Improvements Committee have under consideration the suggested widening of Battersea Bridge-road in connection with the proposal to construct a tramway from Battersea Park-road to Chelsea Bridge, *viâ* Battersea Bridge and Chelsea-embankment, and that the estimated cost of acquiring the necessary property and executing paving works in Battersea, excluding the cost of laying down and paving the tramway track, is £32,600. The London County Council have already powers to construct a tramway in Albert Bridge-road, and the Highways Committee of the Battersea Borough Council are of opinion that it is hardly necessary to construct a tramway in Battersea Bridge-road also, and they recommend that the London County Council should be so informed, and should be requested to proceed with the Albert Bridge-road tramway only.

Pontypridd.—A Bill confirming a provisional order made by the Board of Trade authorising the Urban District Council to construct additional tramways in their district has come before the examiner. It was found that the Bill had duly complied with the further Standing Orders of the House of Commons, and was sent for second reading. The Bill has already passed the House of Lords. At a meeting of the Ratepayers' Association last week a resolution was proposed protesting against the District Council proceeding further with their electric tramway scheme on the ground that the tramways could not be constructed and maintained except at a great loss to the already overburdened ratepayers. In the course of the discussion several speakers supported the Council proceeding with the scheme, though that authority was generally condemned because they had not consulted the ratepayers upon such an important matter. Eventually the question was adjourned for further consideration.

New Issue.—The Bath Electric Tramways, Limited, has been formed with a capital of £230,000, divided into 75,000 5 per cent. cumulative preference shares of £1 each, 125,000 preferred ordinary shares of £1 each, and 30,000 deferred ordinary shares of £1 each, for the purpose of constructing (and operating either direct or by means of the ownership of shares) a complete system of electrical tramways and light railways (with extensions), and also undertaking other electrical business in the city of Bath and the surrounding district. An issue at par is now being made of the whole of the preference shares and 100,000 preferred ordinary shares of £1 each. The subscription of shares to the extent of £135,000 (which is the minimum subscription) having been guaranteed, the directors will proceed to allotment as soon as the lists are closed; 25,000 preferred ordinary shares are reserved for future issue if required. The whole of the deferred ordinary shares are to be issued as fully paid, in terms of the contract mentioned in the prospectus.

Jarrow.—The first report of the Electric Light and Tramways Committee, just issued, states that, regarding the mode of constructing the tramways, the committee have directed the town clerk to forward to the British Electric Traction Company a copy of the Corporation's proposals recently submitted to the Board of Trade. Plans showing the lines had been considered, but as these are not sufficiently clear, the committee recommend that formal notice of objection be given to the company and to the Board of Trade. They suggest that the attention of the company be called to the awkward corner in Commercial-road, at the junction of Buddle-street and Staple-road, and that they be requested to take down the property scheduled for the purposes of improvement; and, further, that it be pointed out that the curves shown from Commercial-road to High-street are not in accordance with the deposited plans. They also recommend that the company be asked to place the poles in such position that they will not obstruct the way into any premises on the route, and that the company take all risk and liability in connection therewith. They further request that the permission of the company be granted for the Corporation to use the poles for purposes of street-lighting.

Mexborough.—The Court of Referees of the House of Commons this week sat to consider the petition of the Corporation of Rotherham to be heard by counsel against the Mexborough and Swinton Tramways Bill. Mr. H. Lloyd said two competitive Bills were promoted in 1900, the one by the Rotherham Corporation and the other by the Rawmarsh Urban District Council, for the construction of a through route through those places. By an arrangement come to each party was to construct their own tramways to the boundary, and thus Rotherham would construct their trams over three-fourths of the length of Rawmarsh Bridge, and Rawmarsh would construct theirs over one-fourth of the bridge, so as to join with the Rotherham tramways and complete the through route. The bridge was to be rebuilt at a cost of £12,000, of which Rotherham would have to pay £9,000 as the cost of their three-fourths. The present Bill enabled the Mexborough Company to take over the powers of the Rawmarsh Council, and the clause enabling the Corporation to agree upon running powers having been struck out in the other House the Corporation of Rotherham would be put to the expense of £9,000 without obtaining the desired through route. They, therefore, asked to be permitted to appear before the Select Committee to which the Bill was remitted, and argue that if they spent this £9,000 they should be empowered to make agreements with the new company. Mr. Wedderburn, K.C., for the promoters, contended that although the Corporation had under the Bill as brought in a power to agree, no agreements had really been arrived at and the Corporation had no vested rights. He was willing, nevertheless, that the Corporation should have a clause giving them the power to agree. The Court eventually granted a *locus standi* to the Corporation. On Tuesday the Bill came before the Select Committee of the House of Commons of which Mr. Ashton is chairman, and after a short enquiry the preamble was declared proved.

Huddersfield.—Major Druitt, of the Board of Trade, on Saturday held an enquiry into the recent tramway accident, which resulted in the loss of three lives and personal injuries to a number of passengers. The witnesses included the driver of the car, who repeated the evidence given by him at the coroner's enquiry on Friday. He emphasised what he had previously said, that he had received no instructions about reversing the motor to brake the car until after the accident. He had had trouble with the hand brake, but not with the electric brake. He had not turned either of them the wrong way. An official inspection of the car was made by the inspector at the Great Northern-street shed, and its brake fittings were examined by experts, after which the car was driven out into Ray-street and the hand and electric brakes were tested and found to work satisfactorily. On the enquiry being resumed, Mr. H. N. Thomas, the tramway manager, said the car had been under lock and key since the accident, and had not been interfered with. He considered that at the time of the accident the car was in perfect order. Mr. F. W. Taylor, electrical engineer, Golcar, who had made an expert examination, said he found the controller perfect in every way. The connections were good, and the brushes making contact. He had looked at all the vital parts which would have a tendency to cause failure, but could not find anything wrong in them. One in eighteen was the steepest gradient on the Almondbury route, and he judged that the electric brake alone should have pulled the car up on a much steeper gradient. The Inspector: Even with a speed of 12 miles an hour?—Yes; I should say at 18 miles an hour, any way. Mr. John W. Wainwright, engineer to the British Electric Car Company, Manchester, said the company were the contractors for the complete car. He had examined the car, and was perfectly satisfied that the electric apparatus was perfect. The enquiry closed. On Wednesday we received a memorandum from Mr. H. N. Thomas, the tramway manager, stating that at the time of the enquiry Major Druitt thoroughly tested the car without it having been interfered with, and the brakes were found to be in perfect order. The car was driven at full speed and pulled up by both the hand and electric brakes. The inspector then got off the car and expressed himself satisfied. Another run for the benefit of the members of the Press was afterwards made, and the trolley was taken off the wire to show that the electric brake would operate without the trolley being on the wire. This also brought the car up satisfactorily.

London County Council.—At the usual weekly meeting of the County Council on Tuesday the Highways Committee presented a report on the South London Tramways Company's undertaking. The report stated that negotiations have been proceeding for the acquisition by the Council of the whole of the company's undertaking, with the result that the directors of the company have stated that they are prepared to recommend the shareholders to accept the sum of £198,500 for the lines and depôts, including goodwill in respect of the parts of the undertaking not yet purchasable under Section 43, and £2,650 as compensation to directors and officials, making a total of £201,150. The committee accordingly recommended (*a*) that the estimate of £205,000 on capital account submitted by the Finance Committee be approved, and that the Council do enter into an agreement with the South London Tramways Company for the purchase by, and transfer to, the Council on Nov. 1, 1902, of the whole of the company's undertaking; (*b*) that the Highways Committee be authorised to settle the precise terms of the agreement to give effect to the above resolution, and that the seal of the Council be affixed to the said agreement when ready. Another report from the same committee stated that the estimated cost of the special type of cars required for the Streatham lines of the Council's system is £59,000, and they recommended that this estimate be approved, and that the committee

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be authorised to issue an advertisement inviting tenders for the electrical cars. As already stated in these columns a week or two ago, it has been decided to have single-truck cars for these lines on account of the steep gradient of Streatham-hill. The Highways Committee presented another report, in which they recommended (*a*) that the expenditure on capital account of a sum not exceeding £30,000 be approved in respect of the first portion of the building and other works in connection with the car-shed accommodation to be provided on the site of the Clapham depôt of the London County Council tramways and land adjoining; (*b*) that the Works Committee be authorised to carry out the work specified in the above resolution, and to charge the tramways account with the actual amount expended in the execution thereof, together with the necessary proportion of establishment and other expenses. They further recommended that the expenditure on capital account be authorised of a sum not exceeding £3,500 in respect of fuel economisers required for the electricity generating station to be established by the Council at Greenwich, and that an advertisement be issued inviting tenders for the supply of such fuel economisers. As will be seen from our "Tenders" columns, the tender of the Sir Hiram Maxim Electrical Company has been accepted for the supply, delivery, and erection, for the sum of £2,268. 7s., of the steam, exhaust, feed, and other piping, valves, etc., required in connection with the temporary electricity generating station to be established by the Council at Loughborough Junction. The company are to be allowed to sublet parts of the work included in the contract as follows: to Messrs. A. J. Stewart and Menzies the steam-pipes, to Messrs. Clay, Henriques, and Co., Limited, the exhaust pipes, to Messrs. J. Hopkinson and Co., Limited, the steam and feed valves, to Messrs. Hamilton, Woods, and Co., Limited, the exhaust valves, to Messrs. Suffield and Brown the expansion joint, to Messrs. Newton and Nicholson the joint rings, and to Messrs. Jones and Horsfield the non-conducting material. With regard to the reconstruction of further portions of the Council's tramways to electrical traction, the Highways Committee reported that they think it desirable that steps should now be taken for the reconstruction of the tramways between New Cross and Greenwich, the length of these lines being equal to about five miles of single track. As regards the bridges specified, the Committee have consulted the Bridges Committee, and, with their concurrence, they propose that they should be authorised to arrange for the alterations of the bridges to be carried out as soon as the necessary arrangements can be made, so that the bridges may be ready when the reconstruction of the lines is about to be commenced. The estimates, approved by the Council on Jan. 28, in respect of the 19¼ miles provide for sufficient machinery to drive the cars for the remaining five miles; and they propose to submit at a later date estimates to cover the cost of the car-shed accommodation required in connection with this and other portions of the tramways. The committee have had estimates before them, from which it appears that the total amount which will probably be required for the reconstruction for electrical traction of the tramways above specified is £114,000, which may be roughly divided under two heads—namely: (*a*) alterations to and reconstruction of bridges, £9,000, repayment of which might be spread over the full term of 60 years; and (*b*) lines and rolling-stock, £105,000, to be repaid in 25 years. They recommended that the estimates of £9,000 and £105,000 be approved, and that the expenditure on capital account of sums not exceeding those amounts be authorised in respect of the above-mentioned works.

LIGHTING AND GENERAL.

Bedford.—A further loan of £8,000 is to be obtained for electric light purposes.

Lincoln.—The judges' lodgings have been fitted with electric light at a cost of £116.

North Metropolitan Electric Power Supply Bill.—This Bill has been read a third time in the House of Lords.

Stonehaven.—Messrs. Barlow and Young, London, will shortly lay before the Town Council an electric lighting scheme.

Fulham.—The London County Council have agreed to lend the Fulham Borough Council £25,000 for electric light installation.

Renfrew.—The Town Council intend to oppose the Electrical Supply Corporation's application for an electric lighting provisional order.

Newcastle.—A report is being prepared on the lighting by electricity of Corporation properties, etc., such as the markets and the lower part of the quayside.

Change of Telephone Number.—Mr. A. P. Lundberg, Liverpool-road, informs us that his telephone number has been changed to 1,746 North (National).

Kensington.—Forty-eight of the new electric arc lamps in the borough are now in lighting, and 40 further lamps will come into lighting during this week.

Berwick.—Edmundsons, Limited, propose to start work on the electric light installation during the present year. The Corporation are pressing for a definite date.

Falmouth.—The Town Council are considering a draft agreement with Messrs. Crompton and Co., Limited, embodying their offer for the electric lighting of the borough.

Cupar.—The Fife and Kinross Asylum Board have decided to instruct the architect, Mr. James Gillespie, St. Andrews, to have the electric light installed in their building.

Scunthorpe.—The Urban District Council have resolved to oppose an application for power to supply electricity, it being their intention to apply for a provisional order themselves.

Crompton and Co.—The directors have decided, subject to audit, to recommend the payment of a dividend at the rate of 6 per cent. per annum for the half-year ended March 31 last.

Brierfield.—We understand that the Nelson Town Council are prepared to supply the District Council with electric current for illuminating purposes at 2d. per Board of Trade unit.

Nantwich.—An enquiry is to be held into the Council's application for sanction to borrow £12,505 for the purposes of electric lighting, and £1,275 for the provision of a refuse destructor.

Eastern Telegraph Co.—Payment is announced, on the 23rd inst., of a further dividend of 1½ per cent. and a bonus of 2 per cent., making 7 per cent. for the year ended March 31 last.

"Feilden's Magazine."—We note that Mr. J. T. V. Feilden has resigned his position as editor of *Feilden's Magazine* and managing director of the Feilden Publishing Company, Limited.

Bray.—The Urban District Council's new electric light station is now ready. An enquiry will be held on the 22nd inst. into an application for a loan of £7,000 for the electric light works.

Burton.—The electric light returns for the last month give the quantity of electric current sold as 10,119 units, showing an increase of 4,155 units in the corresponding month of last year.

Eastern Extension, Australasia, and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share, free of income tax, payable on the 15th inst.

Beverley.—The Town Council have obtained sanction to the borrowing of £14,784 for electric lighting, and to the application of the land near the railway station for the purpose of erecting the working plant.

Redbourn.—The Parish Council have instructed their clerk to make enquiries of the authorities who control the nearest telephone wires with the object of procuring the use of the telephone for the parish in case of emergency.

Brandon.—The Urban District Council's Electric Lighting Committee are considering the electric lighting at New Brancepeth. There are at present 16 oil lamps, and they propose to put in 20 electric lamps, and so bring the light further down the bank.

Taunton.—It appears that there has been a number of breakdowns in the Haine's Hill district owing to the cable being too small for the number of houses. The Electric Lighting Committee will, however, at the earliest convenience remedy the defect.

Dartmouth.—Messrs. Callender and Co. are busily engaged laying the electric light cables on their solid system in wooden troughs. Three single cables are being laid for private lighting, and the public cable, which is armoured, runs along by the side of the trough.

St. James's and Pall Mall Electric Light Co.—The directors have declared the following interim dividends for the half-year ended June 30: at the rate of 7 per cent. per annum on the preference shares, and at the rate of 10 per cent. per annum on the ordinary shares.

Hebburn.—The District Council intend to apply to the Board of Trade in conformity with a request by the Northern Counties Electrical Supply Company for permission to use a high-pressure electric system in order that the Felling district might be supplied from Hebburn.

Swansea.—The plans of the proposed telephone exchange have been approved. The Telephone Committee do not intend to proceed at once with the whole of the proposed building on the site in Pier-street. We understand that the lighting of the free library by electricity has been agreed upon.

Heston and Isleworth.—The Electric Lighting Committee of the District Council are about to visit Ealing and other places where dust destruction is combined with electric lighting. It is thought probable that an attempt will be made to upset the former decision of the Council to lease their provisional order.

Victoria.—The municipality of Melbourne took over the electric lighting of the city and suburbs towards the end of 1899. The loss to the city on its electric supply for the year ended Feb. 28 last was £8,710. 11s., which appears to have been occasioned by causes which will no doubt be remedied in the near future.

Direct United States Cable Co.—The Board recommend a final dividend of 3s. per share and a bonus of 1s. per share, both tax free, payable on and after the 31st inst., making a total distribution of 3½ per cent. for the year ended June 30; £5,000 is placed to reserve fund account, and about £2,196 is carried forward.

Morley.—Mr. H. Drewett, the borough electrical engineer, in his last report states that the output from the electricity works during the four weeks ending June 14 was 4,143 units, as compared with 2,678 units for the corresponding period last year, being an increase of 1,465. The lamps connected to date numbered 8,397.

Cardiff.—A new system of street-lighting has been proposed, by which the tramway overhead wire poles will be utilised so as to reduce the number of standards in the streets. The electricity department has made a clear profit of £1,200 in the last 12 months, irrespective of £600 devoted to lightening the rates.

Yorkshire College, Leeds.—The next session's day and evening classes in the electrical engineering department begin Oct. 6. Prospectus, giving information as to lecture and laboratory courses, with particulars of the equipment of the department, which has recently been further extended, may be had from the registrar.

Rochester.—The Provincial Electric Supply and Traction Company, the Kent Electric Power Company, and the Kent Electric Power Syndicate, Limited, intend to apply to the Board of Trade on or before Dec. 21 for a provisional order authorising the supply of electricity for public and private purposes within the area of the city.

Cheltenham.—There is some difficulty in extending the electric light to Cleve Hill, owing to the action of the Parish Council of Prestbury, through which the mains would have to pass. It appears

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that unless the original agreement with the Parish Council is adopted, the proposals for extension in that direction will have to be abandoned.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and grant a quotation to Willans and Robinson's 4 per cent. first mortgage debenture stock, and a further issue of 4 per cent. first debenture stock in lieu of the 4½ per cent. first mortgage debenture stock now quoted.

Weymouth.—The Council have approved of the scheme for electric lighting submitted by Messrs. Kennedy and Jenkin, and of the estimate of £44,800, and have instructed the engineers to prepare the necessary drawing and estimate to be sent to the Local Government Board with the application for power to borrow the money for carrying out the works.

Illuminations.—Last week Brighton and Hove illuminated in joy at the King's rapid progress towards complete recovery. In Brighton alone over 100,000 incandescent lamps were used on the public buildings and enclosures, and Hove sea-wall presented a brilliant spectacle. The grounds and buildings will be further illuminated when the Coronation actually takes place.

Newport (Mon.).—The Council have adopted a report dealing with the proposal to provide for a third unit of 500 kw. at the new power station, thus providing for 1,500 kw. in all. The estimate of the cost of the machinery, plant., etc., for producing the third unit is £17,933. 11s., and the Electricity Committee have been authorised to accept tenders for supplying the same.

Ashton-under-Lyne.—The price for electrical energy supplied to private consumers has been reduced from 4½d. to 4d. per unit, with the alternative of paying 1s. per 8-c.p. lamp fixed per quarter, and in addition 1½d. per unit consumed; current for power purposes will be supplied at from 3d. to 1½d. per unit; applications for extensive use of power are to be dealt with as they arise by the committee.

Mexborough.—The Urban District Council intend to apply for a loan of £2,500 to cover cost of distributing mains in several streets and a 100-kw. engine and dynamo. The Council are supplying already 1,598 8-c.p. lights for private consumers and 1,250 8-c.p. lights for public lighting, a total of 2,840, or within 160 of the full complement. Fresh applications for current are being received almost daily.

Basingstoke.—The United Electric Light and Power Company propose to apply for a provisional order to supply electricity within the Town Council's area. At present, however, it is the intention of the Council to carry out the work themselves, and they have asked Mr. Wilson, the electrical engineer who prepared the scheme for the Council, to have an interview with the Council in committee with the view to action being taken as early as possible.

Frome.—The Urban District Council intend to apply for sanction to the borrowing of such a sum as may be necessary for the installation of works for the supply of electricity for power and lighting purposes within the Frome urban sanitary district. Mr. F. H. Medhurst has been engaged as consulting engineer. A deputation is conferring with an electrical company, who propose to carry the scheme through on the seven, fourteen, or twenty-five years' system.

Ayr.—The burgh electrical engineer, in his last report, states that during the month the whole of the works have run satisfactorily. The following statistics are also given: number of consumers as per last report, 552; number of consumers connected during month, 14—total 566; number of lamps connected as per last report, 23,116; number of lamps connected during month, 262—total, 23,378; units generated as per last report, 44,887; units generated during month, 56,979—total, 101,866.

London Gazette.—The partnership existing between A. H. C. Gibson, E. G. Miles, and Ada Gibson (trading as Hugh Gibson and Co.), electric light and power contractors, 14, Temple-street, Birmingham, has been dissolved by mutual consent. The estates of A. J. Greenberg (trading as the Midland Electrical Company), electrical engineer, 30, Arthur-road, Erdington, Birmingham, and G. F. Cook (trading as G. F. Cook and Co.), Lightcliffe, Yorkshire, have been released from trusteeship.

Bridgwater.—The Bridgwater and District Electric Supply and Traction Company, Limited, intend to apply to the Board of Trade for a provisional order under the Electric Lighting Acts to enable the company to supply electrical energy for public and private purposes within the borough of Bridgwater, and the several parishes of Bridgwater Without, Durleigh, and Wembdon, over which areas the Bridgwater Town Council and the Bridgwater Rural District Council have jurisdiction and control.

Lowestoft.—The Town Council intend to apply to the Board of Trade during the next session of Parliament for a provisional order authorising them to supply electricity for any public or private purposes to the following parishes within the rural district of Mutford and Lothingland: Hopton, Lound, Ashby, Belton, Fritton, Herringfleet, Blundeston, Corton, Flixton, Somerleyton, Oulton, Carlton, Colville, Pakefield, Gisleham, Mutford, Barnby, Kessingland, Rushmere, Bradwell, and Gunton.

New Firms.—We are informed that Mr. Philip Dawson, M.I.E.E., is joining the firm of Kincaid, Waller, and Manville, 29, Great George-street, Westminster, and that the firm will henceforth be known by the title of Kincaid, Waller, Manville, and Dawson.—The Newton Electrical Works, Limited, electrical and mechanical engineers, Taunton, have purchased the gas and oil engine business lately carried on by Messrs. Allen and Barker. We understand that Mr. Barker and portion of the old staff and hands have joined the new firm.

Ashton.—Two new engines of 250 h.p. have been installed, which will enable the electricity department to save both in coal and water when a light load is on the system. The price of the current to private users is to be reduced from 4½d. to 4d. per unit, with an alternative contract, the terms of which require the payment of 1s. per quarter per 8-c.p. lamp and 1½d. per unit on current consumed. The cost of the current for motive power is to be reduced from 3d. to 1½d. per unit, with special terms for users of power on a large scale.

Catalogue.—We have received a new price-list from Mr. G. Braulik, 217 and 218, Upper Thames-street, London, E.C., illustrative of direct-current generators, fan motors, etc., and we are glad to note that the efforts of this firm to introduce and push arc lamps of first-class English manufacture, in preference to those of Continental make, are meeting with the success they deserve. Showrooms have been fitted up and supplied with current in order to convince the British public that they need not go to the Continent for a reasonably priced arc lamp.

Truro.—The City Council are prepared to receive proposals for the electric lighting of the city on or before the 31st inst. The Council have informed Messrs. Deacon and Co., the United Electric Light and Power Company, and the Provincial Electric Supply and Traction Company, who proposed to apply for a provisional electric supply order within the Council's area, that the Council have already an electric lighting order for the city, and will be glad to receive suggestions from any firm relative to an electrical lighting installation.

Penzance.—The Provincial Electric Supply and Traction Company and the United Electric Light and Power Company intend to apply for a provisional order authorising the supply of electricity for public and private purposes as defined by the Electric Lighting Acts of 1882 to 1889, within the area of Penzance. The Cornwall Electric Power Syndicate, Limited, have submitted a draft agreement indicating the basis upon which they would be prepared to supply electricity in bulk for all purposes that it may be required for in the area controlled by the Town Council.

Islington.—At the meeting to-night the Finance Committee will recommend that in the event of the London County Council sanctioning the borrowing of £8,630 for electric lighting purposes for a period of 42 years, the Islington Borough Council will undertake that during the currency of the loan no further loans will be raised to replace any of the plant and machinery, the cost of which is to be defrayed out of such loan, and that any renewals required during the period thereof shall be provided out of a sinking fund to be created for the purpose or from maintenance account.

Hull Telephones.—The *Eastern Morning News* is officially informed that at the recent interview between the Postmaster-General and representatives of the Hull Corporation and the National Telephone Company, a long discussion took place with respect to the wayleaves and agreements between the Corporation and the company. After hearing both sides the Postmaster-General told the Corporation representatives that he would grant them their license immediately. He added that he hoped the differences between the Corporation and the company would be settled amicably.

National Telephone Co.—The directors have resolved to recommend at the forthcoming meeting the following dividends for the half-year ended June 30 last: at the rate of 6 per cent. per annum on the first and second preference shares; at the rate of 5 per cent. per annum on the third preference shares; at the rate of 6 per cent. per annum on the preferred stock; and at the rate of 4 per cent. per annum on the deferred stock, being equivalent to 5 per cent. per annum on the ordinary shares, now divided into preferred and deferred stocks; carrying £70,000 to reserve and about £8,000 forward.

Wolverhampton.—The abstract accounts of the electric light undertaking for the year show a profit of £507 on the last year's working, as compared with a loss of £130 in the previous year. During the year the price of electricity has been reduced from about 4·31d. to 4·18d.; £8,209 has been placed to the loans fund in reduction of their liabilities. The total amount paid off is £11,920. The output has been increased, but the coal bill was £400 lower than the one for the previous year. The revenue account shows a gross profit of £6,444. Of that there has been paid in interest to sinking fund £5,937. There is now £1,195. 5s. 8d. to the credit of the revenue account.

Illuminated Canadian Arch.—Upon two recent occasions the London public were delighted to see at the Canadian Arch, Whitehall, a very brilliant illumination executed chiefly with Nernst lamps. All the graceful and prominent lines of the arch were covered with these lamps, each giving a very brilliant and dazzling white light of 160 c.p. to 180 c.p.; the total number of lamps exceeded 350. We are informed that notwithstanding this immense mass of light of about 60,000 candles the current consumed was exceedingly low, as each lamp did not consume more than one ampere on a 200-volt circuit, thus the average power required per candle was about 1·5 watts, showing a great saving indeed. The arch was further illuminated with 24 arc lamps, each of about 1,000 c.p., eight of which were provided with red-coloured globes, and also 750 small incandescent lamps of about 5 c.p., which were fitted on the lettering. All the different colours and shades of the various kinds of lamps gave an exceedingly pretty and effective result. Although the municipality had, in the first instance, great fear of permitting illumination of this very inflammable structure which was standing between buildings containing very valuable property, there was not the slightest accident, owing to the far-reaching precautions that the Electrical Company, Limited, London, had taken to prevent any mishap. This company at the present time is in communication with several electrical supply corporations with a view to supplying these Nernst lamps for street-lighting purposes.

Kirkintilloch.—The Landlords' and Factors' Association are discussing the question of the Glasgow Corporation telephone department breaking up the foot pavements for the purpose of laying underground wires, as they are not satisfied as to the legality of the Town

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Council's acquiescence, and what that involved in the matter of ownership and upkeep. A committee has been appointed to consider whether the Council should take advantage of the clause in the Clyde Valley Electric Power Bill to apply for a provisional order to become the distributors of electricity within the burgh.

Longton.—The price of electricity to places of worship has been fixed at 4½d. per unit. A requisition from six firms of china manufacturers outside the compulsory area requiring the laying down of distributing mains is under consideration. The accounts for the half-year on the electric light station show a working profit of £382; the interest on capital was £357. 4s. 4d., and the proportion of sinking fund £274. 5s. 6d.; leaving a deficiency of £249. 2s. 5d. To this must be added the accumulations of interest previous to the starting of the station, amounting to £177. 9s. 3d., making the balance to carry forward £426. 11s. 8d.

Hollingbourne.—The clerk reported at the last meeting of the Rural District Council that the Corporation of Maidstone had laid their electric light mains in the parish of Boxley—*i.e.*, in the Sittingbourne-road—and the provisional order obtained by that body did not allow them to do that. He had, therefore, written to the town clerk asking him what powers they had for doing this. The town clerk replied that the light was laid for a few feet (the clerk said that it was 150 yards), and the surveyor said that the Sittingbourne-road was a main road and repaired by the Borough Council, the money being refunded by the County Council, and that the mains were laid on the Boxley side of the road for convenience sake. It was decided that the action of the Maidstone Council should not be objected to.

Telephone Exchange Fire.—The damage done by the fire at the London-wall headquarters of the National Telephone Company (reported in our last issue) is estimated at about £30,000. Over 3,000 subscribers were absolutely cut off, and steps were at once taken for providing a new exchange, certain rooms, generally used as offices, being used for the purpose. The following circular has been received by subscribers: "The National Telephone Company regret to inform their subscribers that their exchange at London-wall was totally destroyed by fire last night. Owing to the extremely complex nature of the apparatus it must necessarily be some considerable time before the exchange is in full working order. Arrangements have, however, been made for the opening of a temporary exchange, and a very large staff are already employed upon this work. The company trust to receive the indulgence of their subscribers till the re-erection of the permanent apparatus. As both outside and inside plant have been destroyed, it is impossible to state how soon the service may be restored. The company, however, hope that a considerable number of subscribers will be connected within the next few days.—WM. E. L. GAINE, general manager."

City of London.—At last week's meeting of the Court of Common Council at the Guildhall it was resolved to instruct the several committees of the Corporation to afford every facility to the Post Office in introducing the telephone service in the departments under their respective control. It was also decided that the proposed charge of £1 per annum for each attachment in the Central Markets be not insisted on. Mr. A. A. Voysey, in his annual report, says there are distinct evidences that a genuine competition is at present controlling the price of electric energy in the City. He considers it an advantage that both the companies which supply the City have now the right to use the higher pressure, because the consequent decreased size of mains will result in less interference with the surface of the streets. In 1895 the charge to consumers was 7·56, while last year it stood at 4·45. The number of consumers supplied on Dec. 31, 1894, was 2,740, and on Dec. 31, 1901, 10,618. In 1894 135,460 8-c.p. lamps were connected, while in 1901 the number was 549,175. In that year 11,526,951 Board of Trade units were sold, as against 11,272,968 in 1900. The total number of public arc lamps increased from 493 on Dec. 31, 1897, to 508 in 1901. The police reported 1,306 failures and Mr. Voysey 160 in 1897, whilst in 1901 144 were reported by the former and 133 by the latter.

Personal.—Another name has to be added to the list of consulting electrical engineers practising in this country, Mr. A. Venning having opened an office at Sanctuary House, Tothill-street, Westminster, S.W. We may here state that Mr. Venning is an engineer who has had large experience both in this country and the United States, being well known on both side of the Atlantic. After completing his articles with a firm of mining engineers in the West of England, he joined the engineering staff of Bolckow, Vaughan, and Co., Middlesbrough, and in 1882 was engaged by Messrs. Crawshay Bros. during the reconstruction of their works in South Wales. Leaving them in 1889, he next went to America and was engaged by the Edison Company in their central-station department, and in 1893 was appointed assistant mechanical engineer of the World's Fair, Chicago. Shortly after the close of the Exposition he joined a leading firm of consulting engineers in that city who were engaged on the design and construction of several large electrical installations, and in 1897 accepted an offer from the British Thomson-Houston Company to take charge of their steam engineering department in London. He has now commenced business as stated above, and has, we understand, been retained by Mr. Clifton Robinson to carry out the extensions of his generating plant for the London United Tramways at Chiswick.

Underground Telegraphs.—On Saturday Mr. Fithian, secretary of the Associated Chambers of Commerce, issued a circular in which he stated that a reply had been received from Lord Londonderry, the Postmaster-General, to the appeal of the Associated Chambers forwarded to him early last month urging that steps should be taken to ensure uninterrupted communication between London, Liverpool, Glasgow, Edinburgh, Leeds, and all other commercial centres of the United Kingdom by means of underground wires or other efficacious method, so as to obviate the great disorganisation and prejudice to business, which has resulted from the stoppage of telegraphic communication owing to the destruction by storm of the overhead telegraphic wires. In his reply Lord Londonderry says: "In reply to your letter I am glad to give you the following information: The number of reserve wires, which are carried as far as possible by alternative routes, is being largely increased; the existing lines are being strengthened in many parts of the country, and, further, the underground line to the North is being continued from Stafford to Warrington. From Warrington there are existing underground lines to Liverpool and Manchester, so that before the end of the year there will be a system of underground wires from London through Birmingham to Manchester. North of Warrington also another section of underground work is to be proceeded with, the section, namely, between Kendal and Shap, which is one of the most exposed on the north-west route. Next year I hope to obtain from Parliament a still larger sum of money for underground work, and the council may rest assured that the work will be proceeded with as quickly as possible."

Wireless Telegraphy.—It is reported that successful experiments in the application of wireless telegraphy to submarines by a system invented by Lieutenant Tadie have recently been made at Cherbourg. A mast with receivers was fixed to a submarine, and the vessel, after submersion, received signals transmitted from the central submarine station with perfect clearness. A Reuter's telegram from Cronstadt says: "The Italian cruiser, 'Carlo Alberto,' on Monday night, for the first time, received messages by wireless telegraphy from the Poldhu station in Cornwall. These are the first experiments in wireless telegraphy over a distance of 1,600 English miles in a straight line by land, and the results have been most successful, the messages received having been most distinct. Signor Marconi, with the co-operation of Lieutenant Solari, had apparatus erected on the 'Carlo Alberto,' and he has been working for 10 days past to achieve this result. The experiments are regarded as of great importance, a new receiver, called the 'detector magneticum,' invented by Signor Marconi two months ago, having been tried. This instrument works independently, so that the 'Carlo Alberto' received messages from Poldhu which it was impossible for the other wireless telegraphic stations on the British coast to interpret. The detector magneticum acts in similar fashion to the telephone and typewriting machine, but it works better at night than during the day. Signor Marconi, however, has invented an instrument which works the same night and day. Signor Marconi proposes to erect a station in Italy for communication with Great Britain, Canada, and the United States. He believes that he will succeed shortly in telegraphing round the world. The King of Italy is greatly interested in these experiments.

Cape Town Exhibition.—The scheme for holding a British and Colonial Exhibition at Cape Town for a period of four months from November, 1903, to February, 1904, is, we are happy to learn, says the *British and South African Export Gazette*, making definite progress. The patronage of his Excellency Lord Milner, G.C.B., G.C.M.B., the High Commissioner for South Africa, has been secured. The reception accorded to the project by the mercantile community in South Africa is evidenced by, in the first place, the support of the Cape Town Chamber, while similar support, or promises of support, have been received from other chambers and merchants in the main cities of the several South African Colonies. A like cordial reception has, we understand, been met with in this country and even in our most distant colonies, the fact of the exhibition being confined to exhibits from the British Empire proving one of its chief attractions. Indeed, the view of South African merchants has been expressed that it is only reasonable and fair that an industrial display which will inevitably tend to increase the commercial relations between the South African Colonies and the various participants should be confined to those who had come to their help in the recent desperate struggle for their existence as a British community. It has been arranged that the Cape Town Chamber of Commerce and the Town Council, representing the leading merchants and business men at the Cape, shall appoint an advisory board in order to forward the arrangements and interests of manufacturers participating in the exhibition. The promoter and general manager of the exhibition, Mr. A. P. Baker, F.R.C.I., who is now in England, having just completed a six months' tour on behalf of the exhibition throughout the South African Colonies, returns to South Africa in November, when the preliminary works will have made considerable progress.

Tawstock Court.—One of the first of the county mansions in North Devon in which the electric light has been installed is Tawstock Court, near Barnstaple. It was about 12 months ago that the Alliance Electrical Company, of 137, Regent-street, London, received a commission from Sir Bouchier Wray, Bart., the work being commenced in March last and the installation having been completed during the past week. There are about 400 lights, ranging from 8 c.p. to 32 c.p. in the house proper, including some very handsome antique fittings. The current is distributed over the house by means of eight independent distribution boards, so that each section is controlled by a separate switch. The whole of the "boards" are in Sicilian marble about 1½in. thick. The main switchboard contains two switches each of 15 ways, one for charging and the other for the discharging of the batteries. The whole of the stables and outbuildings have also been fitted up, about 30 lights being employed of 16 c.p. For the purpose of the engine, dynamo, and battery, a building was especially erected in the court-yard. The steam plant consists of a loco. boiler and horizontal engine of 21 h.p., by Marshall, Sons, and Co., of Gainsborough. A compound dynamo has been supplied by the Newton Electrical Works, of Taunton, the firm which is also supplying the electrical plant for the installation at Barnstaple. The battery (supplied by Pritchetts and Gold, of Feltham, Middlesex) is of the 19-plate type with 54 cells, and is capable of giving an output of 81 amperes for six hours, or, in other words, equal to feeding 380 lights during the same time. Carried out under the direction of Mr. F. Pether (the foreman) in about four months, the work reflects the greatest credit on all concerned. The total cost has been about £2,000. Mr. Fred Woolfries

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of London, has been engaged as the resident electrical engineer for the estate.

Ealing.—During a discussion at the last Council meeting with regard to an extension of cables estimated to cost £800, it was said that in 1899 the number of units sold was 445,000, while for the year ending March, 1902, the number was 705,000—nearly double. In 1899 the income was £7,987; in 1902, £14,249. We have been supplied by the Improved Electric Glow Lamp Company, 7, Great Newport-street, W.C., with the following interesting figures showing tests made with regard to the respective merits of silvered reflector lamps and incandescent gas with Welsbach Kern burners:

	Type		Type
	Welsbach.		I.E.G.L.
—	No reflector.		16 c.p.
	New mantle.		New.
Height of post	11ft.	.....	10ft. 6in.
Distance.	Candle-power feet	.....	Candle-power feet
10ft.	·034	.....	·08
20ft.	·02	.....	·038
30ft.	·007	.....	·01
40ft.	·005	.....	·0053
	Type		Type
	Welsbach.		I.E.G.L.
—	With reflector.		16-105.
	Old mantle.		Very old.
Height of post	10ft. 6in.	.....	10ft. 6in.
Distance.	Candle-power feet	.....	Candle-power feet
10ft.	·04	.....	·055
20ft.	·009	.....	·023
30ft.	·004	.....	·009
40ft.	No register.	.....	·004

Eldon.—The North of England Institute of Mining and Mechanical Engineers visited the South Durham Colliery, Eldon, Bishop Auckland, last Friday. The following is the description of the new electrical generating plant, which met with so much praise on all sides, and for which we are indebted to the *Northern Echo*: "The pumping plant comprises a compound steam-engine, a continuous-current generator, two electric motors, and two high-lift pumps. The horizontal compound engine has 440 i.h.p., gives 80 revolutions per minute, and is fitted with a flywheel 16ft. in diameter, grooved for 14 driving ropes each 1½in. diameter. The dynamo is constructed for an output of 220,000 watts, or 400 amperes. There is an approximate speed of 400 revolutions per minute. The switchboard is certainly a thing of beauty, and is of marble panel design. The main pumps are two in number, and these are capable of delivering 500 gallons per minute to a height of 400ft. at an approximate speed of 28 revolutions per minute. The pumps are rope-driven by the motors. The motors are multipolar, and are capable of an output of 120 effective horse-power at 450 revolutions per minute. There are motor-room switchboards, and for stopping and starting the motors two Scott and Mountain single-pole liquid starting switches are provided. The coal-cutting plant consists of three Goolden dynamos, with an output of 36,000 watts each at 350 volts. A Robey (Lincoln) engine drives them. Five coal-cutting machines of the Goolden bar type are at work, three in the Harvey and two in the Hutton seam. One machine in each seam is driven by a 25-h.p. four-pole enclosed motor, and others by 18-h.p. two-pole enclosed motors. The plant was erected by the Electrical Coal-Cutting Contract Corporation, and the cutting done by that company at a price per ton. The plant was afterwards bought by the South Durham Coal Company. In addition to the foregoing, this generating plant is driving a three-throw pump, pumping 100 gallons per minute, and a 4in. Gwynne centrifugal pump, delivering about 130 gallons per minute against a head of 60ft.

Willesden Electricity Works.—The laying of the foundation stone of the sub-station in Salusbury-road, Kilburn, took place last Thursday afternoon. After a short introduction by the chairman of the Electricity Committee (Mr. C. Cowley), Mr. E. T. Ruthven-Murray, the electrical engineer, described the District Council's scheme, an account of which appeared in our issue of July 13, 1900. A large generating station is now being erected in Taylor's-lane, the site of which covers 3½ acres of land, where it will be possible to erect plant equal to 30,000 h.p. The present installation provides for 6,000 h.p. In all, 31 miles of cables are being laid, including 20 miles along 14 miles of streets. It is proposed to charge consumers on the maximum-demand system—1s. 9d. per 8-c.p. lamp per quarter and 1½d. per unit for lighting and 14s. per month and 1d. per unit for each motor, or by prepayment meter at a flat rate of 4d. per unit. Having been presented by Mr. Murray with a silver trowel, Mr. C. Cowley, after depositing a pickle jar containing a number of local papers, proceeded to well and truly lay the stone, and then gave a short history of the Council's struggles during the last five years. A vote of thanks was proposed to the chairman of the committee by the Rev. H. G. Bonavia Hunt, Mus.D. (chairman of the Willesden School Board), seconded by Dr. Crone, J.P. (chairman of the Willesden District Council). Mr. J. Pinkham, for many years chairman of the Electricity Committee, supported the motion in a breezy speech, well appreciated by his audience. A very large number of plans and sections of the electricity works in Taylor's-lane and of the sub-station were exhibited, and were scrutinised by many with the greatest interest, open umbrellas notwithstanding; in fact, the inclement weather was, if anything, in favour of the undertaking, as the large number of people who attended the ceremony gave a good indication of the great local interest which is being taken in the enterprise. What could be seen of the buildings showed them to be substantially built and most conveniently arranged. We are informed that the machinery is practically ready, and that it is hoped to have the work finished by October next. The contractors for the buildings were Messrs. Braid, Pater, and Co., Bow-churchyard, and the operations are superintended by the borough engineer, Mr. O. Claude Robson, assisted by Mr. E. Willis.

PROVISIONAL PATENTS, 1902.

JULY 2.

14728. An instrument for the measurement or comparison of quantities of electricity conveyed by transient electric currents. Robert Beattie, Physical Department, Owens College, Manchester.

14732. Improvements in magneto-electric generators or dynamos. Thomas Blackwood Murray and Norman Osborne Fulton, 121, West George-street, Glasgow.

14738. Improvement in electric lampholders. Thomas Chalmers, 18, Cawdor-road, Fallowfield, Manchester.

14741. Improvements in or relating to the electric propulsion of wheeled vehicles and boats. Maunsell Mercier, 57, Barton-arcade, Manchester.

14760. Improvements in speed indicating or recording apparatus. The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

14761. Improved tumbler switch for electric lighting. Joseph Davenport Finney Andrews and Electrical Productions, Limited, 61, Carey-street, Lincoln's-inn, London.

14767. Improvements in or relating to electric lamps and switches therefor. Edwin Ruthven Gill, 111, Hatton-garden, London.

14768. Improvements in or relating to portable electric lights. Edwin Ruthven Gill, 111, Hatton-garden, London.

14772. Liquid starting apparatus for electromotors. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

14773. Apparatus for controlling from a distance electromotors serving to actuate ships' rudders, sluice gates, swingbridges, and the like. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

14774. Electrical apparatus for working reciprocating tools. Vickers, Sons, and Maxim, Limited, Alfred David Williamson, and Cecil Leslie Sumpter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14775. An improvement in the construction of laminated armatures and the like for ventilation thereof. Vickers, Sons, and Maxim, Limited, and Alfred David Williamson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14780. Improvements in and relating to the creation, multiplication, and application of electromotive force or power to machinery of all kinds. Thomas James Howell and Alfred Andrew Andrew, Stoneleigh House, Sawbridgeworth, Herts.

14781. Improvements in process and apparatus for subjecting gases to high-tension electrical discharges. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (The Atmospheric Products Company, United States.) (Complete specification.)

14788. Improvements in automatic switches for telephones. Eugene William Schneider, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14790. Improvements relating to armature windings for electric motors or dynamos. The Johnson-Lundell Electric Traction Company, Limited, 45, Southampton-buildings, Chancery-lane, London. (Robert Lundell, United States.) (Complete specification.)

JULY 3.

14809. An improved electrical high-tension switch. Thomas Henwood, 14, Pelham-square, Brighton, Sussex.

14829. Improvements in detectors of electric current induced in systems of space telegraphy. Ernest Wilson, 64, St. John's-park, Blackheath, London.

14836. Improvements in the field-magnet cores of dynamo-electric apparatus. Keijiro Kishi, 46, Lincoln's-inn-fields, London.

14851. Improvements in or relating to electric vehicles. Ludwig Lohner and Ferdinand Porsche, 111, Hatton-garden, London.

14855. Improvements in electrical transformers for mono- and polyphase currents. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

14869. Improvements relating to electric arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Herman Cuénod, Switzerland.)

14878. Improvements in the construction of incandescent electric lamps. Ignace Hippolyte Hegner, 18, Buckingham-street, Strand, London.

14883. Improvements in telephonic intercommunication systems. William Aitken, 129, Muswell-avenue, Muswell Hill, London. (Complete specification.)

JULY 4.

14887. An electric battery. James Cluderay Booth, 57, Victoria-street, Bradford.

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14884. Improvements in electric distribution systems. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

14897. An improvement in "frogs" or points for overhead wire systems of electric traction. William Harris, Henry Brecknell, Edward May Munro, and Hugh Innes Rogers, Lloyd's Bank-buildings, Bristol.

14899. Improvements in connection with the safety fuses for electric circuits. Ernest Schattner, 55, Chancery-lane, London.

14901. Improvements in or connected with the brakes of electric and similar tramcars and vehicles. Giles Atherton, 5, John Dalton-street, Manchester.

14916. Improvements in electric capstans. Herbert Innes Jacques, 152, Coronation-road, Bristol.

14947. Improvements in or relating to electric systems. Charles F. Baudry, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Dec. 14, 1901, being date of application in France.) (Complete specification.)

14962. Improvements in conduits for electric cables. Arthur Wakefield, 40, Chancery-lane, London.

14971. Improvements in automatic telephone exchange apparatus. Max Margowski and Charles Gorick, 53, Chancery-lane, London.

JULY 5.

14977. Improved type of electric reflector glow lamp. R. C. Harpur and L. W. Woodman, Park-street, Dover.

15029. Improvements in and relating to lifeguards for tramcars and other electrically-propelled vehicles. William Simm, 6, Lord-street, Liverpool.

15037. Improvements in posts for supporting telegraph wires, cables, and the like. Léon Griveaud, 56, Ludgate-hill, London. (Complete specification.)

15038. Improvements in connection with electric arc lamps. The British Thomson-Houston Company, Limited, Arthur James Ireland, and Frederick Samuelson, 83, Cannon-street, London.

15039. Improvements in method and means for connecting multiphase electric circuits. The Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter S. Moody, United States.)

15049. Improvements relating to telephone switches. Isidore Bernard Birnbaum, 45, Southampton-buildings, Chancery-lane, London. (Telephon Fabrik Actiengesellschaft vorm. J. Berliner, Germany.) (Complete specification.)

JULY 7.

15095. Improvements in instruments for indicating the phase and frequency relations of alternating-current circuits. Frank Conrad, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, July 12, 1901, being date of application in United States.) (Complete specification.)

15103. Improvements in thermo-electric maximum demand indicators. Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

15119. An improved method of providing copper cables, intended for use as electrical conductors, with solid ends. George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (Felten und Guilleaume Carlswerk Actien-Gesellschaft, Germany.)

15124. Improvements in wearing apparel for protecting from electric currents under high voltages. Nikolaus Artemieff, 65, Chancery-lane, London. (Complete specification.)

15128. Improvements in apparatus for electrolytically coating sheet metal with zinc. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. ("Columbus" Electricitäts-Gesellschaft m. b. H., Germany.)

15142. Improvements in and relating to incandescent electric lampholders. Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London.

JULY 8.

15218. Electric safety apparatus for controlling the traffic upon railways. Friedrich Prochaska, 8, Quality-court, Chancery-lane, London.

15226. Improved mechanism for electrically controlling mechanical motion. Arthur Penrhyn Stanley Macquisten, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

15244. Improvements in and relating to electrical transformers. William Phillips Thompson, 322, High Holborn, London. (The firm of Louis and H. Leowenstein, Germany.)

15245. Improved electro-semaphore. Bernard Petsch, 322, High Holborn, London.

15271. A new or improved process for the electric smelting and refining of metals and other substances. Charles Albert Keller, 18, Buckingham-street, Strand, London. (Complete specification.)

JULY 9.

15299. Improvements in or relating to contact breakers for electrical ignition purposes. Stephen Brindley Hardcastle, 18, Hertford-street, Coventry.

15310. An improved telephone receiver. Alfred Wilson, 115, St. Vincent-street, Glasgow.

15311. Improvements in arc lighting lamps. Lorenz Sigfrid Andersson, 62, St. Vincent-street, Glasgow.

15312. Improvements in accumulators or secondary batteries. Louis Albert Génard, 100, Wellington-street, Glasgow. (Complete specification.)

15324. An improved device for enabling low-tension lamps of high amperage to be employed on electrical distributing circuits of any voltage. Joseph Klopfenstein, 55, Chancery-lane, London.

15325. Improvements in apparatus for controlling electric currents, chiefly designed for use in lighting the stages of theatres. Louis Mornat, 11, Southampton-buildings, Chancery-lane, London.

15334. Improvements in and relating to conduits for electric or other cables. James Fulton Cummings, 45, Southampton-buildings, Chancery-lane, London.

15346. Improvements in magnetic clutches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

15347. Improvements relating to arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

15350. Improvements in arc lamps. William Phillips Thompson, 6, Lord-street, Liverpool. (Christian J. Toerring, United States.)

JULY 10.

15373. Improvements in or relating to the covers of dynamos and electromotors. Robert Frederick Hall, 24, Temple-row, Birmingham.

15374. Improvements in dynamo suspension gear for use in connection with the electric lighting of railway carriages and the like. Robert Frederick Hall, 24, Temple-row, Birmingham.

15378. Improvements in electrical switches. Harry William Cox, Brougham-chambers, Nottingham.

15381. Improvements in magnetic separators for ores or the like. John Thomas Dawes, 4, Clayton-square, Liverpool.

15387. Improvements in telephone receivers. Lionel Marston and Reginald Howard Jones, 128, Colmore-row, Biamingham.

15413. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

15417. Improvements in multiplex telegraphy. George Lewis Hogan, 35, Buckingham-gates, St. James's-court, London.

15431. Regulating devices for electrical machines driven by steam motors. The Honourable Charles Algernon Parsons, 18, Southampton-buildings, Chancery-lane, London. (Charles Eugen Lancelot Brown, Switzerland.)

15435. Improvements relating to secondary or storage batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Consolidated Batteries Company, United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 31.

1901.

13984. Electrical storage batteries. Barham.

14236. Working and controlling of electrically-driven cars. Siemens Bros. and Co., Limited, and Siemens.

14466. Electrical storage batteries or accumulators and electrolytes for electric batteries. Stiens and Smith.

15876. Electrical storage batteries. West.

16182. Connecting boards for use in junction boxes and the like for multiple electric cables. Hardingham. (Waskowsky.)

17023. Alternating-electric current transformers. Hobart.

17416. Protection of electric tramcars from falling wires. Timon.

17664. Electric transformers, exciter coils, and field magnets. Pichler.

17860. Electrical primers. Sir W. G. Armstrong, Whitworth, and Co., Limited, and Stuart.

18023. Electric storage batteries. Bristol.

18400. Controlling apparatus for electrically operated or driven ammunition rammers. Reichwald. (Firm of Fried. Krupp.)

19461. Transmitting and receiving apparatus for Hertzian waves. Ducrétet.

1902.

993. Telegraph and telephone wires. Womersley and Womersley.

11077. Supports for high-tension electric conductors. British Thomson-Houston Company, Limited. (Batchelder.)

11940. "Frog" for overhead conductors or lines of electric tramways or railways. Palatine Engineering Company, Limited, and Blakiston.

12536. Electric tramcars. Black and Hogg.

12755. Method for reducing or entirely suppressing synchronising currents of single or multiphase alternators working in parallel. Kolben.

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12870. Apparatus for charging electric accumulators. Soc. Lespagnol and Mériguet. (Date applied for under International Convention, Nov. 14, 1901.)

13175. Equalising appliances for interconnected polyphase current systems. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	July 12	5,241	4,906	+ 335	134,112	122,625
Blackburn Corporation	,, 11	860	742	+ 118	12,931	10,793
Blackpool Corporation	,, 10	996	1,291	- 295	11,062	11,781
Blackpool-Fleetwood Tramways	,, 12	714	1,042	- 328	1,171	1,827
Bolton Corporation	,, 13	1,611	1,690	- 79	41,499	39,618
Bradford Corporation	—	—	—	—	—	—
Bristol Tramways Company	,, 11	5,151	5,065	+ 86	—	—
Carlisle Tramways Company	,, 12	470	214	+ 256	4,621	4,272
Central London Railway	,, 14	6,847	6,145	+ 702	14,043	12,224
City and South London Railway	,, 13	2,786	1,872	+ 914	5,607	3,844
Cork E. T. and L. Company	,, 10	764	611	+ 153	12,995	12,205
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 5	264	254	+ 8	5,314	5,108
Dublin & Lucan Electric Railway	,, 13	120	158	- 38	240	301
Dublin U. T., electric cars	,, 11	4,051	4,172	- 121	—	—
Dublin S. District, Electric	,, 11	1,151	1,205	- 54	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 12	11,125	12,952	- 1,827	—	—
Halifax Corporation	—	—	—	—	—	—
Huddersfield Corporation	,, 12	1,017	1,101	- 84	—	—
Hull Corporation, E. S.	,, 12	1,806	1,775	+ 31	25,927	24,998
Liverpool Corporation	,, 5	10,484	9,936	+ 548	254,087	231,574
Liverpool Overhead Railway	,, 13	1,584	1,765	- 181	3,179	3,497
Newcastle-on-Tyne Corporation	,, 12	2,688	—	—	—	—
Portsmouth Corporation	,, 12	1,945	1,008	+ 937	—	—
Sheffield Corporation	,, 13	4,277	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Sunderland Corporation	,, 13	1,190	1,287	- 97	17,399	15,692

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £63 increase.

Barcelona Ensanche y Gracia, £106 decrease. Barcelona £378 increase.

Brisbane, £459 decrease (month of June, £10,187; increase, £1,813).

Buenos Ayres and Belgrano Electric (month of June, receipts £12,229; increase £478), £418 increase.

Calcutta, £246 increase.

Cape Town (month of June), receipts, £14,148; expenditure, £6,689.

Isle of Thanet Electric, £89 decrease

Mexico Electric (month of June), receipts, £20,285; expenditure, £12,275.

Perth Electric, £143 increase.

Port Elizabeth (month of June), receipts, £3,849; expenditure, £1,891.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-½
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Insulated Wire, Ord., 1-70,000	5 ..	7½-8½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6 xd
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5½-6½
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	1½-2½
—— 4½ per cent. 1st Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15½-16½
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	2⅞-3½
—— 5 per cent. Debentures	100 ..	101-106 p.c.
Edison and Swan United, "A" Shares, 1-98,261	3 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1½-2½
—— 5 per cent. Debentures	100 ..	76-81
—— 4 per cent. Deb. Stock, Red.	100 ..	76-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-1⅝ xd
—— 7 per cent. Cumulative Pref.	2 ..	2½-3 xd
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-100 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9½-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15½ xd
Telegraph Construction and Maintenance	12 ..	35-38 xd
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	—
—— 5 per cent. Cum. Pref.	5 ..	—
Electric Railways.—		
Central London, Ordinary	100 ..	106-109
—— 4 per cent. Pref.	100 ..	107-110
—— ,, ,, deferred	100 ..	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118 xd
City and South London, Consolidated Ordinary	100 ..	72-74
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	129-131
—— ,, ,, ,, '01	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-96

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	½-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref.	10 ..	10-11
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	9-9⅛
—— 7 per cent. Preference	5 ..	9-9⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8½-9⅛
—— Nos. 20,001-30,000	5 ..	8½-9⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, £10 Ord.	6 ..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-107
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5½-5⅝
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5½-5⅝
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8½-9⅛
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6-6½
—— 6 per cent. Cum. Pref.	5 ..	6-6½
—— 4½ per cent. First Mort. Deb.	100 ..	105-108 xd
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4½-4⅝
—— 5 per cent. Debenture Stock, Red.	100 ..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5⅜-6½
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1½-1⅝
—— 6 per cent. Pref.	5 ..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	94-99
Metropolitan, Ordinary	10 ..	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6½-6¾
Notting Hill Electric Lighting	10 ..	13½-14½
Oriental, 1879	1 ..	1½-1⅝
—— £5 Shares	5 ..	7-7⅛
—— £4½ Shares, New	4½ ..	6-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	97-100 xd
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2½-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8½-9⅛
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3½-3⅝
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3⅞-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3⅞-4⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅛-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	102-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9½-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	12-13
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12½
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105
—— Prov. Cert., all paid	100 ..	95-98
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	4⅜-5⅛
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4⅛-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref.	Within 10 ..	10½-11
—— ,, ,, ,,	1-82,500 5 ..	8-8½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	107-109
—— ,, ,, Prov. Crts.	50 ..	81-83
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3½-4⅛
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8½-9⅛
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9½-10⅛
—— 4½ per cent. Debenture Stock	100 ..	107-110
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £251,132 6 per cent. Preference	12s. ..	⅛
—— £250,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	60 p.c. ..	60 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Preferred, 590,001-790,000	3½ ..	4⅛-4⅞
—— Deferred Stock	100 ..	55-59
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅛-5⅛
—— 3½ per cent. Deb. Stock, Red.	100 ..	94-97
—— 4 per cent. Deb. Stock, Red.	100 ..	102-106
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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Supplement to "The Electrical Engineer,"

JULY 18, 1902.

THE UNION INTERNATIONALE PERMANENTE DE TRAMWAYS.

TWELFTH ANNUAL MEETING.

(Continued from page 23.)

SECOND SESSION OF CONGRESS.

The second session of congress in connection with the twelfth annual meeting of the above union was held on Wednesday, 2nd inst., when the chair was occupied by Colonel Boughey, C.S.I., commissioner of light railways. The prearranged order of the programme was not observed, as it had been found impossible during the first session to dispose of all the papers allotted to that session, a re-arrangement for the succeeding sessions having consequently to be made. Evidently the time necessary for translation had been underestimated.

CENTRAL STATIONS.

The first contribution to the proceedings of the second session was an interesting report on "Central Stations" by M. Ch. Thonet, director of the General Contract Company, of Liège. This report appears to have been compiled with a view to giving comparative statistics as to the efficiency of different plants, with special reference to the relative cost of producing electrical energy at the main switchboard of a tramways power station when using steam, producer gas, or water power as the prime mover. With regard to boilers, we gather from the report that for tramways power stations on the Continent cylindrical boilers of the Cornish type, with interior flues, are more generally employed than multitubular boilers. The cost of maintenance works out in favour of the Cornish type on account of the absence of tubes. Drier steam is also obtained. In some instances grate bars of polygonal section are used. It is stated that their employment permits of the use of slack, while an increased economy of at least 5 per cent. is effected. Furnaces designed to burn injected producer gas are in one case successfully employed. In another station they have adopted inclined grates with overhead air inlets, which are said to have given satisfactory results. Smoke consumers are seldom employed, a notable exception being at Nuremberg, where their use has effected a saving in fuel of 20 per cent. In other cases the results have not been so satisfactory. Mechanical stokers are not generally used, the opinion being that they offer no great advantage, and that a good fireman can produce steam more economically. By way of experiment, an apparatus has been adopted at the Stettin tramways power station for controlling the supply of air to the boiler furnaces, while at Nuremberg use is made of the Orsat meter for analysing the waste gases from the furnaces. It is suggested that the latter apparatus should be more generally employed in large stations, in order to ascertain the quantity of carbon in the gases, so that the necessary steps may be taken to rectify any excess and thereby obtain the most economical conditions of working.

Passing on to steam-engines, the report states that the compound tandem type is mostly used; above 1,000 h.p. they are generally cross compound in order to bring the dynamo between the two cylinders, and are worked condensing, condensers of the jet type being used. The daily cost of maintenance per car kilometre for the steam-engines, including the salaries of the drivers, ranges from 0·004fr. to 0·008fr. As regards the steam consumption per indicated horse-power hour, this varies considerably, we are told. For compound condensing engines under ordinary working conditions it varies from 6·5 kg. to 8·8 kg. In three specific cases in which condensing tandem compound steam-engines of 300 h.p. to 700 h.p. are used, the consumption of coal per unit generated is given at 1·38 kg., 1·94 kg. and 1·70 kg. respectively. Good ordinary coal was used, it is stated, but we are not told its calorific value. The efficiency of the steam-engines varies from 80 to 90 per cent. Attention is called to the influence of varying load on the efficiency and consumption of steam-engines. Thus, with a load of 45 per cent.—the normal one—the coal consumption was found in a certain instance to reach 1 kg. 850 grm. per kilowatt-hour, while the consumption was only 1 kg. 700 grm. when the load reached 60 per cent. The advantage of having regulating batteries when operating small systems, on which the load is apt to vary widely, is deduced from this.

The report next goes on to consider gas-engines worked with producer gas. As examples, the plants working in Barcelona and Andrès (Spain) are given. The engines at Barcelona are of the Crossley four-period type, two being of 165 h.p. and one of 300 h.p. The maintenance costs of these engines are not greater than those for steam-engines, excepting lubrication. On the other hand, less labour is required to tend the plant, and it may be unskilled. The maintenance cost for the gas-engines and producers averages from 0·0025fr. to 0·006fr. per unit generated. At present the average consumption of screened anthracite is 850 grm. per unit generated. The other comparisons made between gas-engines working with producer gas and steam plants are all in favour of the former.

From information given concerning the dynamos in use we gather that these are mostly of the continuous-current shunt, compound, or over-compounded types, generating at 550 volts. There are a few three-phase high-pressure generating plants, with transformer sub-stations. In Marseilles, for instance, the current is generated by alternators having each an output of 1,100 kw. at 5,500 volts terminal pressure. This voltage is reduced in the sub-stations to 340 volts by the aid of stationary transformers, the three-phase current being then converted into continuous current at 550 volts by means of rotary converters. Puffer batteries are employed in many instances. These are generally of the Tudor type. At several stations a battery is used for the first and last hours of service. In these instances the batteries are of greater capacity than is required for ordinary work, and operate a booster dynamo. The maintenance expenses of the battery, when undertaken by the contractor, amount as a general rule to from 5 to 10 per cent. of the original cost, the total maintenance expenses aggregating about 0·005fr. per kilowatt-hour.

The latter portion of the report deals more exclusively with the cost of generating electrical energy for differently-driven plants—that is to say, it attempts a comparison between the relative merits of steam, producer gas, and water as the primary force. Some figures are given relating to the prime cost of erection, from which it is deduced that for a steam-driven plant of moderate dimensions the cost of erection per kilowatt available must be estimated at 1,000fr. But for large power stations the advantages resulting from situation outside the town, and from the adoption of larger units, enable, generally speaking, a reduction of this cost to 700fr. per kilowatt available. On the other hand, the total cost of erection per kilowatt available in Barcelona, where gas plant is installed, is given at 1,525fr., there being 440 kw. available for traction purposes. But it is pointed out that the conditions were exceptional in this case, the purchase of a very large property being included in the figure, while the cost of materials at the time of erection was 25 per cent. greater than at the present time. Another gas plant is instanced where the total cost of erection amounted to 1,053fr. per kilowatt available. Little definite information is given regarding the cost of erection per kilowatt available when water power is employed, but it is suggested that the cost is not less than 1,000fr., and may even be twice as high, according to local difficulties, and to the length of the water-mains, etc. Some companies and municipalities take their supply of current from an outside source, but generally at a high price, the following prices per unit supplied being instanced as an illustration:

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0·13fr. at Christiania; 0·135fr. at Zürich: 0·17fr. at Havre; and 0·20fr. at Liège. In the latter case a gas-power station has offered to supply current for traction purposes to the Municipality at a cost of 0·10fr. per unit. The water-power stations supply the current at a cost varying from 0·05fr. to 0·08fr. per unit.

At the conclusion of the report under notice there are given some statistics relating to the cost of operation per kilowatt-hour, including wages of all kinds, coal, lubricant, and water consumption, maintenance and repairs to boilers, engines, and dynamos, and also the maintenance of the storage battery necessary with producer-gas plants.

The following conclusions are made: for large power stations, operating 1,000-h.p. engines and above, the price of coal lying between 15fr. and 20fr. a ton, the cost will range between 4 and 6 centimes per kilowatt-hour; for medium size power stations, operating engines from 300 h.p. to 600 h.p. capacity, the price of coal lying between 15fr. and 20fr. a ton, the cost will range between 6 and 8 centimes per kilowatt-hour; for small power stations operating engines from 100 h.p. to 200 h.p. capacity, the price of coal lying between 15fr. and 20fr. a ton, the cost will range between 8 and 10 centimes per kilowatt-hour; for producer-gas power stations operating engines from 150 h.p to 200 h.p. capacity, the price of coal lying between 30fr. and 40fr. a ton, the cost will range between 5 and 7 centimes per kilowatt-hour; if the price of the coal be reduced to 15fr. or 20fr. a ton, the cost will range between 4 and 6 centimes per kilowatt-hour.

A vote of thanks was accorded to M. Thonet.

Conditions under which Tramways may be Laid on Roads.

M. Albert Janssen, general secretary and director of the Brussels tramways, then read a paper dealing with the above question. The paper may be described as an attempt to formulate a principle upon which payment to be made to conceding powers for tramway concessions should be based, in order to conciliate, as far as possible, the interests of the public, the authorities making concessions, and the concessionaires. The author enumerates the systems of payment most generally in use, and then proceeds to an argument of which the following is an abstract: "If the public authorities may justly claim benefits from the tramway companies in return for those they grant them, they must not insist on excessive payments for concessions, or exact too heavy charges from the enterprise, or choose a base of taxation which would impose on the undertaking the adoption of measures which might cause the public comfort to suffer, such, for example, as the tax per car in service, or others of that nature. Of all the formulæ examined and bases discussed, the system of fixing the payments for concessions on the net profits is the most equitable, the most rational, the most just, and the only one, perhaps, which is of a nature to reconcile all the interests concerned. Every public enterprise being subject to certain risks, it is not just that the conceding power should be freed from the risks of the enterprise to which it grants rights, and should receive payment for concessions, even if that enterprise gives no profits, aggravating by doing so the risks of the enterprise. But it follows that, in view of guaranteeing the public authorities, the manner of establishing the figure of the net profits must be determined in advance. It will suffice to stipulate what are the charges to be deducted from the gross profits; and to annex, if necessary, to the deed of concession a complete scheme of the establishment of the net profits, to prevent every discussion on that head, and preclude all misconception on the part of the conceding power.

In the author's opinion, the most simple basis to take for the establishment of the payment for the concession is the return of the dividends paid. The shareholders have an interest in seeing all distributed which is distributable, taking into account the sinking fund, and necessary provisions; the conceding authorities, he thinks, will find in this very interest their proper guarantee, and the concessionaires will not have to submit the audit of their books to the public authorities, or have discussions with them. He further points out that in Germany the principle of the fixing of the payments for concessions on the profits is already officially adopted.

The author arrives at the following conclusions: Considering that, if the conceding authorities claim with justice from the tramway companies franchise taxes in return for the rights and powers which they confer upon them, public interest, clearly defined, requires that these charges should be judiciously established, and that they should at the same time be equitably fixed. That, indeed, the cities receive from the tramway services many other advantages besides direct money gains, notably from the point of view of their development and their prosperity. There should be put aside every system of taxation susceptible of pushing the management in counter-action, to adopt measures opposed to the interest and the comfort of passengers. That it is just, equitable, and rational to establish the payments for concessions in such a manner that they shall be bound up with the lot of the enterprise, and proportional to the results which it produces.

Finally it was urged by the author, and put in the form of a motion, that the assembly should agree that it is on the principle of a participation in the net profits of the undertakings that the taxes payable to the conceding authorities should be established. That participation can be determined either by a percentage on the net profits distributed in the conditions and under the guarantees indicated above, or, if it were necessary, by the allotment of a certain portion of the excess of the gross receipts over the expenses of working. These being fixed according to the distance per kilometre run, at a cost per kilometre car agreed upon between the conceding authorities and the company.

Discussion.

In the course of the discussion which ensued objection was raised to the last paragraph, which if agreed to, it was suggested, would enable the authorities to force the concessionaires to increase the number of car miles without any advantage to them. It might happen that the increased car miles could not be worked economically, and for this reason it was suggested that the participation of the authorities should be based upon the net profits only.

After some further discussion the meeting adopted the conclusions arrived at by the author, with the exception of the last.

Legislation in all Countries relative to Tramways and Light Railways.

A paper dealing with the above subject, by Mr. R. H. Scotter, was next read. In introducing his subject the author says: "The study of the law with regard to tramways and light railways in various countries reveals the fact that although the general procedure is nearly the same in many parts of Europe, various obstacles are placed in the way by which the practical results are widely divergent." He also makes the following suggestions: (1) that a complete collection of laws, acts, rules, and regulations relating to tramways and light railways should be obtained and deposited at the head office of the union; (2) that translations of the most useful and the most harmful points and clauses should be made as guide-posts for tramways and light railways engineers; (3) that an effort should be made to gradually standardise all regulations, especially those connected with electric traction. The causes which have in the past retarded the progress of tramway enterprise in this country are briefly touched upon. The author then goes on to express the opinion that we have a great deal to learn from the excellent system of *chemin de fer vicinaux*, now working in Belgium, and suggests that the success which has attended the system is due to the clever binding together of three discordant elements, which separately are placing a great deal of hindrance in our way all over the world—namely, the Government, the local authorities, and the public. Belgium has united these interests in such proportion that each one is, alone, relatively harmless. In the author's opinion no light railway or feeder line can be successfully worked unless these three interests are combined. Exactly in what proportions their help and influence are obtained is a matter for local arrangement. Further, he is of the

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opinion that not one of these three elements alone can show good results as a light railway authority. Private enterprise, represented by the investing public, cannot see sufficient return for its capital from the districts which are most in want of light railways.

Continuing the author says: "There are many reasons why the State cannot single-handed supply money for the construction and working of these lines, because the beneficial results which will accrue are more local than national, and there are still greater reasons why local authorities—in England, county and district councils, in other countries, provinces and communes—should not embark in this enterprise. Their horizon is strictly limited, and their purses are as a whole already too heavily drained. But the principal reason is that the work needs the attention of an expert with world-wide experience of a lifelong character. Summing up this point, the author ventures the opinion that for interurban and country districts the Belgian system of uniting these three elements—the State, the local authorities, and private enterprise—is decidedly the best. In urban districts," he continues, "private enterprise certainly produces the best results, because it secures the best and most economical management, and allows of that continuity in the carrying out of the work which local authorities, subject as they are to periodical changes, cannot aspire to. But it is always possible to accord to the local authority that equitable amount of consideration which will secure the most beneficial results both as to traffic facilities and payment for the concession. Excellent traffic results can only be attained by linking up the town with the country, and this is only possible where the whole system is in the hands of one organisation."

Proceeding to the consideration of the time required to obtain concessions in different countries, and the duration of the concessions when obtained, the author remarks that under the Tramways Act 21 years from the date of authorisation was fixed as the limit of time granted with each concession. It was largely on account of the approach of the day of reckoning—the end of the 21 years—that tramway directors hesitated before adopting electric traction. Hence it is, also, that many electric tramways in England to-day are municipal undertakings They were bought at a low price from the original promoters and converted by the local authorities. The new Light Railways Bill gives 33 and even 42 years for the concession, and also directs that the ultimate purchaser shall acquire the line as a going concern. It is pointed out, however, that even with this extension of time we are still behind most other countries.

With regard to gauge, the author is of the opinion that it is advisable that each country should adopt one, or, at the most, two gauges for light railways, in order that rolling-stock, locomotives, etc., may be more economically constructed and worked.

Passing on to the question, What authority will ultimately become the owner of all concessions? the author considers that Belgium again leads the way in granting its concessions in perpetuity. This he considers to be by far the best practice, but it needs a strong organisation to initiate it. In conclusion, the author suggests that a few subjects should be selected—for instance, "The Evils of Municipal Trading," "Uniformity of Gauge," "Length of Time for Concession," or any others, and actual examples of the working of the law for or against these obtained from members of the union.

Discussion.

A brief discussion ensued, and it was agreed that the council of the union should appoint a committee to take the matter up and delegate representatives to collect information in each country.

The Arrangement of Car-Sheds.

The next paper read was by Mr. A. Trautweiler, chief engineer of the Strassburg Tramway Company. In this paper the arrangement of car-sheds is discussed; the conclusion arrived at being that a small number of large depôts, each allowing of a grouping of 100 to 150 cars, is much to be prefered to the scattering of rolling-stock in numerous small depôts.

Traction Systems.

The concluding paper of the second session was contributed by Mr. E. A. Ziffer. In this paper the author deals briefly with the different conduit and surface-contact systems of electric traction at present in vogue. The advantages and disadvantages of each system are pointed out as far as possible, and some interesting figures given relating to the initial and maintenance costs of the different systems. It is interesting to note that the conclusion arrived at by the author is that since the Geneva congress in 1898 there has been no real progress made either with regard to conduit or surface-contact systems. He points out that these systems are, nevertheless, coming into more extended use in large towns, especially the Siemens and Halske system, in which a lateral conduit is employed. Some improvements, he remarks, have been effected in the surface-contact system within the last few years, and he sees no reason why the installation and maintenance costs of this system should compare unfavourably with those for the conduit system. Although the Diatto system has been largely adopted in France, it does not, in his opinion, recommend itself. As his reasons for this conclusion he enumerates the following defects: defects in the distribution, defective drainage, obstruction offered by the contact studs to the passage of vehicles, possible danger to foot-passengers and animals, difficulties of conveying the current to the crossing and switches, and insufficient protection of the apparatus against damp.

In summing up, the author concludes that of the systems discussed the conduit system merits, in practice, the preference over the surface-contact system, which latter, as yet, does not offer sufficient security in service.

Third Session of Congress.

On the resumption of the deliberations of the congress on the Thursday morning, Mr. John Young (general manager of the Glasgow Corporation tramways) took the chair. The Chairman having addressed a few words of welcome to the delegates present, Mr. Poetz (engineer-in-chief of the Hamburg Tramways Company) was then called upon to read a paper on "Tramway Brakes" of which the following is a digest:

Tramway Brakes.

In the first half of his paper on "Tramway Brakes" Mr. Poetz gives the systems of brakes in use on a number of electric tramways, and the conclusion as to their working arrived at by the different owners. With regard to the hand-brakes in use, these are chiefly of the chain type, the ratio generally adopted between the handle and the blocks being as 1 : 80 or 1 : 100. Experimental tests have shown that with light double-axle cars running at moderate speeds these brakes are sufficient under ordinary conditions, it being understood that no trailers are employed. With the screw brake the gearing ratio can be carried to above 1 : 100, but great inconvenience results owing to the slowness of bringing the brake into action, another drawback being the wear caused by dust getting upon the screw. Bearing in mind these defects, it is concluded that the screw brake cannot be relied upon as a regular service brake, and ought not to be considered as a safety brake.

Proceeding to the consideration of electric brakes, the author remarks that the maximum braking power is obtained with these, and, shortly, with all other systems acting on the wheel flanges, as long as these are not prevented from rotating. The greatest possible useful power is reached just before the wheels are caused to skid. When this condition can be realised for all the wheels at the same time, the braking power is at a maximum. When the motorcars run single, and all axles are driven, the short-circuit brake will, as a general rule, answer every purpose of a reliable service brake, it being understood that the hand-brake can always be called upon. The simultaneous working of the hand-brake with the electric brake is of advantage, as it keeps both systems under proper working conditions. The experience which the Hamburg Strassen-Eisenbahn Gesellschaft has had with the simultaneous use of short circuit and electromagnetic brakes as ordinary service brakes on all its cars is highly satisfactory. This company has not experienced any

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increase in the repairs to motors, switches, gear wheels, etc. Moreover, no magnet branch of the electromagnetic brake has as yet been broken. The fault found with this system, the author remarks, seem more likely to be due to want of sound construction, or of the proper proportioning of the resistances.

Some figures, not included in the published version of the paper, were given by the author relating to tests which had been made on the Continent with various types of brakes. The results obtained showed that with the car running at a speed of 14 km., the Helios electromagnetic brake pulled up in 15·5m., and four other brakes in a distance of 9m. At 20 km. the results were as follows: Siemens and Halske electromagnetic brake, 13m.; Schuckert, 15m.; standard air-brake, 16m.; Carpenter air-brake, 16·7m.; and the Helios electromagnetic brake, 21m. In 28 km.: Siemens and Halske, 17·8m.; Schuckert, 24·5m.; standard air-brake, 23·6m.; Carpenter, 24·2m.; and Helios, 27·2m. In 32 km.: Siemens and Halske, 27·2m.; Schuckert, 43m.; standard air-brake, 38·8m.; Carpenter, 35 8m.; and Helios, 43·5m. The author in his conclusions, however, gives the palm of simplicity to the electric brake.

Discussion.

An interesting discussion followed, and it was agreed that the matter should come up for further consideration at a future congress.

NARROW VERSUS ORDINARY GAUGE.

The paper which followed, by Mr. C. de Burlet, general manager of the Société National des Chemins de Fer Vicinaux de Belgique, may be summed up as a plea for the extension of narrow-gauge light railways rather than the construction of no lines at all. The author considers that narrow-gauge light railways might be adopted with advantage in many cases where it is impracticable on account of financial and topographical difficulties to construct standard-gauge tracks. He sums up the advantages of narrow gauge light railways for local service as follows: "Saving in the expenses of construction and working—an essential element for the creation and the vitality of secondary lines, which generally have small receipts—and the great flexibility of the track permitting it to conquer topographical difficulties, and to seek for traffic at its direct sources."

FOURTH SESSION OF CONGRESS.

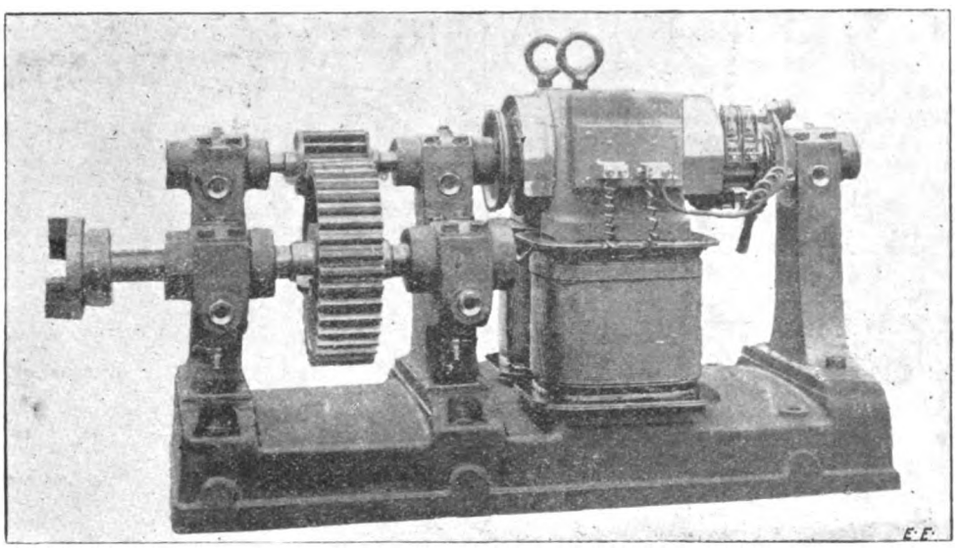
The fourth and concluding session of the congress was held on Friday, July 4, when the reading and discussion of papers was continued.

A contribution by Mr. P. V. McMahon (chief engineer of the City and South London Railway) on "Underground Tube Railways" was generally appreciated. We hope to refer to this paper again in a future issue.

At the conclusion of the business proceedings, the President formally closed the congress, his remarks being interpreted into English by Mr. R. H. Scotter.

500-VOLT DISTRIBUTION.

For power distribution over large works such as a steel manufactory a 500-volt system of distribution is most convenient, and allows of the section of the conductors being kept down within reasonable limits. Such an installation has recently been completed by the Electric Construction Company, of Wolverhampton, at the Tipton works of the Horseley Steel Company. In this instance most of the motors are placed at a considerable distance from the power-house, so that the 500-volt system was absolutely required. The generating plant consists of a standard compound-wound dynamo of the above company's make, and of 105 h.p. capacity. This machine is driven by a Stockport gas-engine. The use to which the motors are put up are extremely various—for instance, the large shears and plate-planing machines used by the company are now all driven by means of electric motors. We illustrate one of these with its reduction gear and coupling for direct driving.



E.C.C. Continuous-Current Motor, with Reduction Gear.

Besides this there are a number of hydraulic pumps which are motor driven, and the lines of shafting in the various fitting shops are also electrically driven. The firm have decided to extend their electrical work, and the Electric Construction Company have now orders to equip for electrical working the steam-driven jib cranes, which are used extensively about the works.

MUNICIPAL TRADING.

BY A BARRISTER.

In recent numbers we dealt at some length with the question of municipal trading from an outside point of view, endeavouring to trace some principle upon which the question might be practically dealt with.

A discussion which took place a few days ago in London, under the auspices of a prominent society, seems to have elicited nothing but wholesale condemnation of any form of enterprise which might be adopted by a local authority. Indeed, to judge from the tone taken by some of the minor speakers, want of argument was made up for by abundance of abuse. Many persons have a purely individual interest in denouncing all forms of municipal trade. They have got their own axes to grind, they want to run their own particular interest, and they are indignant at the thought of being deprived of the opportunity of making money out of the public. On the other hand, the public prefer, with some show of reason, to conduct some of these paying operations for themselves, and to put the profit in their own pocket in the shape of reduction of rates. If the opposition to municipal trading were less characterised by interested motives, if the exponents of the other creed were men of greater experi-

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ence in municipal affairs, or had greater weight in the public estimation, the result might be beneficial to the community.

It is idle to suggest that no limit ought to be placed upon the enterprise of a local authority, for it must be apparent to every man that there are certain limits beyond which Parliament should forbid any municipality extending its operations. But the solution of the difficulties concerning the question is not advanced by declamation from individuals whose remarks are mostly a denunciation of the London County Council.

Without a very wide and comprehensive acquaintance with the requirements of urban and rural district councils, of large cities and small boroughs, without a knowledge of the progressive schemes taken up by all kinds of local authorities, and of their relative success and failure, it is impossible for any person to give any useful opinion upon the question.

The main difficulty lies in defining what is meant by the word "trading." Let this be satisfactorily settled, then the only two questions arising for discussion are: Shall any local authority be allowed to "trade" in any shape or way whatever? If yes, then to what extent and under what limitations?

Now, difficult as the matter may appear to be, a reference to the annual budgets which are issued by local authorities will provide us with, at all events, a workable answer to the main definition. In every such budget a distinction is always drawn between productive and non-productive works. In the first place are discussed works which have involved the ratepayers in a loss—for example, drainage schemes; in the second place follows the sugar to make the statement palatable to the aggrieved ratepayer—in other words, a statement of the additions to the income of the local authority gained from the profits made on any business they have carried on. These profits are usually applied in reduction of the loss which has been incurred in carrying out non-productive works.

The distinction between productive and non-productive works has always been recognised since municipalities become active. The earliest powers conferred upon local authorities were of a sanitary nature, and in all the Sanitary Acts we find a duty cast upon the local authority to do work which nobody else would do because it would not pay anyone to do it. Hence the distinction was carefully drawn by the Legislature between a sewer constructed for profit, which, therefore, does not vest in the local authority, and sewers not made for profit, which do vest in the local authority. This is the present law, and it is common knowledge that most sewers are an onerous undertaking, a source of loss which has to be met out of the rates.

Let us apply the principle of the distinction betweeen non-productive and productive works a little further. Take the case of highways. It pays nobody to maintain a highway, unless he is allowed to charge a toll upon all persons using it—it is a non-productive business. The maintenance of highways is, therefore, one of the onerous duties cast upon the local authority. If the highway authority properly maintained the roads in such a good condition that all vehicles could run thereon at high speed, there would be no necessity to put down iron rails in the middle of the roadway in order that one special vehicle might get along quickly. The mere existence of a tramway in the middle of the road, is a tacit condemnation of the manner in which the surface is maintained. The primary duty of the local authority is to keep, whatever the cost may be and in any event, the surface of the highway in such a condition that individual enterprise can safely use it any rate of speed. It is common knowledge that this elementary principle is never acted up to. The loss sustained on repairing the roads in an insufficient manner is recouped by the local authority embarking in a tramway enterprise, and making a profit by carrying on the business of common carriers; in short, it is the neglect by the local authority of their primary duty which raises any sort of necessity for the existence of tramlines. It does seem curious that they should take advantage of their own default to embark in an enterprise, which is not always profitable, mainly to hide their own deficiencies and to appease the ratepayer, who is annoyed by a lavish and unremunerative expenditure upon the highways.

In view of the improved methods of traction, and of the likelihood of an immediate advance in that direction, it is dangerous to speculate in any fixed form of traction. What is to-day a useful and valuable means of carrying people about may be in a few years antiquated and expensive. Yet to such a fixed system of traction a municipality becomes pledged when it deliberately adopts the policy of trading as a common carrier. The rates are invested in a special class of enterprise, which may in a few years become superseded by fresh inventions.

The other aspect of the case must not be disregarded. In proportion as fresh inventions increase, so is there a greater need for a first-rate surface on the highway. The idea of a fast vehicle being fixed to a pair of rails is rapidly disappearing, and will soon become obsolete; clearly it is to the advantage of the ratepayer to expedite and encourage the advance of fresh methods of locomotion at the expense of other people than himself; he does not want to pay for experiments. Limit the liability of the ratepayer to providing a really good roadway, and the ultimate result will be to his benefit. Unfortunately, this doctrine, although sound, is unpalatable, because it has nothing attractive about it for those who administer affairs. The handling of productive business is in most cases merely a specious endeavour to propitiate the ratepayer, the seeming necessity for it arising from the neglect of their duty by the local authority.

Experience tells us that an urban authority does not run tramcars merely to benefit its own ratepayers; they are run as a rule for persons who dwell outside the urban area and are anxious to get into it at a cheap rate, therefore we find a strong tendency to the enormous extension of urban areas. In other words, the urban authority tries to go outside its district to find a field of productive enterprise. Now, assuming this doctrine to be correct in the distinction between non-productive and productive works, there are many people who will say that to some extent the local authority must carry on "trade," must embark in productive works, and that one of the primary necessities which they are justified in trying to deal with is locomotion within their own area. Then comes the difficulty of saying where you are to draw the line. Once answer the first question, mentioned at the commencement of these remarks, in the affirmative; once admit that some class of business in locomotion, some "trading," may be taken up by the municipality, it is impossible to say where they shall stop. First, they want to extend their own area; they must get outside by hook or crook. Then they will try to run 'buses to connect two points of their tramway system, as the London County Council did. Again, one authority may risk the rates in an experimental form of locomotion which results in a loss; another local authority will take 10 years to consider what is the best scheme to adopt, leaving the inhabitants all that time suffering under the want of proper means of communication, and while the local authority thus considers private enterprise will cover an area with tramlines, risking its capital to serve the public convenience, as actually happened in West London. Again, the local authority does not rest content with buying cars; they extend their trading to manufacturing clothes for the use of their servants—for example, Liverpool. It is obvious that once any kind of productive enterprise is allowable, no sort of hard-and-fast line can be drawn. The result is inevitable; the local authority will trade to any extent. There is no restraint; the matter to which it is everybody's business to object never finds an individual objector.

Take another illustration of non-productive works. The lighting of streets is a primary duty of the local authority; obviously it cannot pay. The elementary process of paying somebody else to supply you with the means of carrying out your public duty is too bald and sterile for the modern councillor. He does not like paying a gas company a fixed sum every year without seeing any return coming in for it. He wants to get some cash return for the money expended; this is the vital error at the root of all which follows.

It is too plain for argument to demonstrate that a coun-

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cillor's first duty is not to hunt for profits, but to pay out and to keep payments out as low as is consistent with efficiency The council proceed to acquire the gasworks, with the avowed intention of selling their gas at a profit to the people who want it, and thus recouping part of the expenditure on street lamps. Let us apply the same principle as in the case of highways. Assume that the distinction between non-productive and productive works is the correct doctrine, it is clear that the council ought not to sell gas at a profit to the individual consumer. Assume you refuse to apply this doctrine, and say it is right that the council should buy the gasworks because they will sell the gas cheaper than a company will to the individual, you are immediately confronted with two serious objections. Firstly, the business is not for the benefit of all the inhabitants, whereas street-lighting is. The gas is sold only to those individuals who want it; there are many people who do not want it, who cannot afford it; there are others who prefer lamps or candles. In other words, this affair is a competition in which the council are trying to sell their illuminant cheaper than any other form of illuminant, and the ratepayer who makes a living out of selling oil or candles, and the ratepayer who earns a livelihood by selling lamps, each has to pay so many pounds a year in rates to the council to enable them to become his rivals in trade; each has to subsidise the council until they can compete successfully against him, and he has to put up his shutters. Is that fair?

Of course, the individual must suffer; and let be carefully observed that in this case it is not for the benefit of all the inhabitants he suffers loss, but only for the benefit of those persons who desire to use gas as an illuminant. The council are, therefore, catering for a part at the expense of the whole. On the other hand, the streets with the benefit of street-lighting are used and must be used by all the inhabitants.

Then there is the second serious objection. No line can be drawn here any more than in other cases. Once admit the right to sell gas for the purposes of lighting, then why should they not sell it for the purposes of power. Even now Manchester is competing with the Mond Gas Company by endeavouring to sell their gas so cheap that manufacturers will use it as a power gas in preference to the Mond gas. Why may not the local authority sell it for heating purposes, regardless of the competition thereby created with all other forms of artificial heat supplied by individual ratepayers? Neither need the authority stop here. Why should it not deal in gas fittings as well, selling them retail as Birmingham does, where the unfortunate tradesman has to pay 7s. in the £ to enable the Town Council to compete with him and ruin his business.

It is worth while turning to another aspect of the question and see what enormous facilities the local authority has got when it chooses to compete with any form of enterprise. Take only the two examples above mentioned. If the council want to lay tramlines, then as highway authority they offer no objection to the damage done to the roads; they ask for no compensation, they demand no maintenance, and, in fact, their accounts as a tramway authority of the tramways working are usually wholly misleading. The profits shown are nothing like the real profits, because as highway authority the council take most of the burdensome expenses off the tramway business.

Look at the lighting question or the supply of electricity. The laying of pipes under the highway is easy enough when the council are the highway authority. They may do things and frequently do which in any private company or individual would constitute a serious nuisance, but there is nobody to check or restrain the council, because they have all powers in their hands. Clearly this does not benefit the inhabitants who want to use the highway, nor is it fair competition against any individual who embarks his capital in a similar enterprise.

There are other serious dangers besetting an increasing sphere of profit-making enterprise by local authorities; necessarily it leads to having many employés, and the power of the franchise vested in each of these tends to make the administration of affairs anything but impartial. This has been painfully evident in the proceedings of more than one county council The larger the army of servants, the more tendency there is to undue public influence exercised through the vote, or to secret private corruption exercised upon the individual. There is also the risk that the benefit of the inhabitants as a whole is completely forgotten in an endeavour to cater for some individuals who may happen to want a particular thing, which is really only another way of putting the distinction between non-productive and productive works.

If it is asked why the growth of trading by a council has increased so rapidly of late, it may be answered that it arises from the endeavour to attract a better class of men on the local council. The doings of an obscure vestry or some unimportant authority were not sufficiently attractive to induce any man of position to give his time and devote his energies to such work. A wider field had, therefore, to be provided for the scope of those powers which are to be found in a successful business man. Thus it was hoped he would be induced to devote some of his time to public work. With this object in view, the policy of succeeding Governments has been to magnify the position of the local authority, to increase, to add to their duties. No doubt the result has been to attract a far better class of men to the board of the council than has hitherto been seen there, but the result of this policy has borne an unexpected fruit. The new councillors were not content with the powers given to them, they sought to extend them. The apparently large scope of the matters entrusted to them by Parliament was soon discovered to be restricted on every side by departmental regulations: here the Home Office, there the Local Government Board, and in another direction the Board of Trade. What was the result? These men of business sought to free themselves from such shackles, they deliberately extended the field of their activity because they found insufficient outlet for their business proclivities in the dull routine of public work. They promoted Bills which became private Acts of Parliament. They procured provisional orders. They tried by every scheme and artifice, by the exercise of their public and private power, to extend the scope of their public work. In plain words, they carried into public life the habits of their private career. It was foolish to expect otherwise! The Government has found that a man does not drop his acquired proclivities for extending his business when he goes into the council-chamber. It is too late to complain; the only thing to do now is to act.

Before suggesting any remedy, let it first be carefully noted that the non-productive work of the local authority tends to increase; there is no sign of its diminution. Everything points to an increase of the duties of the councillor. Already the power of assessment has been transferred in the Metropolis to some of the borough councils; unquestionably this power will before long be vested in the local councils all over the country. Poor-law guardians have really no practical or historical connection with the valuation of property. Once part of the powers of the guardians are taken away, it is but a step to transfer their other powers. The care of the sick is now cast upon the local authority, who have to find a hospital with other requirements; the care of the pauper sick must soon follow With that comes provision for the aged and the maintenance of children, which leaves only the able-bodied pauper or casual wayfarer to be dealt with. There is every symptom that the whole of the powers of guardians of the poor will, at no distant date, be united in the hands of the local authority.

As to education, already the movement has begun. Before long the powers of the school boards will be transferred to the local council. When these and similar public duties are part of the business of the local authority, surely there will be enough scope for the activity of the best business men. It may be that an alleviation of the present passion for trade is to be found in giving more public work to the local authority.

Further, it may be suggested that legislation is imperatively called for which should absolutely forbid certain enterprises.

With regard to other businesses which are upon the doubtful line, the local authority for the purposes of trade should be put upon equal terms with all individuals who may desire to compete with them; otherwise a monopoly

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must grow up, and the objection to monopoly in any hand, whether private or public, only needs to be mentioned. Moreover, in all enterprises profits made out of the particular trade should be strictly applied to the carrying on of that trade. Such profits ought not to be handed over for the reduction of the rates, still less ought they to be employed in the furtherance of some other project of the council. The accounts should be kept upon prescribed lines, and the proper sums should be allowed as expenses and outgoings, which would have to be provided for by any private company; in other words, in calculating their profits, the local authority ought not to be allowed to make use of their other public powers. No harm can come from applying profits to the benefit of the trade in which they are earned, because the only justification for such trade is the benefit of the individual ratepayer, who is the consumer, and the cheaper he can get the article the better for him.

The suggestions here thrown out are not necessarily meant to be conclusive. It may be that the difficulty is, in the present state of things, to secure any widespread appreciation of the doctrine of non-productive works. But every thinking man knows that there are some limits beyond which he would not wish the local authority to proceed. To discover and define these limits is most difficult, if not impossible; still, it is hoped that the foregoing remarks may lead to some elucidation of the problem, and may be of assistance to all who are interested in considering the pressing question of municipal trading.

QUESTIONS AND ANSWERS.

[The following answers received to Question No. 492 were unavoidably held over from our last issue.—ED. *E. E.*]

Answer to No. 492 (*awarded* 5*s.*).—Cross-talk on telephone lines is generally accounted for by the loose term "induction." It is not so well known, however, that it is to electrostatic induction particularly this trouble is due, and only in a much smaller degree to electromagnetic effects, as many still are apt to think. This error, perhaps, originated with the knowledge of the inducing effect of the magnetic transforming coil, which is an essential part of any long-distance telephone. On a route of single-wire circuits it may be taken that over 80 per cent. of the noises and cross-talk is caused by electrostatic charges; the remainder being either due to earth currents, atmospheric conditions, magnetic induction, or leakage through weak insulations, etc., according to the circumstances. It will be seen, then, that as long as these aerial wires have "capacity" (and a 10-mile wire has a considerable surface area, which forms the prime factor), so must the charge on them be affected by neighbouring charges. To reduce the area means having a thinner wire, which, besides increasing the resistance, reduces the tensile strength of the line. The condition of the dielectric (the air) cannot well be altered, and its thickness—*i.e.*, the distance of the wires apart—can only be

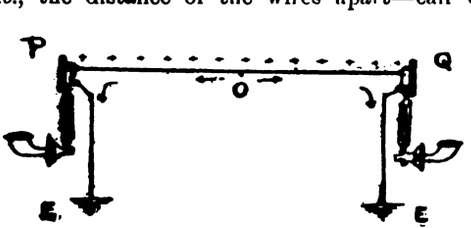

FIG. 1.

increased within limits. Hence there is no doubt that the absolutely sure remedy is to run another similar wire, B, as return, equidistant with A, from the lines of disturbance. This wire, then, will receive corresponding equal charges, which, acting in the opposite direction, so neutralise the effect on the receivers in the circuit.

An artificial method of reducing the noise may be suggested by the accompanying diagram (Fig. 1). Let P Q represent the line charged by its surrounding influence; then, presuming everything is uniform, the centre of the resistance is at 0, and should the charge become less or reversed there will be a flow of current through each of the receivers to earth in direction of the arrows, and *vice versâ* for an increasing charge. It will be seen that the receivers being equidistant from the electrical centre of the circuit, they will both hear the induced sounds to the same extent. If, now, some key device be fitted to the receiver, which, when the listener depresses, introduces a coil (Fig. 2) equal in resistance to the line and the apparatus at the far end, it will be seen that he puts his own receiver temporarily at the electrical centre of the circuit, at which point the induced charges are nentralised and no noise is heard.

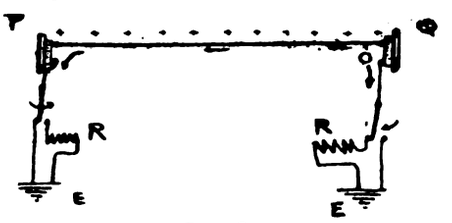

FIG. 2

These keys, of course, must be depressed alternately, or they are non-effective.—F. N. D.

Answer to No. 492 (*awarded* 5*s.*).—There are many faults that would cause loud noises and cross-talking in a telephone circuit. First of all we shall deal with the microphone. It takes very little battery power for the speaking circuit, three No. 1 Leclanché cells being quite sufficient for the telephone in question—that is, if the line wire is 10 miles long. If too much current is given to the microphone, scratching and grating noises will be heard The same noises may be heard if there is a loose connection or bad joint in the circuit. If only one receiver is at fault, the instrument may want a little

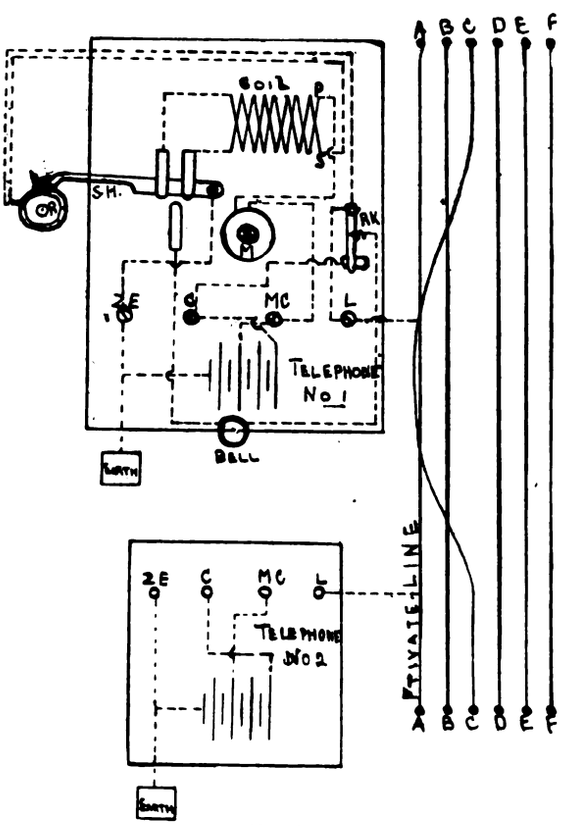

FIG. 1

adjusting, or perhaps a speck of dirt has got between the diaphragm and the poles of the magnet.

There are only two alternatives for cross-talking—namely, neighbouring wires coming into whole or partial contact with each other, as shown in Fig. 1, also induction. Suppose the line wires *were* to be in contact with each other and all the returns earthed the same as the telephone in question, the current would flow when the speaking circuit was made thus. Along the line wire, through the receiver and secondary winding, and return through earth, it also

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flows from microphone copper, through microphone and primary winding, unto switch hook, and back to zinc and earth, and so putting all telephones in circuit with each other, according to whichever lines are touching. It would also ring the telephone bell whenever the neighbouring wires were in use. This can easily be detected and put right by means of testing with a galvanometer, as shown in Fig. 2. Test each of the neighbouring wires one at a time, always keeping one wire from galvanometer on the private line, and use the other one on the neighbouring lines. When you get a deflection, then that is the wire that is doing the damage. They must be separated, and if that does not stop the cross-talking, then it is induction through the neighbouring wires.

When a telephone is employed for conversing through one of a number of telegraph wires suspended on the same poles, it has been found that messages sent by ordinary telegraphic instruments along the other wires that loud taps can be heard; so loud are these taps that they interfere with the conversation. By experience it has been found that the starting or stopping of a current in one wire induces a current in a neighbouring wire.

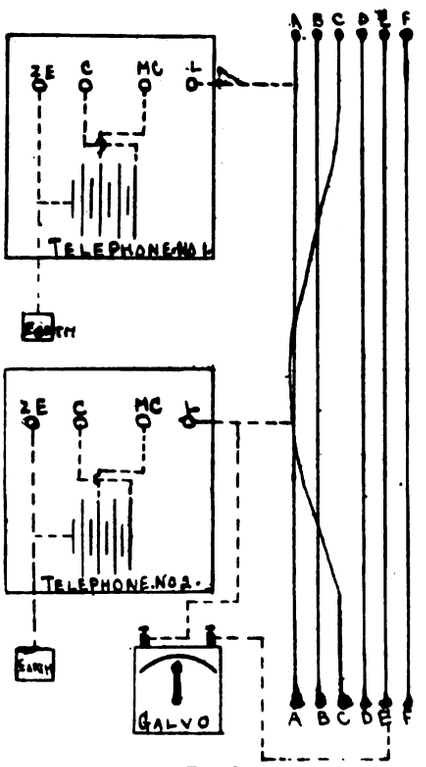

Fig. 2.

The telephone in question would answer best on metallic circuit. Both wires should be so placed with respect to every neighbouring wire that it will influence them both equally. The insulators on the posts should be at two heights, which we will call high and low, and in two positions, measured laterally, which we will call left and right. The course of a wire, if it forms a right-handed quasi-helix, is—high left, high right, low right, low left, high left, and so on. A complete turn is thus divided into quarters by the insulators. When there are four wires, the two which belong to the same circuit differ in position by half a turn, and from the wires of the other circuit by a quarter of a turn. The courses of all four are alike, and have one and the same axis.—J. P. S. Sunderland.

Answer to No. 492 (*awarded* 5*s.*).—Cross-talk between two telephones is often a very difficult matter to eradicate. There are a few devices used for reducing this inductive disturbance, but none of them can be said to entirely eliminate the trouble. One way by which this trouble can be surmounted is to reduce the sensitiveness of the receiving apparatus so as to make it insensible to induction currents, though responsive to telephonic currents. But, although this method would prevent "S. B. W." from hearing the conversation going on through the other telephones, yet it would not prevent them from recording his conversation. Another way to overcome the difficulty is to neutralise the effects of induction. This can be done by crossing the wires at every third or fourth post (see Fig. 1). This method is generally adopted where there

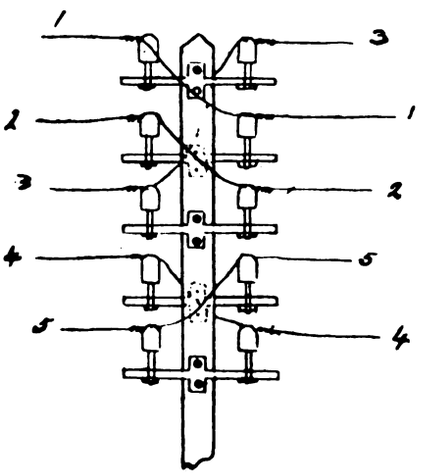

Fig. 1.

are several wires on one post, and reduces the cross-talk to a minimum. Since "S. B W." says "other than a metallic return," one gathers that he thinks that if that were laid it would end the trouble.

Perhaps I may quote Sir W. H. Preece on this point: "If, in Fig. 2, 1 and 2 be two wires running side by side, then the induction from neighbouring wires in one wire is neutralised by the currents set up in the other wire. But then this assumes that the disturbing wires are at an infinite distance from 1 and 2, or that 1 and 2 are infinitely near each other. All attempts to use return wires on existing poles or in cables have utterly failed to do away with inductive disturbance."

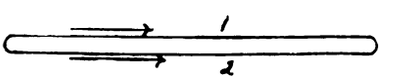

Fig. 2.

As a proof of the foregoing, I will state an experience the writer had while engaged in fixing two telephones, the wires of which ran parallel—*i.e.*, on the same posts—for about 1¼ miles. First of all, we ran the two line wires, and had an earth return for each instrument. Cross-talk between the two was very distinct. We next ran a metallic return for one instrument, but the disturbance was as pronounced as ever it was, and it was not until we introduced a method of crossing on the same principle as Fig. 1 that the trouble was sufficiently overcome.—W. F. Saunders.

Answer to No. 492 (*awarded* 5*s.*).—There is no really effective remedy for the cross-talk other than the employment of a metallic circuit, but from the nature of the question, it is probable that an improvement might result from the introduction of high resistances at the extremities of the line, and the use of induction coils having a higher ratio between the secondary and primary windings than those ordinarily used, in order that the increased E.M.F. thus obtained may overcome that of the obtrusive disturbances, and have a sufficient margin to act effectively through the increased circuit resistance. An increase in the speaking battery power might likewise prove beneficial, but this can be done only within relatively narrow limits, as too strong a current in the transmitter circuit is productive of minute arcs, which are fatal to the transmission of speech. The best conditions in both these cases could only be found by trial. If the single-line circuit is on the same poles as the other disturbing wires, part of the difficulty may be due to leakage, in which case we must look for the remedy in the thorough earth wiring of the poles.—A. F.

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NOTES.

Dublin Section.—In consequence of the resignation of Mr. F. Gill, who is leaving Dublin, Mr. W. Tatlow, M.A., B.E., has been appointed hon. secretary to the above section of the Institution of Electrical Engineers, and all communications should be sent to Mr. Tatlow at 20, Fleet-street, Dublin.

A Thousand Pounds for Wireless Telegraphy Research.—The curators of the Jubilee Foundation of German Industry have awarded Prof. Slaby £1,000 for the purpose of enabling him to prosecute his studies in connection with wireless telegraphy on the Slaby-Arco system of wireless telegraphy, which has been introduced into the German navy.

Western Society of Engineers.—The June issue of the *Journal* of the above society, which has its head-quarters in Chicago, has just reached us. In its contents are included the following four papers: "Wet, Dry, or Medium Concrete," by Mr. H. W. Parkhurst; "Mechanical Draught," by Mr. F. R. Still; "Early Engineering in Chicago" and "The Economic Need of Technical Education," by Mr. V. C. Alderson.

Bombay Tramways.—The Corporation of Bombay are about to purchase the tramway undertaking within the municipal boundary which is owned by the Bombay Tramway Company. The purchase is to be at a figure determined by arbitration, and Mr. H. V. R. Kemball, an executive engineer of the Indian Public Works Department, is to act as arbitrator. We gather that the Corporation is paying a large proportion of the cost of the arbitration.

The Cauvery Power Scheme.—We understand that the electric and hydraulic work required for the utilisation of the power of the Cauvery Falls is now practically complete, and that experimental runs of the machines have been made. Our contemporary *Indian Engineering* has a note on the subject in its issue for June 28, in which, as usual, it throws doubts on the success of the undertaking. Without a more detailed account of the equipment we have no means of judging how far these doubts are reasonable, but it is certainly not fair to assume that a continuous supply of energy cannot be given by means of an electric power distribution scheme. As the present undertaking is to supply mines in areas where coal is dear, it has every chance of success, provided that its capitalisation is reasonable.

New South Wales Tramways.—The increase in the passengers carried each year by the Brisbane tramways since the introduction of electric traction has been most remarkable, as is evidenced by some abstracts made in the columns of our contemporary the *New South Wales Railway Budget*. From this it appears that the first electrical car on these tramways commenced to run on June 21, 1897, and the last horse car went out of service at the end of May, 1898. At that date 32 electrical cars were required to give the service, whereas now over 70 are in use. The average number of passengers carried by horse cars during the years 1894-5-6 was 4,160,000; while the numbers carried by electric cars are in round figures as follows: 1898, 8,460,000 (first year with electric cars); 1899, 11,960,000; 1900, 13,397,250; 1901, 16,183,800; 1902, 20,000,000 (estimated). During the eight days ending May 25 (Royal visit) there were 632,067 passengers carried.

The Pacific Cable.—There is every probability that the Pacific cable will be laid and exchanging messages between this country and the other side of the world by November; at least, so says Mr. C. H. Reynolds, the general manager of the undertaking, who has recently returned from superintending the inauguration of the southern section of the cable. Australia has now been connected with New Zealand, and the line has been laid as far as the Fiji Islands. The steamer "Colonia" is now on her way to Vancouver, and from that point, which is the terminus of the system, the cable will be carried to Fanning Island by the "Colonia," while the steamer "Anglia" will join up the section between Fanning Island and Fiji. From Vancouver the messages will be transmitted across Canadian wires, but nothing has yet been settled with regard to an all-British cable from Canada to England. As we stated last week, the subject will probably be considered by the Colonial Conference before its deliberations come to an end.

Electrolytic Condensers.—At the recent Pittsburg meeting of the American Association for the Advancement of Science a paper "On the Effect of Electrolytic Condensers in Alternating-Current Circuits" was read by Profs. A. Trowbridge and E. R. Wolcott, University of Wisconsin. An oscillograph of the Duddell type was used to get current and E.M.F. curves simultaneously. A comparison of these showed that there is a true phase difference, and that a sine wave is not distorted. Two aluminium electrodes in a solution of $Al_2K_2SO_4$ gave the best results. A set of experiments made with platinum electrodes in sulphuric acid solution led to these conclusions: (1) the current through the electrolytic cell is not in step with the applied E.M.F.; (2) the higher the applied E.M.F. the higher is the value of the capacity; (3) the greater the distance between the electrodes the less is the capacity, but the capacity is not inversely as the distance; (4) the equivalent resistance of the cell increases when the distance between the plates is increased. Resonance effects were obtained. The authors conclude that it seems incorrect to regard the electrolytic condenser as two condensers in series, each consisting of an electrode, gas layer, and the liquid.

Electrons.—In a valuable paper recently presented to the Franklin Institute, Mr. Mackenzie discusses the question of the divisibility of the atom. He begins by giving a concise *résumé* of the various experimental researches which have led to the modern hypothesis of electrons, cathode rays, Leonard rays, Becquerel rays, etc., and the Zeeman phenomenon, and outlines the different methods by which Prof. J. J. Thomson has calculated the relation of the mass of electric charge of an electron and both these quantities separately. The mass in grammes of a negative corpuscle or electron in a gas at low pressure is about three divided by the twenty-sixth power of 10. It is found not only in low-pressure vacuum tubes, but is given off by incandescent metals, by metals illuminated by ultra-violet light, and by radio-active substances, and in every case it has the same mass and the same charge, and a velocity which is a large fraction of that of light, the radium corpuscles having the greatest velocity—namely, two-thirds that of light. The author freely discusses the bearing of this hypothesis on the structure of matter: "If mass is our criterion, we have in the electron a sub-atom, and since it is the same for all elements, we have by inference the ordinary 70 odd atoms as aggregations of this sub-atom."

Resistance in Lightning Arresters.—At the recent annual convention of the American Institute of Electrical Engineers, Mr. P. H. Thomas presented a paper showing the use of both shunt and series resistance in the successful operation of lightning arresters for high-tension transmission lines and circuits. In the course of the ensuing discussion, which is shortly reported in the *Electrical Review* of New York, Mr. Steinmetz stated that the three essentials of successful lightning arresters were: first, series resistance; second, a multiplicity of spark gaps; and third, large terminals, so that the heat might be rapidly

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conducted away from the point of arcing. An ideal lightning arrester would include no resistance, but this is impossible owing to the vicious short-circuiting which would occur, causing bad surging and burning. It was also shown that there is required a smaller voltage to maintain the arc than is required to strike the arc. Therefore, if there were means for increasing the resistance of the circuit after the arc had established itself, the effects on the line as to surging and the burning of the lightning arrester would be greatly decreased. Such an arrangement might be accomplished by utilising a smaller number of gaps over which the spark would pass, and then increasing the number in order to break the current.

The Gordon Bennett Cup.—At the Whitehall Rooms of the Hôtel Métropole on Wednesday last an interesting and somewhat unique banquet was held, at which there was received for the first time in this country the Gordon Bennett International Cup, which is held by the automobile club of the country whose representative wins the annual international motorcar race. For this race each competing country enters three of the best cars which the country can produce, and these cars are driven by the most expert drivers. The cup was first raced for in 1900, when it was won by M. Charron for the Automobile Club of France. In 1901 it was won by M. Girardot, again for the Automobile Club of France; but in 1902 it was won by Mr. S. F. Edge on his 30-h.p. car, manufactured by Messrs. D. Napier and Sons, of Lambeth, for the Automobile Club of Great Britain and Ireland. The race was from Paris to Innsbrück, and Mr. Edge defeated the three French champions—M. Girardot, on a Charron-Gir-Voight; the Chev. Rene de Knyff, on a Panhard-Levassor; and M. Fournier, who was driving a Mors car. The banquet was given in honour of Mr. Edge and Mr. Napier; the handsome silver trophy being received from the Automobile Club of France by Mr Roger W. Wallace, K.C., the chairman, on behalf of the Automobile Club of Great Britain and Ireland.

Velocity of Light.—The retiring address of Vice-President D. B. Brace, of the physics section of the Pittsburg meeting of the A.A., was on "The Group Velocity and the Wave Velocity of Light." He traced the history of the measurement of the velocity of light from the time of Galileo to the present day, both physical and astronomical methods. The highest accuracy at present attained was one part in five thousand. He showed that no method heretofore used in the laboratory had given the absolute velocity of light. He pointed out, further, that from astronomical observations light of all colours travel with the same velocity. He claimed that the observations by the American observers were superior to those of foreign observers. He showed, further, the bearing of electro-dynamic experiments on the velocity of light. He pointed out the difference between what is called the group velocity and the wave velocity, and illustrated it by a group of waves on water, showing that the individual waves move with a different velocity than the average mean of all of them. He pointed out the connection with that of the velocity of light, and showed that no method had yet given the true absolute velocity. He described some new methods for determining each of these velocities, and light moves with a velocity of 185,000 miles per second; these methods could detect that there was such a thing as the velocity of light in a distance of less than 1in., thus illustrating the extreme refinement of modern methods in research.

Power Lost by Flywheels.—A series of tests recently concluded in the Nurnberg central electricity station, show very clearly that the resistance which a flywheel offers to the air may give raise in some cases to a considerable waste expenditure of energy. The station in question is provided with two tandem compound engines of 450 h.p., direct-coupled to the dynamos, and working at 95 revolutions per minute. In order to equalise the running with the great variations of load which occur, a very heavy flywheel was used with the arms of a channel section. These arms were found to offer a great resistance to the air and to create a powerful draught. It was therefore decided to cover the wheel with sheet iron in order to reduce the resistance, and thus gain considerable power. In order to test the amount of energy lost, the dynamo was made to run as a motor, and thus drive the engine and flywheel at no load. When the latter had no protecting covering it was found to absorb 13,300 watts, but when the covering was replaced it took only 9,874 watts, thus showing a gain of 3,426 watts, or 5·7 h.p., this being 1·2 per cent. of the power of the engine. Counting the current price per kilowatt-hour and a day's run of 17 hours, it was calculated that this represented an economy of nearly £56 annually. Another test of a similar nature was made upon a 630-h.p. engine, and showed an economy as high as 30 h.p., or 4·8 per cent. of the engine power, which was gained by properly diminishing the air resistance of the flywheel.

The Niagara Power Plant.—At a recent meeting of the Institute of Electrical Engineers of America, Mr. H. W. Buck read a paper on the "New Generating Plant of the Niagara Falls Power Company." This paper is now being reproduced in full with illustrations in the *Electrical World* of New York, and it is worthy of the most careful attention of all engineers having to do with large generating units. Owing to the fact that the company is the great landowner of the district, it has attracted large consumers of power, and in consequence the bulk of the energy taken by the company from the Niagara Falls is used in the immediate neighbourhood of these falls. In the earlier days a good many looked to the transmission of power to a distance as the means of providing load for the company's plant. The directors' idea, however, of combining cheap power with a land scheme has proved most successful and has attracted to Niagara large new industries to which cheap electricity is a *sine qua non*. In the new plant recently installed the old frequency and size of unit—*i.e.*, 5,000 h.p.—has been maintained, and the machines are still of the two-phase type. On the Canadian side, however, 10,000-h.p. units are to be adopted. The company will have, however, some 21 units of the 5,000-h.p., each coupled to its own turbine, on the American side. We understand that the old umbrella type of dynamo is now to be abandoned, and that vast improvements in the switchboard equipment are to be made. As we mentioned above, our readers will do well to consult the paper itself and its illustrations for the details of the new equipment.

Stand-by Charges.—The question of the charges to be made by electric lighting undertakers, whether municipal or company, for a partial supply to act as a stand-by to a private plant is one which was overlooked in the drafting of the Electric Lighting Acts. Under these Acts and the provisional orders issued under them, the undertakers who refuse to give a supply to any consumer along their mains exceed their powers. In order to obviate the unfairness of the present state of the law, amendment is needed. In the meantime we note that the Glasgow Corporation in their Bill for acquiring the right to supply gas and electricity in certain new areas have successfully added the following clause: "Notwithstanding anything contained in the Corporation's electric lighting order of 1890, or any other that may be granted to them during the session of

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1902 for the supply of electrical energy, or in the Electric Lighting Acts, 1882 and 1888, a person shall not be entitled to demand from the Corporation a stand-by supply of electrical energy to premises having a separate supply unless he shall have previously agreed to pay to the Corporation such minimum annual sum as will give them, for such period as may be agreed, a reasonable return on the capital expenditure and other standing charges incurred by the Corporation to meet the possible maximum demand of such person. In case the Corporation and the person demanding such supply of energy fail to agree as to the amount of the minimum annual sum and the period for which it shall be paid, it is to be fixed by an arbiter to be appointed by the sheriff on the application of either party."

A Large Turbine.—One of the largest steam-turbines yet installed in any station in the world for electric generating purposes is the 2,500-h.p. machine which is now at work in the Pearl-street station of the Hartford Electric Light Company, in the United States. This unit, which is illustrated in the current number of *Power*, has a rated capacity of 1,500 kw., but it is said to carry a load of over 2,000 kw. with no indications of distress and with little loss of efficiency. The length of the steam-turbine over all is 33ft. 3in.; extreme width, 8ft. 9in.; and floor space required, 291 square feet. Its weight, including the generator and fittings ready to run, is 175,000lb. Rating it at 1,500 kw., this is about 116lb. per kilowatt, which compares very favourably with other types of prime movers. The diameters in the Hartford turbine are 24in. at the smaller end and 86in. at the larger. There are in all about 31,000 blades, some 16,000 of which are moving, varying in length from 1¾in. at the high pressure and to 8in. at the low pressure. The exhaust outlet has an area of 10 square feet, or 22·63 times that of the supply pipe. Prof. W. L. Robb, the electrical engineer to the company, has made tests of the turbine, but as yet only the following fragmentary results are available for publication. At a quarter load the steam consumption per kilowatt-hour came out at 28lb. and the coal consumption 2·7lb.; at half-load the figures were 23lb. and 2·1lb. respectively; at three-quarter load, 20·3lb. and 1·9lb.; and at full load, 19·1lb. and 1·7lb. respectively. The average vacuum was 27in., the average superheat 30deg. F., and the average steam pressure 155lb. More complete figures are promised shortly.

A.A.—As the British Association for the Promotion of Science is usually called the B.A., we presume the similar association in America may well be designated the A.A. This association held its annual meeting at the end of last month in Pittsburg, and it attracted some 635 members. This number seems somewhat small, but from the reports which have reached us the meeting was distinctly above the average, as the great proportion of those present were active working members. In this respect the British Association sometimes suffers, owing to the large proportion of holiday makers amongst those who attend the meeting. Amongst the communications to the association this year was one by Mr. G. A. Gibson, of the Westinghouse Company, who expatiated on the influence of the electrical industries of Pittsburg. He claimed that the United States generates 69 per cent. of all the electrical energy used throughout the world, and that of the amount generated in the States 76 per cent. was used for electric traction. He also added that 76½ per cent. of the electric tramway and railway mileage of the world was in the United States, and 83½ per cent. of all the electric cars. The fact that Mr. Gibson is able to get out these results to within ½ per cent. speaks well for the organisation of the Westinghouse Company, but we still should like to see figures making up the totals. During the meeting Mr. George Westinghouse was elected an hon. fellow of the association in recognition of the great work he has done for engineering and science. We understand that the association has only one other hon. fellow, who is Prof. Walcott Gibbs, of the Yale University. The abstracts of several papers read at the Pittsburg meeting will be found elsewhere in this issue, and for these abstracts we are indebted to our contemporary the *Electrical World*.

Tunbridge Wells Telephones.—Up to the present neither side in the fight between the rival telephone interests in the Tunbridge Wells district is tired of the newspaper war which has raged since the opening of the municipal exchange. The condition, however, has become so serious that the local papers have taken sides, and the supporters of the municipal undertaking will only send their letters to one particular organ. In the same way the longer and more heated remarks of the supporters of the National Telephone Company all appear in the paper which editorially condemns the Corporation's telephone undertaking. We do not think, however, that the heat displayed in these letters is felt by the majority of the telephone users. The result to these has been that they can now obtain a telephone service from both of the telephone exchanges at only a slight increase of cost over that which the National Telephone Company used to charge. They have also the advantage that the National Telephone Company have greatly improved the whole of their system, so that they have now two good telephone systems available, whereas before the Corporation commenced working they could only obtain connection to a single inferior system with few subscribers. This advantage of competition is quietly enjoyed by the inhabitants of the Tunbridge Wells district, while the few interested individuals, or those who like to see their names at the end of long letters in the Press, continue to waste their energy and time. The question as to whether the Corporation will have eventually a small balance on the right side after providing for depreciation is not the burning question these correspondents infer, as it is obvious that the Corporation cannot afford to shut down their exchanges and lose the capital invested any more than the National Telephone Company can afford to give the service they are doing at the present rates.

Education and Industry.—The Technical Education Board of the London County Council reported on Tuesday last that they in last June referred to the Higher Education Sub-Committee to enquire and report (*a*) as to the needs and present provision for special training of an advanced kind in connection with the application of science, especially chemistry and electricity, to industry; and (*b*) as to what, if any, developments are needed to secure efficient training in these subjects for senior county scholars and other advanced students who desire to qualify themselves to take leading positions in scientific industries. That report had now been received, and the sub-committee came without a dissentient voice to the conclusions (1) that England, and London in particular, has suffered the loss of certain industries, and that others are in danger; (2) that this loss has been largely due to defective education, especially in the higher grades; and (3) that London is still seriously behind other cities, notably Berlin, in the provision for the higher grades of scientific training and research. The Board concurred with the report, and recommended that it be received and circulated. At the full meeting of the London County Council Mr. Organ moved as an amendment that the following words be added: "and that the Technical Education Board be instructed to report as to the steps it

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proposes to take in order to give practical effect to the suggestions contained in the report." Mr. John Burns contended that neither London nor England was in such a bad state as some people thought, and if it was not what it might be, it was due to the fact that the country had been governed for 40 years by the ignorant upper classes, and the mechanical instinct and craftsmanship of the people had been retarded by that fact, although it had not been killed. Mr. Howell Williams was strongly of opinion that the difficulties of trade in London could be summed up in the one word, apprenticeship. What was necessary was that something should be done to encourage and increase the number of apprentices. After further discussion the report was carried as amended above by Mr. Organ. We trust that the effect may be an improvement in the scholarship regulations of the Board, so as to favour a few of the best students rather than give small assistance to a large number.

New Electric Lighting System.—A novel electric lighting system, involving as one of its constituents light produced by means of electrical energy supplied to the terminals of a gaseous column or body contained in a translucent receptacle, has been invented by Mr. D. Moore with the object of avoiding the use of electrical conductors for distributing the electrical energy to the lamps or light-giving portions of the system. Briefly, the invention may be said to consist in distributing or running a translucent tube or receptacle over the areas or rooms to be lighted. The terminals of the tube being brought to the source of energy outside of the areas to be supplied, or in a location where the terminals may be suitably protected against danger of contact or accidental interference, the tube containing a gas which is of such character or degree or rarefaction that by the application of electrical energy or current to the terminals of the tube, it will be rendered luminous by the transfer of the energy from one terminal or electrode to the other. In the practical installation of the system the translucent tube of glass could be built *in situ* in the position it is to occupy while in use, or could otherwise be distributed as a tube of glass over the spaces to be illuminated, and its terminals, which are provided with the suitable energy-transferring electrodes or caps, could be brought to a protecting cabinet or wall pocket in which they could be connected to the two poles of the energy-supplying devices. These latter might be mains or wires leading direct from the primary generator of E.M.F., or might be terminals of a suitable transformer adapted to give the required voltage at its secondary. A full description of the invention will be found in the issue of the *Electrical Review* of New York for the 28th ult. The two main advantages claimed for this system of lighting are as follows: first, the complete absence of fire risk, even when the lamp is operated by high voltages, since it is not necessary to have any metallic conductors within the areas or spaces where danger from fire may exist; and second, great economy in installation and in efficiency or consumption of power, owing to the fact that the number of electric fixtures required for holding and supplying energy to the terminals of the tube is reduced to a minimum, thus decreasing the cost for fixtures alone, also to the fact that the proportion of cap to length of luminous column is very greatly reduced.

Graphitising Electrodes.—A full and complete disclosure of the present method of graphitising electrodes and other formed articles at the Graphite Works, Niagara Falls, is given this month by Mr. C. P. Townsend in the *Electrical World*. We believe this to be the first authorised description of the process referred to which has yet been published. The principle is simple. Any form of carbon containing the impurities in sufficient quantity and of suitable kind may be graphitised. The reaction seems to occur through the intermediary of the carbides, and, in consequence, the impurities present must be of a character capable of combining with carbon, in quantity sufficient to determine the conversion to the extent desired, and the temperature must be above the point of decomposition of the carbides formed. The reaction being progressive, the amount of carbide-forming constituents actually present is relatively small. The necessary temperature is developed by the electric current, and in the latest patent taken out by Mr. Acheson, the inventor of the process, the mode of application of the current is described, the improvement recorded being two-fold in character. The articles to be graphitised are placed in the furnace with their longest dimensions transverse to the direction of flow of the current If their form be other than cylindrical they are arranged in vertical piles, separated by powdered coke. Cylinders may be placed in contact, the single-contact line reducing the current path sufficiently to develop with economy the required temperature. The furnace comprises a base and end walls of firebrick, carbon terminals, and line connections. A bed of carborundum or other refractory conductor is laid upon the base, and upon this rest the transverse piles of the formed articles, the rectangular shapes separated, and the cylinders in lateral contact. Thin layers of ground coke underlie and cover the piles, and a filling of the same material and sand is placed around and over the conductive charge It might be considered a matter of small moment whether the articles be placed parallel or transverse to the lines of current flow; but, in fact, this simple change represents a distinct principle of operation, for it means that the heat is no longer developed within the body of the article, but exterior thereto, and either in the separating layers of coke or in the single-contact lines of cylinders. That this represents a very considerable economy of current is apparent from the fact that the cross-sectional area of the terminals may be actually less than that of the conductive bed, the relation between these areas being stated as 100 to 102.

Wireless Telegraph Receiver.—Mr. A. Frederick Collins in the current number of the *Scientific American* describes a simple form of wireless telegraph receiver, which consists essentially of three parts only—*i.e.*, a coherer, an ordinary telephone receiver, and a dry cell. Supplementary to these parts are the vertical wire and the earthed connection. The author recommends the use of a specially constructed coherer using carbon granules instead of silver or nickel filings, usually employed in coherers. A carbon coherer, he asserts, has a great advantage over a nickel filing coherer, in that it is self-restoring—that is to say, no tapping is required to decohere the particles, but it assumes its normal high resistance the instant the incoming electric wave ceases to impinge upon it. Another point in favour of the carbon coherer is that the tube does not require exhaustion, since carbon does not oxidise in air like metals. To increase the sensitiveness of the coherer, the ends of the brass plugs that are inserted into the glass tubing may be immersed for a moment in sulphuric acid and then dipped in mercury, the ends thus being amalgamated, after which the ends should be wiped with a dry cloth. The thin film of mercury will prevent the oxidisation of the ends of the plugs. For connecting up to this coherer any description of telephone receiver may be used, but it should be remembered that the higher the resistance of the receiver coils the greater the sensitiveness of the receiving apparatus as a whole. There only remains now for a dry cell to be connected to the coherer, and some slight adjusting for the arrangement, to be ready for

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immediate use. The antenna, or vertical wire, may be of No. 14 or 16 insulated or bare wire. This should be at least 30ft. in length and suspended outside the building from insulators either of glass or porcelain, and just as nearly vertical as possible until the level of the instrument is reached, when the wire may be bent at right angles and led to the coherer. A wire of the same size leads to the ground, and is soldered to a copper or a zinc plate 12in. by 12in. buried in the earth to a depth of a foot or two. Besides being used as a receiver in wireless telegraphy, the above arrangement may also be employed in the study of atmospheric electricity on the difference of potential between the strata of charged air through which the antenna passes and the earth immediately under it. For practical wireless telegraph purposes this form of receiver has one objectionable feature, and that is its aptitude for registering atmospheric disturbances, and thus often confusing the operator by false jamming. The author asserts, however, that this difficulty is not a real one, as operators become so thoroughly proficient in deciphering the messages that they are usually able to eliminate the false from the true wave impulse.

The Bann Falls.—Some nine months ago we published information as to the water power available on the Bann River, in the county of Londonderry. We would remind our readers that this river is the outlet of Lough Neagh to the sea, and that an extensive system of locks was constructed years ago to enable vessels to get from the sea into Lough Neagh. Commercially these locks have not been successful, and it is doubtful if they will be kept up for the sake of the small number of craft which pass through annually. Mr. S. M. Macrory, a member of the Londonderry County Council, then explained to us his idea that these navigation weirs and canals could be utilised for a power scheme. From figures he had it was evident that at least 8,000 h.p. could be obtained from the falls in the summer and 24,000 h.p. during the remaining nine months of the year. On Saturday last Mr. Macrory brought this matter before the Londonderry County Council, which body unanimously decided to appoint a special committee to investigate the following points: (1) how far the county of Londonderry is covered by electric supply companies working under Acts of Parliament; (2) enquire as to any special facilities existing in the county for generating electricity by waterfalls, etc., and as to the practicability of such facilities being employed to advantage in the county; (3) enquire as to the financial results of electric schemes undertaken by municipal bodies; (4) enquire how far it would be practicable and wise to develop a scheme for an electric supply for the county, or through the medium of urban or rural councils, consistent with Acts of Parliament already obtained by existing companies; (5) report as to the best mode of procedure for giving effect to their findings and recommendations, the committee to have full power to enquire into drainage and navigation of the Bann. Mr. Macrory also moved: "That the Government be requested to insert in the Local Government (Ireland) Amending Act, 1902, a clause to enable Irish county councils to promote Bills in Parliament for objects such as obtaining powers to construct and work tramways, and to levy fares; establish and work ferries, and levy fares; the utilisation of such natural resources as waterfalls, and to levy charges for their use; and the creation of county stock for such special undertakings as might be approved by the Privy Council." This resolution was also carried. We understand that Sir William Preece is to visit the Bann Falls early in August in order to inspect the water power available. Mr. Macrory, in preparing information to lay before his County Council, has had the advantage of the practical experience of his son, Mr. R. V. Macrory, the borough electrical engineer of Londonderry, and also of his eldest son, who is a Royal Engineer. There is no doubt but that such a power scheme would be of great advantage to the district, and it is well within the range of commercial engineering to distribute power from these falls to Belfast and Londonderry, which towns are only about 40 miles distant from what would be the site of the main generating works.

Electro-Pneumatic Railway System.—Mr. Bion J. Arnold gave particulars at the recent annual convention of the American Institute of Electrical Engineers of a single-phase railway system based on quite novel principles which he is installing on a 20-mile road in Michigan, in the United States. The system is named by Mr. Arnold the electro-pneumatic system, and its chief features are described by him as follows: A single-phase or polyphase motor is mounted directly upon the car, designed for the average power required by the car, and running continuously at a constant speed and a constant load, and, therefore, at maximum efficiency. Instead of stopping and starting this motor and dissipating the energy through resistance, as is customary with all other systems, the speed of the car is controlled by retarding or accelerating the field or stator of the motor, by means of compressed air, in such a manner that a portion of the energy is saved which is ordinarily dissipated through resistances, and stored to assist in starting the car, helping over grades for use in switching purposes, and for the operation of the brakes. By this method of control, it is claimed, an infinite number of speeds are secured from zero to the maximum speed of the car, which latter may or may not be at the synchronous speed of the motor, for with the air-controlling mechanism working compressing the speeds below synchronism are maintained, and by reversing the direction of the air through the controller speeds above synchronism may be attained for reasonable distances. In the author's opinion this feature gives to the alternating-current motor the element absolutely essential for practical railway work, for it permits a car or train to ascend a grade at any speed with the motor working at its maximum efficiency, and imparting its full power to the car. When descending the grade the motor may utilise its full power drawn from the line in compressing air, or it may be used to compress air with the stored energy of the train, thereby acting as a brake. Another advantage of the system is that since a single-phase motor can be used the motors can be supplied with current from a single overhead wire or third rail, and with a single-rail return circuit. In the installation in question the current will be taken from the working conductor at any voltage up to the limit of the installation, and in case this voltage is high a static transformer will be carried upon each car, and the pressure reduced from the line voltage to the voltage of the motor, which is designed for 200 volts. Mr. Arnold claims that by the adoption of his system the following three all-important results will be obtained: (1) the entire elimination of the present standard system of rotary converter substation plant, together with the maintenance thereon and the cost of the necessary attendants; (2) it would absorb and render available for useful work in starting, or otherwise, a large percentage of the energy stored in the moving mass which under the present methods of operation is dissipated at the brake shoes; and (3) a large reduction in the first cost of electrically equipping long-distance railroads, thereby making it feasible, from an engineering and business standpoint, to equip many roads which cannot now be shown to be advisable, thus opening up the steam railway field to the industry in which we are now engaged.

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NOTES ON THE WEAR AND MAINTENANCE OF TRAMWAYS.*

BY C. F. WIKE, M.I.C.E., CITY SURVEYOR, SHEFFIELD.

During recent years the attention of municipal engineers has been very much occupied with the question of tramways, and particularly those worked by electricity. As this form of traction has only lately been adopted in this country to any great extent, most of the information published has dealt more with the question of construction than with that of maintenance, and it has occurred to the

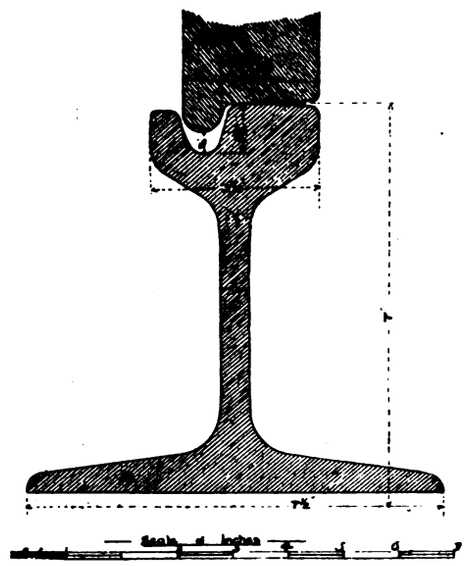

DIAGRAM A.

author that statistics and information as to the wear of electric tramways would be of interest to members of the association. For some time observations have been made of the wear of the permanent way of the Sheffield tramways, and the broad results are given in this paper, together with a few explanatory notes.

General Statistics.—The general statistics as to the Sheffield tramway are as follows: The total length of tramways authorised is 89 miles of single track, of which up to March 25 last 50 miles had been constructed; the population is 409,000; the number of cars in use is about 160, of which about a third are single-deckers; the weight of the double-decked cars is approximately 8½ tons, and of the single-decked cars eight tons; the worst gradient is about 1 in 9·5, and the sharpest curve (except in depôts) has a radius of 40ft.

Wear of Rails.—It may first be advisable to state briefly the Sheffield specification for rails. They are of girder type, 7½in. wide on the flange and 7in. deep The weight is 108lb. to the yard, and the analysis is as follows: the quantity of carbon must not be less than 0·35 per cent., or more than 0·45 per cent.; and of manganese not less than 0·70 per cent., or more than 1·10 per cent. The quantity of silicon must not be more than 0·1 per cent.; sulphur, 0·08 per cent.; arsenic, 0·08 per cent.; phosphorus, 0·08 per cent.; copper, 0·C8 per cent., and there must be no other material present, except iron.

The following are the mechanical tests: A piece of rail 8ft. to 9ft. in length is supported on iron bearings 3ft apart, and a cast-iron monkey weighing 1,000lb. is allowed to fall freely upon the centre of the rail first from a height of 10ft., and at this blow the deflection must not exceed 1in. The second blow is from a height of 15ft., and the deflection must not exceed 2½in. The third blow is from a height of 20ft. under the same falling weight conditions, and the rail must not show any sign of fracture after the three blows. The tensile test piece must be machined

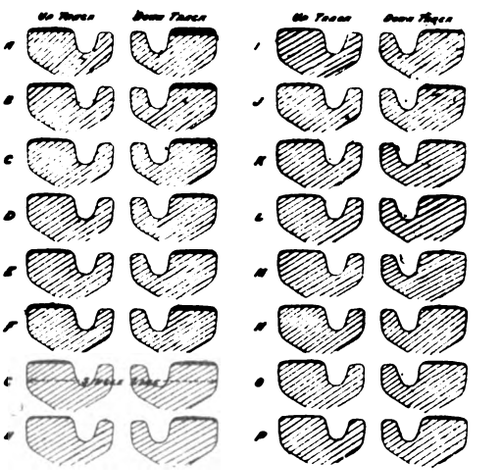

DIAGRAM B.

from the head of the rail; the area for testing must be half square inch, and the length for elongation 2in. The tensile stress must be from 37 to 45 tons per square inch, with a contraction of sectional area of not less than 20 per cent. Up to the present the rails have been rolled in 30ft. lengths, but the most recent order provides for a length of 45ft. The width of tread is $1\frac{1}{16}$in., and the depth of groove is $\frac{15}{16}$in. There is a clearance of $\frac{7}{16}$in. between the lowest point of the wheel flange and the bottom of the groove (see Diagram A), and it is considered that when the rails have worn sufficiently to enable the flange to touch the bottom of the groove their life will be at an end. Before this can happen a sectional area of 0·706in. of steel must be worn away. Observations have from time to time been taken to ascertain the rate of wear upon the rails, and the results are given in Table A. These are interesting, as showing how much more the wear is regulated by the gradient than by the number of journeys, the reason for this being that the action of the brakes is far more destructive than the uphill traction. The figures given in the table are further illustrated by the drawings on Diagram B.

Rail Joints.—Diagram C illustrates the rail joint adopted. The fishplates are 3ft. long, and eight nuts and bolts are

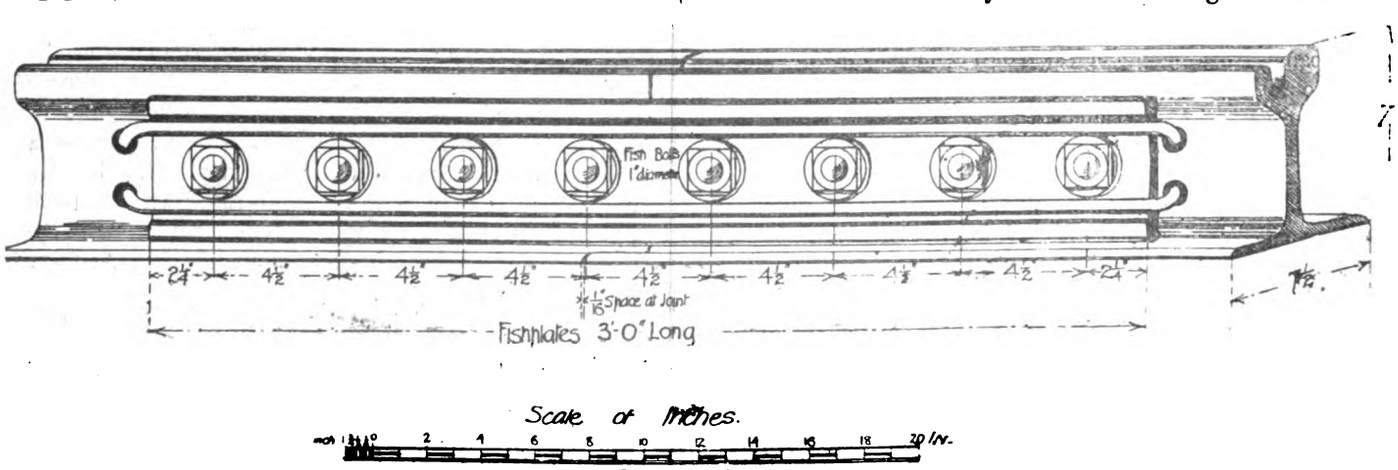

DIAGRAM C.

* Paper read before the Association of Municipal and County Engineers.

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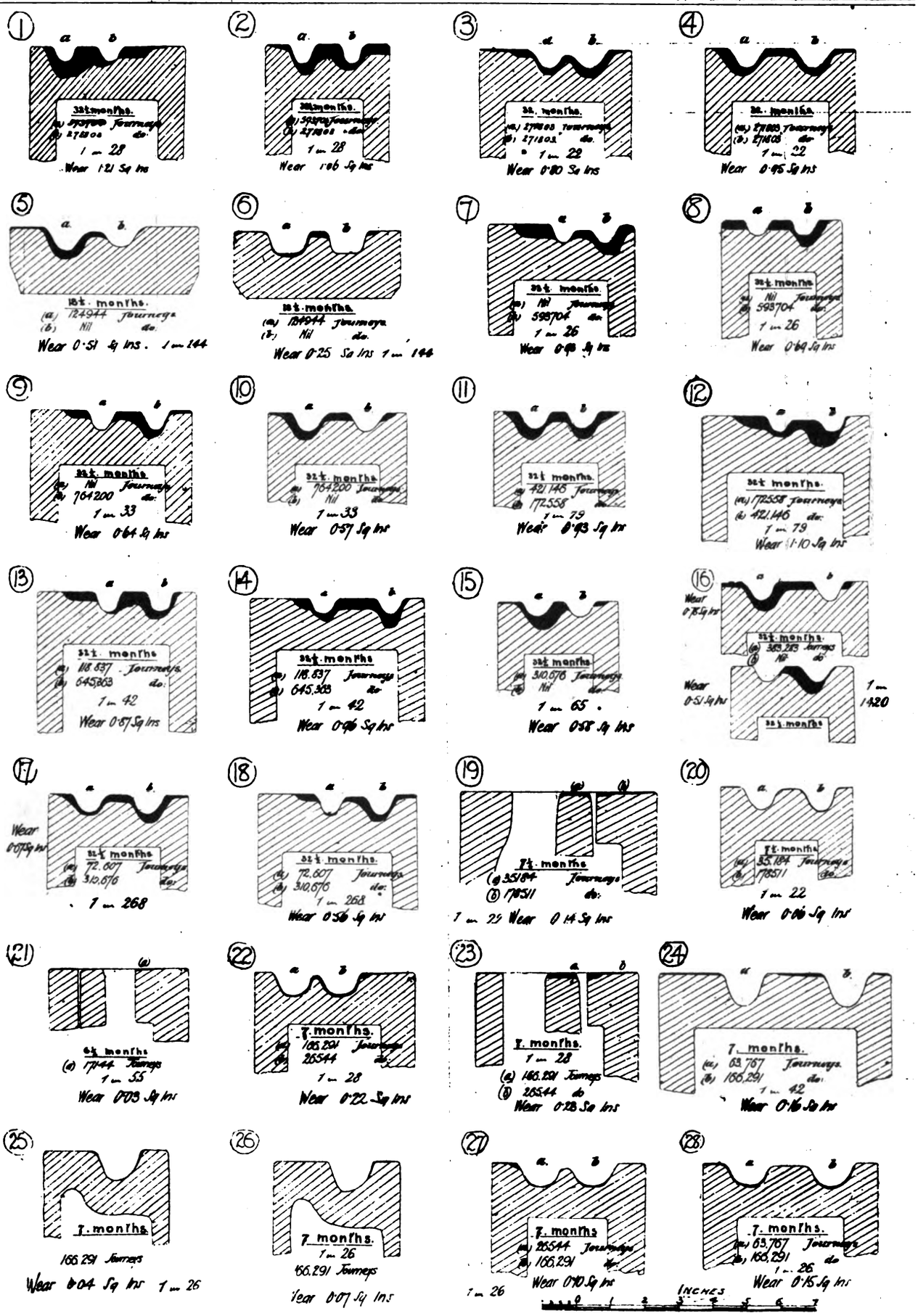

DIAGRAM D.

used to each joint. The weight of the fishplates is 80lb. per pair, and the specification is the same as for rails. Lock-nuts have been used. A space of $\frac{1}{16}$in. is left between the rail ends to allow for expansion. Some of the older and most used lines have already been taken up for the purpose of laying additional cross-overs or doubling the track; and it is satisfactory to know that in scarcely any case has the joint been found defective. It will be noted

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TABLE A.

—	Gradient.	Months wear.	Number of journeys.	Reduction of depth of groove.	Percentage of total possible reduction of sectional area of tread of rail.
				Inch.	
A. down track	1 in 15	34	764,200	0·25	54·1
A. up ,,				0·09	15·1
B. down ,,	1 ,, 23	34	865,507	0·15	30·6
B. up ,,				0·09	15·1
C. down ,,	1 ,, 26	34	593,704	0·14	26·4
C. up ,,				0·06	8
D. down ,,	1 ,, 33	34	764,200	0·125	22·1
D. up ,,				0·07	11·6
E. down ,,	1 ,, 38	34	593,704	0·125	22·1
E. up ,,				0·06	8
F. down ,,	1 ,, 787	34	593,704	0·125	20
F. up ,,				0·06	8
G. Single line	1 ,, 10	34	395,656	0·10	18·7
H. down track	1 ,, 21	34	196,696	0·09	15·1
H. up ,,				0·03	3·9
I. down ,,	1 ,, 15	34	271,803	0·09	15·1
I. up ,,				0·03	3·9
J. down ,,	1 ,, 160	34	579,979	0·09	15
J. up ,,				0·06	8
K. down ,,	1 ,, 268	19	254,412	0·07	11·6
K. up ,,				0·035	5
L. down ,,	1 ,, 15	34	166,734	0·07	11·6
L. up ,,				0·03	3·9
M. down ,,	1 ,, 24	34	197,828	0·07	11·6
M. up ,,				0·03	3·9
N. down ,,	1 ,, 84	30	65,384	0·06	8
N. up ,,				0·06	8
O. down ,,	1 ,, 79	26	172,558	0·06	8
O. up ,,				0·028	3
P. down ,,	1 ,, 17	30	65,384	0·06	8
P. up ,,				0·025	2·9

that no sole-plate is used, and the author would be glad to know the experience of other tramway engineers as to the advantage or otherwise of this addition to a rail joint.

Bonding.—The bonding used is the "Chicago" type. Two bonds are provided to every rail joint, and the tracks are cross-bonded at distances of 40 yards. Up to the present no trouble has been experienced from loosening or other defects of the bonds.

Points and Crossings.—So far as permanent way is concerned, this appears to be one of the matters most in need of improvement. Several types have been put down in Sheffield, mostly of British make, but as an experiment some American points have also been tried. In these a special metal is introduced for the parts subject to the greatest wear. It is more difficult to give data as to the wear of points and crossings than as to the wear of rails, because the conditions under which the points are used vary in nearly every case. A further diagram, D, is however given, showing the amount of wear on some points and crossings of different types in Sheffield, with figures as to the number of car journeys, gradients, etc. One particular junction is, perhaps, worth special notice, and, to explain the author's meaning more fully, a plan of this (Diagram E) is appended. When the tramways were first constructed this junction was not laid quite as at present (some of the points now having been omitted), and the materials used were the ordinary rails, points, and crossings. The inner rail on the main line had a curve of 54ft. radius, and the difficulties were greatly accentuated by the fact that the junctions were on a curve, and also because, on account of the gradients of the converging streets (some of which could not be altered), it was impracticable to get the usual superelevation on the outer rails. As the circumstances were exceptional, perhaps it is scarcely necessary to go into details as to the number of car journeys over this junction, but after a period of 25 months it was considered advisable to relay it. The curves were altered so as to give a minimum radius of 60ft.; the position of the points was somewhat modified, their number was reduced, and the whole of the work was carried out both as to the rails, points, and crossings in manganese steel, the patterns and castings being made specially for this purpose. The work was a very expensive one, costing about £1,500, but the junction has since worked satisfactorily. As it has only been in use a few months since relaying, however, perhaps it is too early to express a definite opinion as to the ultimate result. The case is one almost by itself on account of the curves, gradients, position of points, tramway and other traffic, etc., and the author thought it worth while to mention the difficulties experienced and the nature of the remedy adopted.

Paving.—Various forms of pavement have been laid, including granite, wood, and gritstone setts, a Scotch basalt or whinstone, and also tar macadam with a single row of setts adjoining each rail. Several miles of the

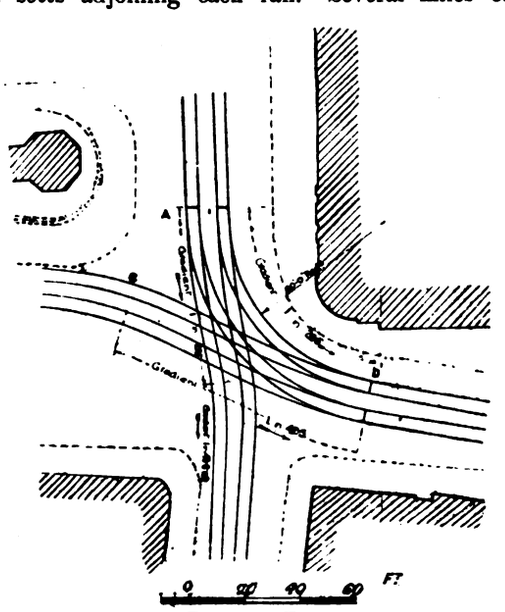

DIAGRAM E.

latter paving were laid, largely as an experiment, and the experience has been such that a repetition is improbable; in fact, a long length of track on one of the main suburban roads—which, it may be mentioned, was seen in course of construction by the association in June, 1899—has worn so rapidly that it is now proposed to replace the tar macadam track with setts. Records have been kept of the cost of maintenance and renewals, and these have been reduced to an average cost per mile per year for each type of paving. New work not necessitated by wear and tear has been excluded from the totals, and two routes to which

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special circumstances apply have been omitted. One of these—a tar macadam road—is maintained by contract, also as an experiment, and the other is subject to conditions which are not likely to obtain in another case. The figures, which are only presented as approximate, are:

Nature of paving.	Average cost.*
Granite paving.....	£19 13 6
Granite-paved tracks, macadam sides	47 9 6
Gritstone	49 11 0
Wood paving	54 8 3
Tar macadam, hit-and-miss setts against rails	64 13 3

* Average cost of maintenance (not renewal) per mile per annum, single track.

The foregoing information is not put forward as a complete and exhaustive survey of the subject. The conditions must vary in different towns; and the author hopes other municipal engineers will also give their experience. The subject is becoming an important one, as the question of allowance for depreciation, etc., is constantly arising, and it would no doubt be to the advantage not only of engineers, but also of municipalities who own tramways, if reliable data as to wear and tear were available. It would also be useful to have expressions of opinion as to the chemical analysis of the rails, the lengths of rails, and type of joint. At present nearly every specification differs in one point or other, and the Engineering Standards Committee is now dealing with the question of tramrails and their accessories in the hope of securing some degree of uniformity. The object of this paper is not only to give information, but also to elicit the views of other engineers upon a subject which is daily becoming more important, and it is hoped that opinions upon the points raised may be freely expressed.

AN INSTRUMENT FOR THE DETERMINATION OF ALTERNATE-CURRENT CURVES.*

BY RUDOLF GOLDSCHMIDT.

If a coil (S_2, Fig. 1) is moved through the field of a magnet excited by an alternating current at such a speed that the whole field is passed through in a small fraction of a period (practically instantaneously), the voltage

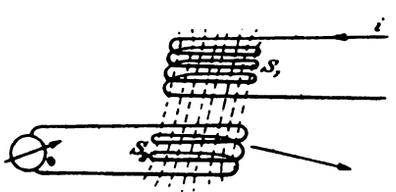

Fig. 1.

induced in this coil will be proportional to the instantaneous value of the magnetic field, and if this field is proportional to the exciting current, the voltage will be proportional to the instantaneous value of this current.

I have employed this principle in an instrument for the determination of alternate-current curves. For convenience of construction I have made both the primary coil, which is excited by the alternating current, and the secondary induced, coil, stationary, and have produced the necessary instantaneous magnetic connection by means of a moving piece of iron.

A narrow horseshoe-shaped iron core, A (Fig. 2), made up of five or six sheets, each ·4mm. thick, carries a primary coil, S_1, on the yoke, excited by the alternating current, and two secondary coils, S_2, coupled in series, on the two limbs. The arrangement thus forms a small transformer with one side missing.

A copper or brass drum, B, in which the missing transformer side, C, is embedded, rotates in front of the opening in the core. The drum is rotated synchronously, so that the magnetic circuit of the transformer is closed once every period or half-period.

Suppose the magnetic connection occurs at the instant when the primary alternating current in S_1 has the instantaneous value, i (Fig. 3A), then a voltage of approximately the form shown in Fig. 3B, will be induced in the coils, S_2. The average value of this voltage over a half period is proportional to the maximum number of lines enclosed by S_2—*i.e.*, proportional to i, independently of all other conditions.

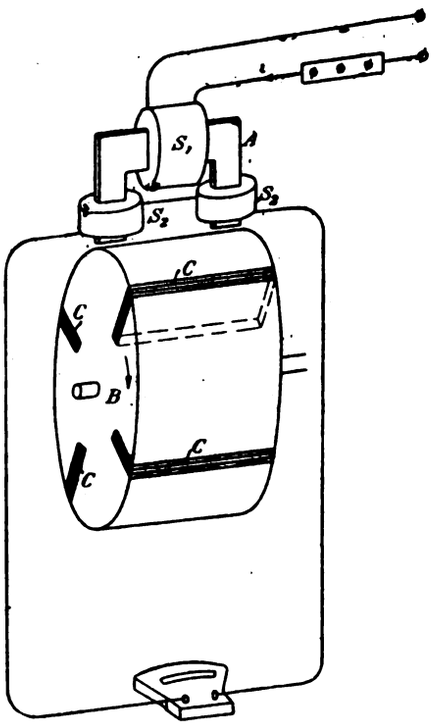

Fig. 2

The shape of the curve (Fig. 3B) depends only on space dimensions, and consequently the effective value of the secondary voltage is also proportional to the instantaneous valve of the current, i. This effective value can be measured

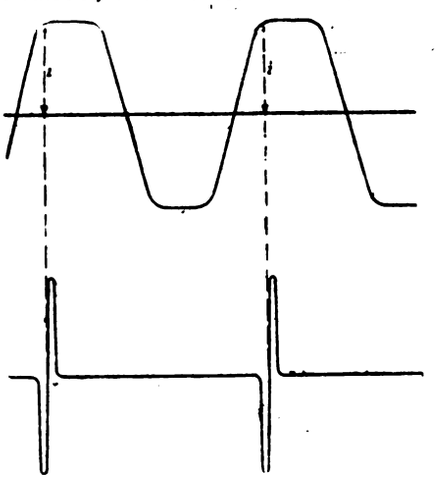

Fig. 3 A and B.

by means of ordinary workshop measuring instruments of sufficient accuracy. By moving the transformer step by step round the periphery, the induced voltage occurs at different instants in the period of the alternating current.

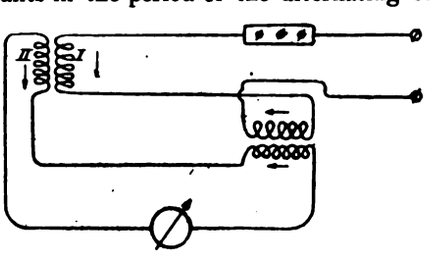

Fig. 4.

The curve is consequently obtained exactly as with the Joubert disc. The whole arrangement is the same as the latter, except that in my apparatus the electrical contact is replaced by a magnetic contact, which is not easily put out of order. The condenser and ballistic galvanometer of the Joubert method are replaced by a direct-reading workshop

* Translated from the *Elektrotechnische Zeitschrift*, June 5, 1902.

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voltmeter. A disadvantage of the arrangement of the primary and secondary on the same iron core is the fact that S_1 induces a voltage in S_2 directly. This directly induced voltage may be compensated for by means of a counter E.M.F. produced in a small stationary auxiliary transformer (Fig. 4).

The iron of the transformer is surrounded by a split copper casing so as to reduce leakage and the directly induced voltage. In this case the drum carries four yoke-pieces, so that if driven synchronously by means of a four-pole motor the magnetic circuit is closed once every half period. A Weston voltmeter for 7·5 volts, with 125 ohms internal resistance, was employed for the measurements with this instrument.

As an indication of the exactness of the measurements readings were taken, amongst others, of the line and phase voltages of three-phase machines. The measured line voltage agreed very well with the curve obtained by the addition of two phase-voltage curves displaced by 120deg.

Fig. 5 shows the curves (I. and II.) in their correct phase relation, obtained from two of the phases of an inductor alternator carrying a slightly inductive load. Curve III. shows the algebraic sum of these phase voltages, whilst IV. shows the observed curve of line voltage.

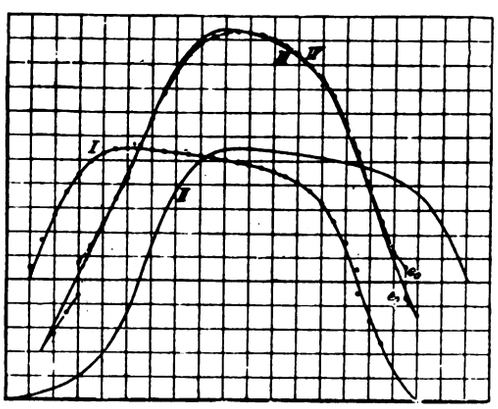

FIG. 5.

It will be noticed that at the points at which the voltage should be zero a certain minimum (e_0) is found. This small voltage is due to the tangential width of iron in the transformer, which was somewhat considerable in the first instruments made. Even here, however, this e_0 is of slight importance, and could easily be reduced still further. This minimum can be entirely avoided by exciting the transformer by continuous current as well, thus making the alternating field into a pulsating one, and so preventing the production of this zero value.

THROUGH TRAFFIC ON TRAMWAYS FOR PASSENGERS AND GOODS.*

BY J. E. WALLER, M.I.C.E.

Until quite lately tramways were practically confined to the large centres of population, but the introduction of electric traction, with the consequent decrease in working expenses and increase in speed, affording pleasanter and more rapid transit, with commodious, well-appointed, and well-lighted cars, has led to a considerable development of tramways or light railways in less populous places, and some of such systems being constructed in the districts lying between the larger cities have resulted in providing an extensive and connected network of tramways. Facilities are thus afforded for comparatively long-distance traffic, bringing the smaller towns and outlying districts into touch with the great business centres, and the modern tramway presents possibilities, not only of through services of passenger cars, but also of introducing goods traffic quite impracticable in the days of horse lines.

In order to obtain the full advantages rendered possible by the linking-up of tramway systems, it is essential that "through" running facilities should be granted by the various authorities owning the tramways physically connected and to the same gauge. This necessity has long since been recognised in respect to railways, and seems to be almost a self-evident proposition. Imagine the dislocation of the passenger traffic of the country, to say nothing of goods, if there were not these through running facilities. Fancy a passenger travelling from London to Edinburgh, proceeding by, say, the Great Northern Railway as far as York, then having to turn out and take his chance of finding a train from York to Berwick by the North-Eastern Railway, then again turning out and waiting for a train on the North British Railway and proceeding to Edinburgh, the termination of his journey. Such a condition of things would appear ludicrous beyond conception, but it is little less ludicrous to propose that when there is a "through" system of tramways constructed between, say, Leigh and the docks at Liverpool, that a passenger who desired to go through the whole length by tramcar should have, notwithstanding the physical connection of the metals throughout that length, to travel in no less than four different cars because the four different sections over which he travelled were in the separate ownerships of the South Lancashire Tramways Company, the St. Helens Corporation, the Lancashire Light Railways Company, and the Corporation of Liverpool.

It is certain that numbers of people would be glad to avail themselves of the tramways in preference to railways if they had the opportunity of so doing. It is true that the actual speed at which the tramcars travel compared with the speed on railways is small. On the other hand, it must be remembered that what is a long journey on a tramway is merely regarded as a small local trip on a railway, and that railways with their enormous amount of through traffic, both passengers and goods, and representing as they do at present the only available means of transit, do not trouble themselves greatly to consider the convenience of the local passenger. Moreover, the advantages of the greater speed on railways when actually travelling is greatly discounted in many cases by the greater length by rail than by road, by the frequent stops at stations, and by the delays at junctions, consequent on making connections with other branches. To get from a station such as Chowbent to Liverpool is often a very dilatory proceeding, and involves changing trains at Tyldesley, Kenyon, and sometimes at St. Helens Junctions. The average time occupied is about two hours, and that, of course, from station to station, while there are no trains between 9.30 a.m. and 1.5 p.m., the total number of trains per day being only seven in one direction and 10 in the other. The distance by rail between Chowbent Station and Lime-street Station, Liverpool, is 26 miles, while by road it is only about 24 miles, and there is no reason why the whole journey should not be traversed by tramway in, say, three hours. Although this is a longer time than taken by rail, it must be remembered that in the case of the tramcars passengers would not be confined to a very limited time table, but would have a frequent service of cars, so that, practically speaking, they could start when they were ready to do so and return when convenient. Moreover, the tramways, passing as they do along the principal and most populous roads, would pick up a large percentage of passengers practically at their doors, obviating the necessity of walking, sometimes a considerable distance, to the nearest station; and instead of being dumped down in Liverpool at the railway terminus, they would be enabled to go straight away to their points of destination in the city.

Again, judging by the present railway fares the tramways would be distinctly cheaper, and there are a large number of people who would be willing to take a little longer over the journey if that were necessary in order to save an appreciable amount on their fare. The following example of the comparative fares by rail and tram may be of interest: The third-class single railway fare from St. Helens to Lime-street Station, Liverpool, is 11½d.; the return fare being ordinarily double that amount—1s. 11d.—although there are special return fares two days in the week, by special trains, at 1s. 3d. The Lancashire Light Railways Company, in conjunction with the St. Helens company are arranging through fares from St. Helens to Knotty Ash at, for a single journey, 6½d., and for the return journey—all days of the week—9d. The fare at present on the Liverpool tramways, from Knotty Ash to any part of Liverpool, is 3d., so that a passenger from St. Helens would be able to go to any part of Liverpool at a single fare of 9½d. and a return fare of 1s. 3d., against a single fare to Lime-street Station only by railway of 11½d., and a return fare generally of 1s. 11d., and on special trains, twice a week, 1s. 3d. It is more than likely that these fares will bear considerable reduction, as it has become an axiom in the tramway world that financial success of electric tramways is best attained by low fares combined with a frequent service.

There is probably at present no other district which could offer such facilities for "through" traffic on tramways as that of South Lancashire. The construction of the South Lancashire tramways now in progress, together with the Liverpool and Prescot light railways, will directly connect up the following tramway systems, constructed or authorised, and all on the same gauge—viz., 4ft. 8½in.—viz., Liverpool Corporation tramways, Liverpool and Prescot light railway, St. Helens tramways, South Lancashire tramways, Farnworth urban district tramways, Radcliffe urban district tramways, Whitfield urban district tramways, Warrington Corporation tramways, Eccles

* Paper read before the Liverpool Chamber of Commerce.

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Corporation tramways, Salford Corporation tramways, Manchester Corporation tramways, Oldham, Ashton, and Hyde tramways, Stalybridge, Hyde, and Dukinfield, and Mossley Junction tramways. These tramways when completed will represent an aggregate length of something approximating to 400 miles.

Important as it is that facilities should be given to the greatest practicable extent for through running on adjacent tramways in respect to passenger traffic, the question becomes of still greater and, indeed, of vital importance if goods traffic on tramways is to be developed on any extensive scale. The proposal to carry goods on tramways is in no sense a novel one. Practically every Act or order authorising the construction of tramways contains a schedule of rates to be charged for goods, minerals, parcels, and animals, of which, however, little advantage has been taken up to the present for the reason already mentioned, that tramways, prior to the introduction of electric traction, have practically been confined to the streets of cities and towns, and have consequently been unable to offer any convenience or facilities for this class of traffic. The possibility of conveying goods traffic by tramways between Liverpool, Manchester, Warrington, Bolton, St. Helens, and other places in South Lancashire was considered by the Liverpool Chamber of Commerce so far back as 1896, when Mr. J. T. Wood, of Liverpool, read a paper on this subject, and since the formation of the South Lancashire Tramways Company the directors of that company have given careful consideration to this subject, and on their instructions their late chief engineer, Mr. Gibbings, obtained certain particulars and information as to the demand for such facilities in the district, and his investigations have been supplemented and largely extended by Mr. Thomas Upton, who has since been retained by the company for this particular purpose, and whose extensive experience in the inauguration of goods traffic on railways enables him to form reliable judgments as to the prospects of the South Lancashire system.

In compiling the present paper, and in considering the question of goods traffic and the methods to be adopted in handling it, every advantage has been taken of the material collected by these gentlemen. In the South Lancashire district there is an enormous goods traffic. The purely local traffic consists principally of coal, bricks, building materials, hardware and machinery, of which an immense amount, representing many thousands of tons per annum, is at present carted, particularly coal, from collieries to mills and brickfields, and the return traffic in bricks to the collieries. This traffic it is impossible for the railway companies to deal with, as the mills and brickfields are not connected with the railways by sidings, and even in the case of collieries so connected such sidings are valueless as regards local traffic, as while the cartage to the transmitting station would be avoided, it would still become necessary to cart from the receiving station to the point of destination. It is found that the cost of double handling and carting thus involved, over and above the railway rate, renders a single cartage from works to works cheaper as well as more convenient and expeditious. The through traffic to the district in question from Liverpool, Manchester, and Warrington covers nearly every conceivable class of goods, including raw cotton, cotton manufactured goods, grain, flour, provisions, ordinary and mining timber, iron and steel manufactures, glass, alkali, earthenware, acids, oil, grease, tallow, and manure. Of this through traffic the bulk is, of course, handled by the railway companies, although a very considerable amount is conveyed by canal and by cart. A large traffic in raw cotton is dealt with by the latter means both from Liverpool and Manchester, as the rates are cheaper, excessive handling and transhipment is avoided, and the delivery is more expeditious. Raw cotton in large quantities is conveyed by canal to Worsley, and thence by road to Tyldesley, Atherton, Bolton, Leigh, and other places. Traffic sent by rail, unless in truck loads, inevitably meets with delay by reason of the transhipment involved at junction stations, and considerable damage frequently arises by reason of so much handling. The existence of this considerable road traffic at the present time indicates pretty clearly that if a cheaper and more expeditious service for goods on the tramways is organised a very large traffic will be available, and if the authorities owning the various tramway systems are prepared to give the requisite running facilities on fair and equitable terms, there appears to be absolutely no difficulty in organising such a service.

The South Lancashire tramways and the Liverpool and Prescot light railways are practically one undertaking, and satisfactory arrangements have been concluded with the Corporation of St. Helens and the St. Helens District Tramway Company, who respectively own and work the intervening system, when, independent of running powers over the lines of any other authority, the following places will be put into direct communication with each other: Knotty Ash, Prescot, Huyton, Roby, Rainhill, St. Helens, Haydock, Earlstown, Warrington, Newton-in-Makerfield, Lowton, Golborne, Ashton-in-Makerfield, Abram, Hindley, Hindley Green, Atherton, Tyldesley, Leigh, Astley, Boothtown, Worsley (for Ship Canal), Eccles, Swinton (for Salford and Manchester), Walkden, Hulton, Chequerben, and Westhoughton. The whole of the foregoing places can also be brought into direct communication with Liverpool, Manchester, Bolton, Warrington, Farnworth, and Radcliffe, if arrangements for through running are made. This alone would introduce a very large goods traffic on the tramways, and it may safely be predicted that even if the other authorities do not in the first instance fall into line they would not be long in doing so. If the traders and the public can obtain advantages by the use of tramways which the railways cannot give, it is only a question of time till all necessary facilities must be granted by the owners of tramway systems, be they local authorities or companies. Such traffic, properly controlled, should prove of no inconvenience to the city of Liverpool, but a source of profit to the tramway undertaking of the Corporation, a convenience to the ordinary traffic during the daytime—to the extent to which it removed this goods traffic off the streets—and, to some extent, a possible increase in the traffic of the port if facilities are given for the conveyance from Liverpool of goods now entering the district through other channels. A depôt or depôts, conveniently situated in close proximity to the tramways, would have to be established, so that a siding might be laid in from these tramways to the depôt. As a general practice, flat-decked trucks would appear most suitable for the conveyance of the whole of the goods traffic. Each such truck or wagon would be provided with detachable tubs or crates on rollers, in place of the ordinary box body, being somewhat similar to the arrangement at present in use by several of the South Lancashire collieries for the purpose of facilitating the transport of coal. This type of goods wagon is also similar to that adopted on the Donegal Railway, where the general manager—Mr. R. H. Livesay—has had to contend with the question of transit over two different gauges. Mr. Livesay's description of this system is as follows: "No lifting arrangements are required, as the bodies are taken over by means of rollers, which run on rails secured to the underframes. We carry any description or class of goods in them. The system was only brought into use about four years ago, and since then it has been such a success that we have decided to gradually alter the whole of our goods, etc., wagons to it; it does away with delays due to transhipment and loss through breakage, besides effecting a great saving in the cost of handling, as two men can do all that is required in a few seconds."

The conditions of working on a tramways system would, however, be somewhat different to those existing on the Donegal Railway. There it is only necessary to move the truck body in its entirety from one deck wagon to another, but the fact that the body would in the case of a tramway service have to be moved from a street lorry to a tramway wagon, and *vice versâ*, involves the necessity of the body being constructed in sections, as previously suggested, the size of these sections being controlled by the size which could conveniently be carried on the ordinary lorries in use in the districts served. Proper provision would have to be made for securing the sections in position on the truck or underframe during transit. The same flat-decked wagons with the crates or bodies removed would also be available for the carriage of other classes of goods, such as timber, girders, portable engines, machinery, and boilers, the deck being provided with rings for roping-in goods, and with sockets for bolsters and stanchions for such traffic as timber. It is not suggested that all classes of traffic could be dealt with by this description of wagon. There are other classes of traffic for which ordinary wagons would be more suitable. For instance, in the event of traffic arising from collieries in the South Lancashire district, where the coal had to be conveyed direct to the docks for shipping purposes, ordinary wagons would probably be needed, which would run direct on to the tipping cradles at the docks. Such traffic as this, however, is somewhat apart from the question now under consideration, which relates to the method of avoiding unnecessary handling in transhipment where there is no possibility of direct communication between the point at which the traffic originates and its destination. It is proposed, wherever practicable, to lay sidings in to the larger collieries, works, and depôts along the tramway routes, and already a number of probable customers have signified their desire to have such sidings connected with their establishments. Much local traffic between collieries, mills, and brickfields would thus be dealt with without any break of bulk whatever and without the use of the special type of wagons suitable for transhipment, but to accommodate through traffic, or traffic originating at, say, a colliery in the district which had to be distributed in comparatively small consignments to general traders and the public, not connected by sidings, it would be necessary to provide suitable depôts at convenient points on the tramway system.

The depôts of the company, whether in proximity to the Liverpool Docks or at any point on the company's system, would all be worked in a similar manner, and the process pro

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posed may be illustrated by taking the case of goods coming to Liverpool by sea for delivery within the district. Such goods would be loaded from the quays or dock warehouses on to an ordinary road lorry in accordance with the present practice, excepting that instead of being placed direct on the lorry, the lorry would be provided with one or more of the company's crates or detachable bodies, and the goods, where practicable, would be packed in such crate. The lorry would then proceed alongside the stage, or platform at the receiving depôt, be rolled off by means of rollers, as previously described, on to such stage, whence it would be transferred to a stage deck wagon on an adjoining siding. A train of these wagons would then be in readiness to proceed on its journey during the following night-time. In the event of the goods being consigned to premises connected to the tramways by siding, no further handling would be involved, but in other cases precisely the reverse process would be gone through at the nearest depôt to the consignee's premises. The handling in either case would be considerably less than in the case of railway carriage, as from the time of the first loading into the crates there would be no interference with or transhipping of goods until they were put out either on the depôt stage or into the consignee's sidings at the point of destination, and bulk would never be broken, except in the case of extremely small consignments.

The Liverpool Chamber of Commerce have had before them for many years the enormous importance of finding some way by which the excessive handling and transhipment of goods, inseparable from the present methods of the railway companies, could be avoided, and it is thought that the methods now proposed for dealing with goods by tramway provides the solution of this important problem. At the present time, in the case of goods to be conveyed by rail from the docks at Liverpool, no less than six transhipments are involved, even in cases where full truck loads can be forwarded, avoiding intermediate handling at junction stations: (1) loading at warehouse into lorries; (2) unloading therefrom to stage at railway company's depôt; (3) loading from stage to trucks—to say nothing of extra loading and unloading when sent through a depôt without rail connection; (4) unloading trucks to depôt stage at destination; (5) loading from stage to lorry; (6) unloading from lorry at consignee's premises.

Wagons with sectional crates would appear to possess all or most of the advantages claimed for Mr. Calthorp's "lorry platform carrier" scheme which was brought before the Liverpool Chamber of Commerce in 1896, and would be applicable not only for the purposes described, but would also afford a means of easy transhipment between tramways and main-line railways without the necessity of breaking bulk. Moreover, these proposals would appear to be free of the objections raised by the railway companies to the proposed lorry platform carrier. There would be no necessity for special railway rolling-stock entirely dedicated to this class of traffic; there would be no serious increase of dead load arising from the carriage of two vehicles instead of one; the horsing difficulties would be absent; and no special inclined roadways would have to be provided for loading and unloading. The tramways, therefore, while creating and dealing with a special traffic of their own, and giving facilities for the delivery of goods to traders along the route of the tramways, would probably become before long recognised distributors and feeders to the railway systems, as the conservatism of the railway companies could not long withstand innovations of proved practicability. A very large traffic could be dealt with, and the carrying capacity of the lines could, if, and when found necessary, be largely augmented by increasing the amount of double lines throughout the system.

Apart from the goods traffic proper on the tramways, there doubtless would be a considerable parcels traffic. Such parcels traffic would probably be carried on in the daytime, either by trailer cars attached to passenger cars, or by special independent self-propelled parcels vans. No novelty would arise in dealing with this traffic, which would mainly have to be handled by means of receiving and distributing depôts. The goods depôts of the company would, of course, be available for this purpose, and, in addition, facilities might doubtless be arranged for the collection of goods at numerous shops along the lines of route. The question of cost of carriage by tramway has not so far been referred to, but the matter is one which has received careful consideration, and though it is obviously impracticable and inconvenient in the present paper to give schedules of rates at which the various classes of goods could be carried, still it may safely be stated that the traffic can be conveyed at a cost considerably less than is at present involved.

It is impossible within the limits of such a paper as the present one to attempt to deal with the many questions involved except in a general way. Numerous detailed considerations must arise in the introduction of what is practically a new industry. It is useless to attempt on paper to organise from the first a complete system of goods distribution; but it is believed that, if facilities are given to organise such a traffic, the advantages will be so fully appreciated that it will grow largely and rapidly, probably to the full carrying capacity of the tramways, that during its development experience will be obtained as to the requirements of the various classes of traffic which it is impossible to fully appreciate in advance, and that the effects of such development in one district may be far-reaching and result in inaugurating throughout the country facilities hitherto unobtainable for the distribution of goods. The subject under discussion seems to be well worthy of consideration from the traders' point of view, but there is another aspect from which it should be viewed: the utilisation of tramways for the conveyance of goods by night, now carried in lorries by day, may do much to relieve the congested traffic in the streets of our cities, and at the same time effect appreciable saving in the maintenance of the roadways. In country districts, whilst the traffic difficulties are not comparable with those in cities, the increased cost of maintenance due to traction engines and heavy lorries is proportionately greater, the roads being mainly macadam. It is hoped that a consideration of the questions involved from these points of view will lead to the hearty co-operation of municipalities and local authorities in the scheme which the directors of the South Lancashire Tramways desire to inaugurate, an outline of which has been attempted in the present paper.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

(Concluded from page 95.)

The Relative Advantages of Two and Three Wire Distribution.

BY JOHN F. C. SNELL, BOROUGH ELECTRICAL ENGINEER, SUNDERLAND.

Nearly all the electric lighting undertakings in the United Kingdom distribute energy on the three-wire system, whether the supply be by direct current or alternating. In 1886, the late Dr. John Hopkinson suggested the three-wire system as a means of saving copper; the claim being that for any set of conditions, the three-wire system showed an economy of nearly 40 per cent. in the weight of copper used, when compared with two parallel two-wire system of the same capacity: and, so far as it affects the copper alone, this is correct. Then 100 volts, or thereabouts, was the pressure adopted at the lamp terminals, and the introduction of the three-wire system enabled the radius of supply to be doubled, and double the amount of the original energy to be conveyed by the addition of only 25 per cent. of copper. Then about 1895 a great change in the conditions took place when 200-volt lamps became commercially possible, by which a simple two-wire 200-volt distributor could give all the advantages of a three-wire 100-volt system, without any of the disadvantages of a balancing wire, or the 25 per cent. extra copper entailed by that wire. But a three-wire 200-volt system with 400 volts across the outers became also possible, with the proviso of the Board of Trade that the middle wire should be connected to earth; thus the radius of supply became again doubled, or a sphere of influence amounting to four times the original permissible area became feasible. This proviso that the middle wire should be earthed was insisted upon to prevent the potential between any conductor and earth rising above the limit of 250 volts.

Such a system has many manifest advantages, which may at once be enumerated: (1) economy in copper, and, therefore, in capital outlay on mains; (2) increased radius of supply from the station or sub-stations; (3) reduced percentage variation of pressure across any pair of terminals, and theoretically, therefore, a steadier pressure across the outers.

There is, however, the other side of the question, which shows many disadvantages: (1) difficulty of balancing consumers accurately, which increases as time goes on, and as the lamp density rises, and consequent variation of pressure due to variable want of balance; (2) actual increased section of the middle wire in practice, much above the theoretical section required; (3) switchboard complications; (4) less reliabilty of supply when compared with a two-wire simple system, especially in large networks; (5) the burning out of consumers' lamps connected to either side of the middle wire, if temporary or permanent short-circuit takes place between the middle and the outer conductors; (6) the effect of permanent stress and of electrolysis on negative cables and service leads due to the permanent earthing of the middle wire and to osmosis; (7) the certain electrolytic decomposition of water, gas, and other pipes, due to local currents between outside faults on a big system and the earth connection; (8) difficulty in localising and rectifying faults on middle conductors themselves, without interference with supply to local consumers.

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The author is taking for comparison a three-wire system with 400 volts across the outers, and a two-wire system 200 volts. A great deal of the economy in copper is largely counterbalanced by the cost of insulation of the middle wire. The author, in discussing Mr. Addenbrooke's paper in 1896 at the Institution of Electrical Engineers, drew attention to the considerable leakage resulting between the earthed middle wire and the negative cables, and the late Dr. John Hopkinson (the then president) said: "In Manchester it is true from a negative terminal there is a substantial leakage, and that exists, *and always* exists, because the middle wire is bound to be earthed. That, of course, really arises from the fact that bare copper is used to a very considerable extent. . . . The leakage does not cause any inconvenience at all, but, of course, there is a certain loss of power from that leakage." The author's note on this is that while they might not cause much trouble to the electric lighting undertaking, such unmuzzled currents frollicking about would get into mischief and eat up the pipes of other undertakers. What is the use of the Board of Trade making stringent rules for the return currents of tramway undertakings, and overlooking the leakage from an earthed three-wire system, which the author ventures to predict will be a serious item in the course of time.

In 1894, in his paper before the Institution of Mechanical Engineers, the late Dr. John Hopkinson stated that "The insulation of the positive conductor is always good, while that of the negative is always bad, and with the Board of Trade insisting upon the middle wire being earthed this obligation involved a certain loss, because there resulted a leakage going on the whole time from the negative conductor, and they would be glad to be set free from the obligation." Again, our esteemed late president, Mr. C. H. Wordingham, in his paper read at Huddersfield, said: "In his judgment there can be no possible doubt that, at all events with continuous currents, the effect upon the insulated material of the negative main is most severe, while it is possible that with alternating currents there may be an effect on the insulation of both conductors. If, however, the middle conductor be deliberately connected with earth, so that the negative outer is kept below earth potential, a current corresponding to the amount of the leakage will be constantly forced through the leak, and the tendency for moisture to flow to the negative conductor will be maintained." And he went on to say, "what happens with rubber may happen with other material," and in the author's opinion, there can be no doubt whatever very grave risk of breakdown of the insulation of negative conductors is introduced by earthing the middle wire. Our last president, Mr. W. A. Chamen, also said, "Some engineers, no doubt, felt happy so long as the earth recorder showed no current, but how many of them knew whether their middle conductor was tight at all other points or not." These quotations will suffice to show that the foregoing eminent authorities recognise the grave risk attendant upon this obligation to earth the middle wire.

The two principal reasons for the adoption of three-wire distribution are (*a*) economy and (*b*) increased radius of supply—a 400-volt supply system being reckoned to supply consumers economically at a distance of 2½ miles from the generating station. Twenty square miles—or allowing for the station not being at the mathematical centre of gravity, say an area of 15 square miles—will cover most provincial towns. This is all very well when the lamp density and the number of consumers are both small, but is it likely in the future, when the lamp density shall be possibly multiplied by 20, that direct current will be supplied from one huge station for so large an area? If one estimates the square inches of copper—one might almost say square feet—which would be necessary to transmit energy over this area at 400 volts in order to maintain an equable pressure throughout the system, one is bound to admit that one of two things must infallibly happen—viz., either the multiplication of stations, or high-tension transmission from one central point to sub-stations, and from thence distribution at low pressure. This is not an essay on the relative merits of such systems of transmission, but it is necessary to show that if the radius of transmission from a central station is in the future to be considerably decreased owing to increased lamp density, the reason for adopting a three-wire system, so far as it concerns increased radius of supply, no longer exists. In short, the denser a system becomes the less necessity hereafter for a three-wire distribution in order to reach a greater distance from the station.

Before dealing with the relative economies, the author is aware that it will be said the variation in pressure due to changes of load—especially with large motors—is a sufficient reason to adopt 400 volts, and, therefore, a three-wire system, instead of 200 volts; with this he does not agree. At Sunderland there are motors of 100 h.p. connected to the supply mains, and other smaller motors, driving punching and shearing machines, and the pressure line is nevertheless surprisingly good throughout the day. With careful attention to the starting devices, this difficulty disappears, and, moreover, as the density increases, the momentary pressure variation due to local change of load will, of course, be less apparent; and therefore this is not a real practical objectical objection, and, so far as the consumer is concerned, 200 volts is better as regards danger to person, and slightly better in cost. A two-wire system costs more than a three-wire. With distributors of two (0·2 square inch) and (0·1 square inch, 0·6 square inch, and 0·1 square inch) respectively, the costs per 100 yards are £78 and £72, or 8 per cent. difference. Also the percentage volt drop and energy loss in the former is twice that of the latter, if the third-wire losses are neglected. In a network covering 25 miles of frontage the costs will be (neglecting feeders):

Two-wire	£34,320
Three-wire	£31,680
Increase	£2,640

Taking the distributed load as being at a maximum for 260 hours a year, and the remainder as equivalent to one-third full load × 2,190 hours a year, the energy losses will be:

Two-wire	156,816 units
Three-wire	78,408 ,,
Increased loss	78,408 ,,

Such a network would be capable of distributing about 5,000 kw., which, at 16 per cent. load factor, will sell 7,000,000 units a year.

In a town of 160,000 inhabitants the gas consumption is roughly 900,000,000 cubic feet per annum. This is equivalent to, say, 8,000,000 units of electricity. Add for tramways 2,000,000, and the total units supplied is 10,000,000. This will represent a maximum demand of not more than 10,000 kw. Such a town will usually measure not less than six miles across each longest axis, and often more than this. Now, a town with no greater output can well afford to centralise its plant, and careful estimates will show that a three-phase 5,000-volt sub-station, with duplicate primaries, is as cheap—when 500 kw. or more are transmitted—as in a 500-volt direct current feeder, when a distance of about two miles has to be reached, and, moreover, that the equated energy losses are the same. The only point in favour of the direct-current feeder being greater simplicity and no sub-station wages, but against these are better control of pressure, less additional cost when *further* power has to be transmitted, and greater flexibility of the sub-station system, as well as better control generally. The greater flexibility is especially to be noted, and the greater ease with which large amounts of power can be distributed. And so far as simplicity is concerned, a star-wound generator, driving either a synchronous or inductor motor-generator at the sub-station, which in turn feeds into a two-wire network, without any balancing transformers or complicated switchboard gear, is only one degree less simple than a simple direct-current system, and, in the author's opinion, not less simple than a three-wire system. That this will have to be adopted by the larger towns, with their ever-increasing boundaries, is the author's belief, up to the above limit, and afterwards it may be found more convenient, and as economical, to add more generating stations. This is essential to the argument, for otherwise a two-wire system would prohibit the radius of supply now reached, or would necessitate the adoption of a second or more stations earlier than would be warranted by the output. From the sub-station must radiate short small feeders, and, to continue the concrete example begun (and which will suffice for argument), let 2,000 kw. be distributed direct from the station and let there be three sub-stations, each distributing 1,000 kw. There would be, say, 10 home feeders, with an average load of 200 kw. each—this number would probably be necessary to preserve uniformity in size of distributor, and to maintain pressure—and five from each sub-station. The home feeders might average 750 yards in length, and the sub-station feeders 500 yards.

500-volt feeders would cost, say	£19,000
250-volt feeders would cost, say	£26,000
	£7,000
Deduct four balancing transformers and extra switch-gear, etc.	£2,000
Increase	£5,000

The energy losses in the two cases would be:

Two-wire	385,580 units
Three-wire	199,400 ,,
Increase	186,180 ,,

Therefore, the two-wire system would cost £7,640, or 14 per cent. more, and the increased interest and redemption fund on this at 6 per cent. would be £458 per annum. The energy loss in the two-wire is 542,396 units, and in the three-wire 277,808 units, being 7¾ per cent. and 4 per cent. respectively. It will be considered that ⅜d. per unit generated is an outside figure to take to cover engineering charges, and the cost of this

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increased loss will be £660. The total charges against the two-wire system being £1,118 per annum, on a system having a capital outlay of about £350,000, and with a revenue of not less than £50,000 per annum.

Consider now the other side of the question. There are not yet sufficient data to give precise figures of the relative lives of negative cables in simple and in earthed systems, but that there is more trouble arising from them and from service leads in the latter is certain, and this entails heavier costs of repairs and greater depreciation, and the author maintains that the increased repairs to an earthed three-wire system of the dimensions taken herein will be absorbed by this 2 per cent. on the outlay, and that over and above this there are the other objections from which the simple two-wire system is free. The losses in the third wire, which at times are greater than is usually thought, have been omitted from the debit side of the three-wire system. One cannot alter a physical law, and osmosis will manifest itself; everyone admits it, so much so that some makers have adopted a special type of negative cable differing from and more costly than the positive. Does not reliability of supply represents value? And will not the Board of Trade have something to say later when the negatives do become weak, and the middle-wire ammeter will not stand at zero, and if it do, what guarantee is there against outside faults and local circuits which may not necessarily be recorded by this ammeter? The author believes that on the ground of reliability and safety, and seeing that the ascertained increased cost cannot exceed a moderate figure, while the other side of the equation is an unknown quantity, it will be found to be a safer investment to be content with a simple two-wire system than to adopt the more fashionable three-wire. This is, of course, most revolutionary, and, it will be said, utterly out of date, and the author expects severe criticism. It will at least enliven the discussion. He hopes, nevertheless, this will be seriously considered, and believes that in years to come his opinion will be justified.

Not to adopt the best and most permanent system is a most serious matter. The author knows of one large system in London, controlled by an eminent engineer, in which the third wire is being taken out (and, of course, used elsewhere), leaving a simple two-wire system at 200 volts. Mr. Bromley Holmes has been most successful at Liverpool, and apparently the only reason he has gone over to the three-wire system in parts of his city is to temporarily meet the demand at distant points, and to enable all his plant to be serviceable for either the tramway or lighting sides at will. Now, however, judging by the last annual report, he has to go the further step and adopt three-phase transmission to meet the ever-growing demand.

A word as to the interchangeability of the steam sets from traction to lighting. It is admittedly a convenience, but, looking at it squarely, is it really necessary? Stand-by plant for both must be always held in readiness, and that being so, the necessity to turn over any set to either system is obviated. For single-phase alternating work little need be said. Here, again, sub-stations play their part, and there can be no question whatever that a plain concentric is better in every way than a triple-concentric cable. It may be said by many that this prophesying of evil to earthed systems is laboured and unwise; that the author is sacrificing economy and efficiency to a mere fad—and he admits that were it not for the infallible troubles which must result from this physical effect of negative leak, he would be among the first to recommend a system which so obviously involves less outlay and less loss in distribution. So much capital, however, is invested in cable systems and they are so comparatively inaccessible that the greater simplicity of the system, and freedom from vexatious troubles to consumers, entitle the simpler and more reliable, albeit at first sight more costly, system to some consideration. That we must aim at giving as reliable a supply as our competitors, and more free from complaints, is a cardinal principle with the author, and looking ahead to the time when our networks will be many times larger than they now are, it will be agreed that the simpler they are the more lasting and better investments will they be. It must not be forgotten that the life of cables on the simpler system must be largely increased, and must prove a more valuable asset at the end of the 25 years—the period now fixed by Government for the redemption of the capital outlay on them. The author has referred alone to three-phase transmission—there are other methods, such as the Hull system adopted by Mr. Barnard, and battery sub-stations, especially now that the Highfield reversible booster method is available—but as this paper is one on distribution only, and not on systems of generation, he has not attempted to bring additional controversy into this subject.

The author will be glad to hear the views of those who have had a long experience of earthed systems, whether in view of the moderate extra cost entailed by two-wire distribution (which he has endeavoured to state boldly and fairly), and the almost entire elimination of negative cable troubles, balancing transformers, frequent rearrangement of service leads, local overloading of balancing wire, occasional dead shorts between that wire and one of the outers, and more frequent interruption of supply, local leakages, and the probable intervention hereafter of the Board of Trade, constitute a sufficient justification for its adoption in preference to the cheaper three-wire distribution, and hopes that because it has become fashionable to use three wires the consideration of these points raised by him will not be too lightly thrown aside.

Discussion.

Mr. E. T. Ruthven-Murray, of Willesden, in opening the discussion, said he was unable to agree with the author in many of his statements about the disadvantages of the three-phase system. He denied that the actual economy in the conductors arrived at by using the three-wire system was counterbalanced by the trouble of balancing, switchboard complications, etc. As regards the switchboard, he hoped that some day there would be actually in use a three-wire board which was as simple as the two-wire board. He also severely criticised Mr. Snell's conclusions that the actual increased section of the middle wire in practice was much above the theoretical section required, and that there was less reliability of supply with the three-wire system when compared with a two-wire simple system. With regard to the last four points raised—*i.e.*, the burning-out of consumers' lamps, the effect of permanent stress and of electrolysis on negative cables and service leads, the certain electrolytic decomposition of water, gas, and other pipes, and difficulty in localising and rectifying faults—he contended that the whole of these objections depended entirely on the system of mains used. With a three-core or triple-concentric conductor many of these points disappeared immediately. With regard to electrolysis, his contention was that engineers should put down a system of mains on which there would not occur external faults. In the same way he was inclined to say that the difficulty of localising faults could be overcome by using a system in which there would be a burn-out. Referring to the numerical example given by the author, he alleged that the comparison there made was unfair—that the author had compared the two-wire system with the three wire on the basis of half the percentage drop in the latter case. Personally he favoured the use of three-core low-pressure mains, largely because with these one could connect on to consumers' premises without disconnecting and leaving the street supply dead. But in using triple-concentric cables, he should earth the neutral wire, and the chance of external faults would be greatly minimised. The ostensible strength of the paper was in the numerical examples given, and if he were right in his contention that these did not afford a true comparison between the two systems, he thought it weakened the author's case considerably.

Mr. F. A. Newington, of Edinburgh, did not agree with the author's statement that with the three-wire system there was much difficulty in balancing on the consumers' premises. The suggested complication of the switchboard also he did not admit. Personally, he did not find any leakage at all with the middle wire earthed as contended; and with regard to Mr. Snell's figures, if he only allowed half the actual drop in the case of the three-wire system as against the two-wire system, it must, of course, be an unfair comparison.

Mr. R. A. Chattock, of Bradford, thought the question of electrolysis had been made too much of in the paper. At Bradford they used a three-wire system, and they had never noticed any effect whatever on the water and gas mains. He stated that the cost of the switchboard for a three-wire system was very little in excess of that for a two-wire. With a three-wire system he had found it advisable to connect motors of 7 h.p. output to the two outer mains.

Mr. J. N. Shoolbred said he could not help thinking that the enormous value of the increased carrying capacity of the three-wire system must prevail in most districts, especially for financial reasons. He expressed agreement with the author's view, however, that the life of cables on the simpler system was longer, and must prove a more valuable asset at the end of 25 years. But although the two-wire system appeared to have such a prevailing element of simplicity in it, he thought the advantages of the three-wire system certainly ought to prevail over the advantages

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of the two-wire. Of course, the matter greatly depended upon the class of engines used, but he should certainly advise the use of the three-wire system at present, as being more economical, although not as simple as the two-wire system.

Mr. J. S. HIGHFIELD, of St. Helens, remarked that Mr. Snell had brought before them the question of altering the whole of their systems to the two-wire system. The real point to consider was whether it was economically practicable to make such a substitution, admitting that such a course involved reducing the voltage by half. They were perfectly certain that the two-wire system was cheaper and more simple than the three-wire, and looking at the question broadly, it seemed to him possible that the single-phase alternating-current two-wire system of distribution would come in very well. The whole question, however, turned upon whether the extra cost of sub-stations outweighed the advantages to be obtained from the two-wire system. He suggested that as a beginning it might be possible to utilise the two-wire system for supplying motors on power circuits.

Mr. V. A. H. MCCOWEN, of Belfast, thought the author had put a good case before them, and the results he gave were certainly astounding, but the crux of his case was really in his figures. He noticed, however, that the author had worked out the two cases on different efficiencies, and he asked that further data should be given on the point.

Mr. H. BOOT, of Tunbridge Wells, pointed out that for some 10 years now the majority of generating stations had used the three-wire system without trouble. Of course, Mr. Snell's idea was to obtain the greatest simplicity in the system of distribution. He should like some particulars from him with regard to the starting-up of the 100-h.p. motors he mentioned in the paper. His experience was that the farther north one went the less attention the consumers paid to the question of pressure, but he ventured to suggest that if one attempted to start a 100-h.p. motor with 200 volts pressure the whole district would be up in arms. He quite agreed with the speaker who advocated the use of three-core cables as a proper solution of the difficulty. What they wanted to do was to so improve cables as to obviate the troubles associated with the three-wire system. The whole point was to keep the mains in perfect order. If engineers would be content not to overload their cables, they would not experience the troubles they at present had.

Mr. W. H. TITTENSOR, of Dundee, criticised Mr. Snell's figures from the point of view that he had only taken half the percentage drop in the one case as compared with the other. He agreed that the two-wire system was a good one, so far as simplicity was concerned, and he was very pleased to hear from Mr. Snell of the good performance of the 100-h.p. motors. As regards the three-wire system, he admitted that its efficiency depended a good deal upon the balance of the system.

Mr. E. E. HOADLEY, of Maidstone, thought Mr. Snell had rather cut short the advantages of the three-wire system. Assuming they decided to go back to the two-wire system, there were many towns which were not large enough to justify the heavy expenditure such a change would entail, involving as it would in some cases the scrapping of a large amount of plant. As regards the 100-h.p. motors, he should like to know how Mr. Snell was able to run these connected to the supply mains without experiencing much trouble.

Mr. A. P. TROTTER, electrical adviser to the Board of Trade, remarked that the gist of the problem was the comparison between the conditions under which the two-wire and the three-wire system were most economical. He supposed it was admitted that in a small installation the two-wire system was the thing. The practice had been as the installation grew to turn it into a three-wire system. He understood that Mr. Snell would prefer, when the installation increased in size, to go in for sub-stations rather than have a large network. But the whole question turned upon when was it worth while to put in sub stations, and—what was quite another thing—how to do it? The matter was one of calculation, and it did appear to him that in some places the installation of three-phase motors in sub-stations had just been a little bit overdone.

Mr. F. THURSFIELD, of Chester, observed that Mr. Snell had quoted the cost of cables in one part of his paper, which at first was certainly rather startling. As a matter of fact, he thought Mr. Snell would find that the cost of cables in the two-wire system was about 50 per cent. higher than in the three-wire. The author had admitted that the losses in the cables of the two-wire system were twice those of the three-wire, and he went on to argue that this was permissible. He (the speaker) did not consider it was permissible, and he contended that it would be necessary to double the cost of copper in every case in order to supply the load referred to by Mr. Snell.

Mr. H. FARADAY PROCTOR, of Bristol, stated that the difficulty of the balance of the three-wire system when dealing with alternate currents was got over by having the transformers diagonally wound. Then, again, the difficulty of localising faults with this system was not a real one, because he did not find that they occurred.

Mr. A. S. BARNARD, of Hull, asked whether the author could give any actual instances of the decomposition of gas and water pipes due to electrolysis?

Mr. A. B. MOUNTAIN, of Huddersfield, said that Mr. Snell's figures were based on the cost of distribution only. He had entirely neglected the cost of feeders, which quite killed comparison. He, however, wished to congratulate Mr. Snell particularly on the fact that he was advocating simplicity in the distributing system He believed this was the keynote to future success.

Mr. T. D. CLOTHIER, of Hull, considered their thanks were due to Mr. Snell for reminding the association that there was such a thing as two-wire distribution. He thought that perhaps the two-wire system might get a look in again in connection with the transmission of electrical energy at high tensions. He did not see in this paper that Mr. Snell suggested that large commercial undertakings should change over from the three wire to the two-wire system, but the suggestion was that it should be considered in connection with future extensions.

Mr. J. F. C. SNELL, of Sunderland, in his reply on the discussion, asserted that the actual saving of copper in the three-wire system was only 40 per cent., and not 60½ per cent., as Mr. Murray had suggested. In regard to the balance difficulty, from his own experience of the three-wire system there was no question about it, that as the consumer density increased the difficulty of balancing, especially in side streets, also increased. In actual practice the balance was varying every minute, and you could not get an accurate balance with that system. On the question of complications, all he wished to say was that the simpler the system, and the less auxiliary plant one had to instal, the happier the lot of the station engineer and the better the whole system generally. The critical point of the whole discussion was the question of cost, and Mr. Murray had criticised the figures given in the paper, and had stated that if one were to use triple-concentric cables the difference in cost would be something like 19 per cent., and not 8 per cent., as he (Mr. Snell) had stated. Another speaker had said that he had not taken into his consideration the cost of feeders, but a glance at the paper would show that this was an error. As regards triple-concentric cables, he should say that while he was aiming at simplicity he was also aiming at reliability of supply, and he thought it would be admitted that it was wiser to put in a type of cable which, in case of fault, would not develop a short-circuit. The present tendency, he thought, was towards direct-current distribution, and, he believed, very rightly so, because engineers did not take into consideration sufficiently often the advantages which batteries would give them in the future. He felt convinced that in years to come batteries were going to be a very much more important factor in electrical distribution than was at present the case. Then, if they adopted direct-current distribution, the single cables laid in earthenware cases were far freer from the trouble of short-circuits—therefore, from interruption of supply—than were concentric cables. With these latter cables, if there was a fault, it developed into a short-circuit, resulting in a burn-out and interruption of the supply. Reference had been made to the fact that so many three-wire systems existed

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to-day, and he was asked, were they to scrap them? Obviously not. He did not suggest that in his paper at all. What he did say was that, with respect to the larger towns, they would find presently that the three-wire system would not meet their needs, and Liverpool and other towns had already found that out. In Sunderland they had the three-wire system, and they now saw that they could not reach the borough boundaries with it. The necessity for reaching long distances by the three-wire system no longer existed, and it opened up the question whether extensions in the future should not be carried out on a more reliable system. He was extremely glad to hear that Mr. Highfield agreed with him in this matter. Mr. Chattock stated that he had had no trouble with the electrolysis of water and gas mains, and he had been asked to quote a case in which the electrolytic decomposition of pipes had taken place. He knew of two towns at the present time where water engineers had tested their mains, and had found differences of eight and ten volts potential. He maintained that with this voltage there must be decomposition. Time, however, had not yet sufficed to show how long was wanted for this decomposition to take place. Mr. Boot stated that at the old pressure in vogue some years ago there was no trouble with the three-wire system. That was exactly the point. He maintained that the earthing of the middle point had brought about all the trouble. Speaking of the starting up of 100-h.p. motors connected to the supply mains at Sunderland, there were at present two of these motors supplied from a 220-volt main. They were controlled by a very well-known starting switch, and there was practically no difference in the local pressure. Referring to the criticisms made in regard to the numerical examples given in the paper, he stated that the whole of the figures were worked out at a current density of 600 amperes. He could not agree with Mr. Thursfield's statement that the two-wire system cost 50 per cent. more than the three-wire. Mr. Barnard asked for examples of electrolytic decomposition. He had already said that at Newcastle it had been found by tests that there was a difference of potential of eight to ten volts between certain lengths of interrupted water-pipe. This undoubtedly meant decomposition, and he was perfectly convinced that the already stringent regulations of the Board of Trade with regard to this matter would be made even more stringent. In that case they would probably find some rule with regard to the voltage drop and leaks on the outside system, and it was from that point of view that he had asked the association to take into consideration this question of earthing the middle wire. Although what he had said was extremely revolutionary, yet he believed that the day would come when some engineers would be converted to his way of thinking in this matter.

A vote of thanks to the author for his paper was carried by acclamation.

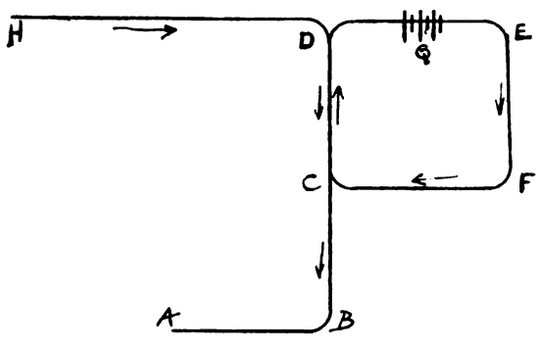
QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

501. The diagram represents the rail-return system of an existing electric tramway, A B C D. A new tramway, D E F C, is about to be constructed, and a further line, D H, is contemplated. The fall of potential is measured at A, and from D to A the drop is found to be six volts. The distances A–B, B–C, C–D are each one mile. The distance from D to H is two miles. It is desired to avoid the cost of a return feeder, but if D H be added to A B C D, the total fall of potential in the return will probably be 10 volts, which is three volts in excess of the Board of Trade limit measured over the greatest length of continuous line, commencing at the measuring point, A. How can the desired end be attained? If the tramway D E F C be fed independently of



the other tramways from a battery sub-station at Q in such a manner that the return current flows in a direction opposite and against the return current in the rails, A B C D, in the portion marked C D, would the result be to reduce the fall of potential between D and A? If not, why not?—C. J.

502. A dynamo may be considered as a machine for creating a difference of potential. Assume that the dynamo under consideration is completely insulated from earth. Is it correct to assume that the negative pole is at earth potential? Why?—E. G. B.

The following further explanation of Question No. 497 has been received from "D. E. J." in reply to a query. Replies to the above question will be received up to Monday next, July 28:

There are two dips, one 100 yards from the pit bottom, the other 250 yards from the pit bottom. Both these dips will go down about 1,000 yards when completed, and the signals, of course, will be required to be given from the bottom of the dip right through to engine-room. The dip engines are on the bank; there are two drums to each engine, and separate signals are required for each drum on distinct bells, but it would only be necessary to give one return to each dip from engine-man. For the pit bank signals from the pit bottom they would want to ring two bells, one on the bank, the other in the engine-house. The return signals to pit bottom would want to be given from engine-house and also banksman, but on to one bell only at the pit bottom.

ANSWERS.

We have received no answer to No. 495 on the measurement of quantity of steam. Will any of our regular readers send us a reply dealing with the best method of ascertaining the quantity of steam taken by a given connection to a steam-pipe range?—ED., *E. E.*

Question No. 496.— At a sub-station 10,000 yards distant from the main generating station there is a 500-kw. synchronous motor-generator, the motor being three-phase star-wound at 5,500 volts, this being the line voltage, the generator direct current at 500 volts. The high-tension motor is run up to synchronism by means of a 75-kw. induction motor-generator. It is found impossible to synchronise the high-tension motor without getting a "kick" on the ammeter unless its volts are at least 200 less than the 'bus-bar volts. After the motor has been switched on to the 'bus bars, the machine volts rise to the same as the 'bus-bar volts. All the voltmeters and voltmeter transformers have been tested and found correct. Please explain fully the reason of this.—H. B. S.

Best Answer to No. 496 (*awarded* 10*s.*).—There are three possible causes which either singly or in conjunction would be sufficient to explain all the observed effects: (1) the demagnetising effect of a lagging current on the generator, thus lowering its E.M.F.; (2) difference of wave shape of the E.M.F.'s of the generator and the motor; (3) a resonance effect due to the capacity of the mains.

It is well known that if E_1 be the total effective E.M.F. across a phase of the generator, and E_2 be the corresponding E.M.F. across a phase of the motor, then the 'bus-bar volts, E, and the resultant E.M.F., E′, driving the current round the two armatures are given by the equations

$$4\,E^2 = E_1^2 + E_2^2 - 2\,E_1\,E_2\cos\theta$$

$$E'^2 = E_1^2 + E_2^2 + 2\,E_1\,E_2\cos\theta,$$

where θ is the phase difference between E_1 and E_2.

If E_1 and E_2 are in exact opposition of phase—as, of

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course, they should be—when the switch is closed, then $\cos\theta = -1$, and

$$E = \tfrac{1}{2}(E_1 + E_2)$$
$$E' = E_1 - E_2.$$

Now, if E_1 were equal to E_2, E′ would be zero, and no current would flow if they were in exact opposition of phase; hence, when the motor is running, the phase difference between E_1 and E_2 cannot be quite 180deg. The armature of the motor will act like an induction coil: the current will, therefore, be lagging in the armature of the generator, the field will be partially demagnetised, and E_1 will be reduced. This will cause a momentary rise of current, which will drive the motor faster until the phase difference between E_1 and E_2 makes E′ a minimum, and, therefore, also the current a minimum consistent with the given load and excitation which is the condition for steady running. If this is the main cause of the kick, then it appears from the question that the demagnetising effect reduces E_1 from 5,500 to 5,300 volts.

If the generator is an inductor machine and the motor is not, or *vice versâ*, then probably difference of wave shape has something to do with the effect. In this case θ is always less than 180deg., and the motor takes a large current at no load even when the excitation is adjusted so that the current is at the minimum point of the Mordey V curve. Just at the moment of switching on there will be a sudden rush of current through the motor armature which will tend to increase the E.M.F. of the motor, as the flux of induction linked with the rotor and stator coils is the resultant of the magnetising turns of the rotor and stator respectively. Hence this would give a possible explanation.

The third possible effect is resonance. We have probably a three-core cable 10,000 yards long, which will have considerable electrostatic capacity in series with the rotor, which has inductance; hence there will probably be a rise of potential difference at the motor terminals when it is switched on, this rise being different at different frequencies, If this be the canse, then the amount by which the open-circuit E.M.F. of motor would have to be lowered so as to avoid a "kick" would be different at different frequencies, and hence it would be easy to find out if it were a resonance effect.—J. C. R.

Answer to No. 496 (*awarded* 5*s.*).—The reason a "kick" on the ammeter is obtained on synchronising is entirely a question of the value of the excitation given to the motor. This can be best understood by aid of a V curve, shown in Fig. 1. This is a curve obtained experimentally, and has values of the armature current for ordinates, and values of the excitation current for abscissa.

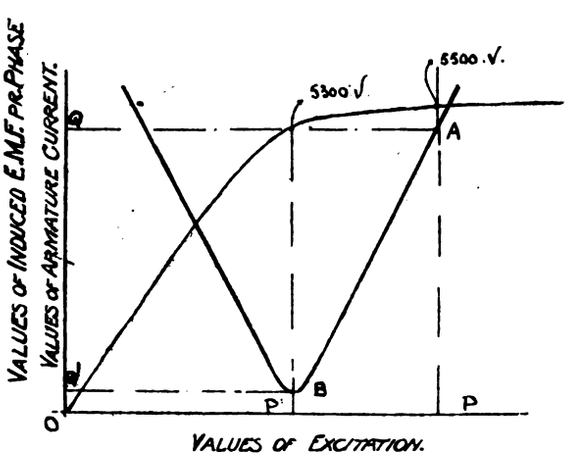

FIG. 1

The thin curve in Fig. 1 is the no-load characteristic of the motor.

Looking at the V curve, we see that as the excitation is increased the armature current decreases until a certain point of minimum armature current is reached, and beyond that point increases in value.

Now, suppose at point A on the V curve the induced E.M.F. is 5,500 volts and at point B 200 volts less than this—namely, 5,300 volts—assuming the motor to be running at synchronous speed

The excitation corresponding to point A is then represented by O P and the armature current by O Q. When, however, we go down the curve to point B—*i.e.*, the volts of the motor are 200 less than the 'bus-bar volts—the excitation is represented by O P′ and the armature current by O Q′. But it is seen that O Q′ (in the present case) is about one-tenth of O Q—*i.e.*, a "kick" on the ammeter would be obtained on synchronising in the first case, while no appreciable deflection would be obtained in the second case.—A. P. Y.

Answer to No. 496 (*awarded* 5*s.*).—A want of accuracy in one of the voltmeters would, of course, be the simplest way of explaining the effect, but as this point has been investigated it must be put aside, and the following explanation probably comes next in order of likelihood: If the voltage curves of the main station generators (sub-station 'bus bars) differ in shape from the voltage curve of the high-tension synchronous motor, it is quite possible that the maximum current flowing between the motor and 'bus bar may be less when the $\sqrt{\text{M. S.}}$ values of the two voltages, as read on voltmeters, differ by 200 volts than when they are exactly equal.

The synchronous motor may have a voltage curve which is decidedly more peaked than that of the main alternators, due to its having less slots per pole per phase, or a smaller ratio of pole width to pole pitch, and in that case a reduction in the $\sqrt{\text{M. S.}}$ voltage of the motor would result in a reduction in the maximum difference between the two voltages. This would naturally mean a reduction in the maximum current which would flow through the motor armature on synchronising, and in the "kick" noticed on the ammeter. This current would in any case only flow at its full strength for an instant, as it would directly tend to strengthen the motor field, and so make the $\sqrt{\text{M. S.}}$ value of the motor voltage practically equal to the 'bus-bar voltage again, as mentioned in the question.—Q.

FORTHCOMING EVENTS.

FRIDAY, JULY 25.

Waterworks Engineers.—Annual meeting at Leicester closes.

TUESDAY, JULY 29.

London Electrical Contractors' Association.—At 6 p.m., at Anderton's Hotel, Fleet-street, annual general meeting, preceded at 5.45 p.m. by an extraordinary meeting to consider alterations and additions to the rules of the association.

Institution of Junior Engineers.—At 7 p.m., visit to the engineering workshops and laboratories of the Battersea Polytechnic.

The following fixtures for meetings have also been made:

Sanitary Institute.—Sept. 9-13, congress, Manchester. Sept. 9-27, health exhibition.

Sanitary Inspectors' Association.—Aug. 7-9, autumn meeting, Middlesbrough.

Waterworks Engineers.—Winter meeting, December, London.

Iron and Steel Institute.—Sept. 2-6, Dusseldorf.

Institution of Civil Engineers.—Birmingham students' visit: Sept. 25, Crewe.

Institution of Junior Engineers.—Aug. 9 to 16, summer meeting.

British Association.—Meeting at Belfast commences Sept. 10.

APPOINTMENTS VACANT.

Engine-Driver, experienced, for high-class steam alternators in country factory, 35s. per week. See advertisement.

Wiring Electricians to sell Consol electric lamps. Consol Electric Lamps, 15, Victoria-street, London, S.W. See advertisement.

Assistant Engineer, Borough of Southend, £130 per annum. See advertisement.

Engineer, used to meter reading and experienced with accumulators, 30s. to 32s. per week. See advertisement.

Electrical Engineer, Tonbridge Urban District Council, £150 per annum, Aug. 2. Particulars may be obtained from Mr. A. H. Neve, clerk, Tonbridge Castle, Tonbridge.

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CONTENTS.

Notes	109	Chester Accounts	129
Notes on the Wear and Maintenance of Tramways	114	Salford Accounts	129
An Instrument for the Determination of Alternate-Current Curves	117	Oldham Accounts	130
Through Traffic on Tramways for Passengers and Goods	118	Wolverhampton Accounts	130
Incorporated Municipal Electrical Association	120	New Companies' Registered	130
Questions and Answers	124	Legal Intelligence	131
Forthcoming Events	125	Companies' Meetings and Reports	131
Appointments Vacant	125	Contracts for Electrical Supplies	134
Collection and Transhipment	126	Lighting Notes	135
Reviews	127	Traction Notes	138
Trade Notes and Novelties	128	Provisional Patents, 1902	142
Southampton Accounts	128	Specifications Accepted	143
		Traffic Returns	144
		Companies' Stock and Share List	144

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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COLLECTION AND TRANSHIPMENT.

The paper by Mr. J. E. Waller, M.Inst.C.E., on "Through Traffic on Tramways for Passengers and Goods," which was read before the Liverpool Chamber of Commerce on Monday last, and is reprinted in the present issue, shows up clearly the essential advantages of a large system of tramways over railways as at present worked. At first sight the casual observer would think that for the conveyance of passengers the higher speeds allowed on railways would render competition by the slower-speeded tramways an impossibility. This is the case over long distances when the trains run without stops between large towns, but it is not correct when a local service has to be given. It may seem absurd to talk of the collection of passengers and their transhipment, but these two factors are those which give a tramway system the advantage. Take, for instance, a suburban passenger who is going to business. What concerns him is not the length of time taken by a train to convey him from the suburban station to the terminus in the town, but the length of time between his leaving his private house and getting to his office. The fact that the tramway is, as a rule, able to convey him almost from his house door to his office door, and that he can get a tramcar every five or ten minutes, much more than counterbalances the faster speed of the more infrequent service of trains. Mr. Waller in his paper also gives examples of the time wasted on railways when a short journey on a railway involving several changes at junctions has to be made Even with the best regulated lines such a journey entails a great waste of time, and the mean speed will be found to be deplorably low. We have in mind the cross routes in the London suburbs, which involve the use of both up and down trains on even the same company's system. When such journeys have to be made on these routes, it is quite usual to take from an hour to an hour and a half to get from one place to another six or seven miles distant. The time is wasted, not so much by the slow stopping trains in this instance, as by the intervals which have to be spent on the platforms at the junctions. Where electric tramways are available, as will shortly be the case in the Lancashire districts described by Mr. Waller, the reduction of time required to make the similar journeys by the tramways would have an important influence on the traffic. Quite apart from the reduction in fare, the saving in time and the increased frequency of service would result in enormous increases in the number of persons travelling. We quite agree with Mr. Waller's advocacy of through traffic wherever possible, and trust that for the convenience of the public the Lancashire municipalities owning tramways which join on to those of the Lancashire Light Railway Company and the South Lancashire Tramways Company will make amicable arrangements for through services over what will then be the most extensive and complete electric traction system in the United Kingdom. The major portion of Mr. Waller's paper deals with the transit of goods over such tramways and light railways. For this service the arguments given above respecting the advantages of the tramway over the railway become much more weighty. At a junction the transfer of passengers from the one train to the other may be said to be automatically effected under the guiding voice of a railway official, but the same is not the case where goods are concerned, as the cost of the transhipment labour forms a serious proportion of the total cost of transit. The same may be said of the collection and delivery of the goods. As the author above referred to instanced, at least six handlings of goods are required between a steamer in the Liverpool docks and the consignee's premises even when no junctions

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have to be negotiated. Where, of course, full trucks are concerned, the extra labour at these junctions is only the cost of shunting, but where smaller quantities of goods are being dealt with, three more handlings are practically required at each junction. With the complete network of tramways and light railways between the docks at Liverpool and the smaller towns and villages or isolated works throughout Lancashire, there will be no difficulty in organising a goods service which will avoid the cost of these transhipments, and also the damage always associated with the same. As to the cost of giving this goods service, we would only say that it can obviously be carried out at lower rates than are at present possible. The more important fact is that a more prompt and efficient system will be available, which in most cases would be preferred by the traders even if no such reduction in price were available. It will need considerable organisation both in designing the lines and in arranging the services to prevent the goods service interfering with the passenger traffic. The difficulty is, of course, minimised by the fact that single cars are employed in both instances, and that the maximum speeds allowed by the Board of Trade are by no means too high for the transit of goods. From the financial point of view the extra income derived from the goods traffic, which will not involve any increased outlay on the permanent way, or the overhead equipment, will render certain lines, such as branches to isolated manufactories, commercially possible, the construction of which would not be warranted for passenger service only.

REVIEWS.

Encyclopædia Britannica, Vol. XXVI.

This, the second of the new and revised volumes of the "Encyclopædia Britannica," deals with subjects from "Austria-Hungary" to "Chess." There are, of course, in this volume, as in the one preceding it, a good many back references to the older issue of the "Encyclopædia," to which the present issue is an extension. In it, however, a vast amount of new information is given which was not available at the time the last edition was brought out, and in a large number of instances this has necessitated the rewriting of all the information under a different heading. This is not the case in the article on "Steam Boilers," which were described in vol. xxii. of the "Encyclopædia," which dealt fully with the construction of Lancashire, Galloway, and Cornish boilers. In the article by Mr. J. T. Milton, who is a member of the Admiralty Boiler Committee, the various up-to-date types of water-tube boilers are illustrated and described more or less in detail. They are divided into two distinct classes—*i.e.*, those used on land installations and those for providing steam on board ship. The author's information is exceedingly clear and concise, and will form a handy reference on the boiler question. The article on "Canals and Inland Navigation" is contributed by Sir E. Leader Williams, the consulting engineer of the Manchester Ship Canal, and General O. H. Ernst, who is a member of the United States Isthmian Canal Commission. On the question of electrical haulage on canals, these authors comment on its successful use in France upon part of the Dordogne Canal, including a tunnel over two miles long. It is also employed on the Charleroi Canal in Belgium, which connects the coal district with Brussels. The canal is a narrow one, and barges towed by horse power seldom reached a speed of 1½ miles an hour. The use of electric power has given a speed of six to seven miles an hour at the same cost per mile. There are two generating stations—one 15 miles south of Brussels and the other at Roux, six miles north of Charleroi. The electric current is taken from overhead wires, and it also serves for lighting purposes and for working machinery at manufactories on the route of the canal, thus reducing the cost of towing by the profit made by adapting the current to secondary uses. The working of the locks is also facilitated by the use of electricity. The authors think it is very probable that electric traction will be largely used in the future for haulage on canals; it would also be useful for working wharf cranes or canal lifts. Apart from the above engineering subjects, the volume before us contains a fund of general information which is indispensable to those requiring references.

Encyclopædia Britannica, Vol. XXVII.

This, the third of the new volumes now being issued by Messrs. Adam and Charles Black, of London, and by the *Times*, contains an unusually large number of articles of interest to electrical engineers. The authors of these are men who command the respect of the profession from the good work which they have done, and they are to be congratulated on the excellent *résumés* they have made of the various subjects in question. The first in alphabetical order in this volume which deals with subjects from C H I to E L D, is that of "Coal." In this article the information on the coal output of the world, and of the methods of mining for coal, is most full, and contains a number of references to electrically driving of colliery plant. The various types of coal-winning machines are described, and the articles states that they are mostly driven by electric motors taking from 25 h.p. up to 35 h.p. as a maximum. The saving effected by this substitution of machines for hand coal-cutting in the English Midland collieries has been proved to be from 9½d. up to 1s. 9d. per ton, of which about two-thirds is due to the smaller proportion of slack coal made by the operation. Owing to the increased wages in the States demanded by men working the machines, the economy there is said to be less. The information given at the end of the article on the horse-power required in actual work in certain of the large collieries will be found exceedingly valuable to electrical engineers in estimating the demand which the collieries would provide for electrical power and distribution schemes. The article dealing with the compass as used on board ship is contributed by Captain Ettrick W. Creak, R.N., F.R.S. In it full illustrated descriptions are given of the more recent form of mariner's compass with which Lord Kelvin's name is so intimately connected. The liquid compass is also described, in which the card nearly floats in a bowl filled with distilled water, to which 35 per cent. of alcohol is added to prevent freezing. By this means the card is exceedingly steady under severe shocks and vibrations, and the friction on the pivot and cap is reduced to a minimum. The article naturally deals with the means of compensating for the magnetic effects of the structure of iron ships, but we should like to have seen a few remarks on the electric wiring of those parts of a ship near the compass in order to prevent the same being influenced by the electric light and power current. The article on the "Conduction of Heat," which occupies six pages of the "Encyclopædia," deals mainly with the theoretical side of the subject. Amongst the other methods described for the ascertaining of the conductivity of materials is the electrical one devised respectively by King and Duncan and Kohlrausch. This latter method is a thermo-electric one, and was largely experimented by Jaeger and Dieselhorst. The article, which is contributed by Prof. H. L. Callender, F.R.S., is most interesting to read, and contains a vast amount of information which will be new to a large proportion of engineers. The same may practically be said of the article on the "Dimensions of Units" by Dr. J. Larmor, or we would rather say that too few engineers recognise the valuable results which can be obtained from a careful application of a knowledge of the dimensions of the units in any equations or series of equations. We can safely say, however, that this information has been brought to the notice of all students at the various City Guilds institutions. Dr. Larmor gives examples of the important results which applications of the subject have had in shipbuilding design. The contribution to this volume of the "Encyclopædia" which deals with the dynamo is from the pen of Mr. C. C. Hawkins, and occupies, as is only right, a large amount of space. Even then, of course, a complete

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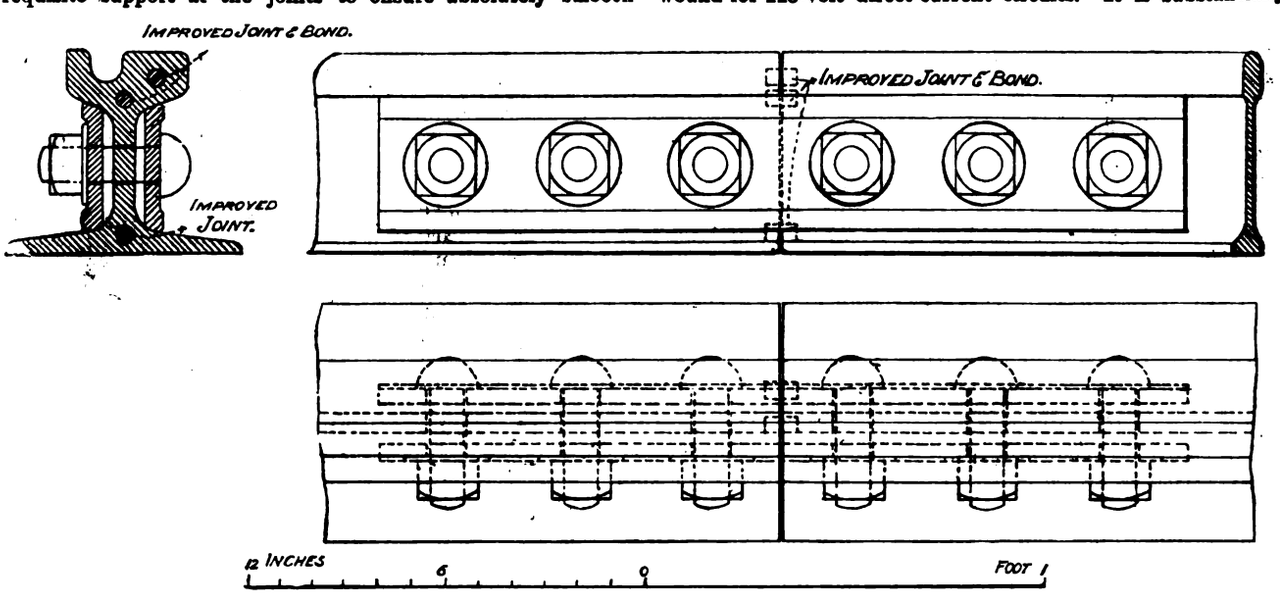
treatise on the design of direct-current dynamos and of alternators is not to be expected. It will be admitted, however, that Mr. Hawkins has given a large amount of critical information in the space allotted to him. He commences with the definition that "a dynamo is a machine in which by means of continuous relative motion an electrical conductor or system of conductors forming part of a circuit is caused to cut the lines of a magnetic field or fields; the cutting of the magnetic flux induces an E.M.F. in the conductors, and when the circuit is closed a current flows whereby mechanical energy is converted into electrical energy." The author proceeds to give by means of diagrams a very clear idea of the steps in the development of the dynamo from Faraday's elementary machines in 1831 up to the present time. If any fault were looked for in the article it would be found in the fact that a few machines which are now practically obsolete are illustrated and described, but in each case the author indicates the fault which has been the cause of the discontinuance of the type. We would also join issue with his statement that the two-pole single horseshoe machines "for all outputs up to 150 kw. remains one of the simplest, most economical, and most compact type." The limit for the economical use of this class of machine is much below 140 kw., as will be seen by consulting manufacturers' lists. In the article on "Alternators" we should like to have seen an illustration of a recent alternator other than of the inductor type. We quite realise, however, that the author was limited to space, and congratulate him on the quantity of valuable matter which he has included. Other subjects which the electrical engineer will find of great service in the present volume are those on "Dynamometers," by Prof. W. E. Dalby; on "Copper," by James Douglas; on "Condensation of Gases," by Prof. J. D. van der Waals; while, of course, the other general information will interest him apart from his profession.

TRADE NOTES AND NOVELTIES.

Improved Joint and Bond for Tramway Rails.

Various attempts have been made from time to time to design a joint for tramway rails which will render the rails to all intents and purposes continuous, that is to say, to give the requisite support at the joints to ensure absolutely smooth running of the cars and even wear of the metals without, however, sacrificing the flexibility of the track. We illustrate herewith a solution of the problem, which has been patented by Mr. A. M. Fowler, M.I.C.E., of 1, St. Peter's-square, Manchester, and 35, Old Queen-street, Westminster. It will be seen that in this joint the extra support is given by steel pins which fit into holes drilled to correspond in the crowns and bases of the successive metals. The resistance to shearing stresses which is offered by these pins is obvious from their arrangement. The electrical continuity of the rails is at the same time improved. We shall look forward with considerable interest to the results of practical experience with this joint.



Improved Joint and Bond for Tramway Rails.

Radial Fan Motor.

We illustrate herewith a new style of fan motor introduced by the British Thomson-Houston Company, Limited, Rugby. This style is known as the radial fan motor, and is designed especially for use on desks and tables, being particularly adapted to public dining and reading rooms, where a strong blast is objectionable. As shown in the accompanying illustration, the fan is placed in a horizontal position, and it so revolves as to draw air from above and force it against the reflecting surface directly beneath the fan, causing a gentle breeze horizontally in all directions. The fan motor is 24in. in height, is fitted with a three-speed regulating switch, and is wound for 115-volt direct-current circuits. It is substantially constructed, and is handsomely finished in streaked oxidised silver. It can also be wound to operate on 200-volt circuits.

Radial Fan Motor

SOUTHAMPTON ELECTRICITY ACCOUNTS.

The accounts of the Southampton Corporation electricity department for the year ended March 31, 1902, show a total expenditure on capital account to date of £125,940. Abstracts of the revenue account, general balance-sheet,

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and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£	s.	d.
Wages	£1,160 13 5			
Coal	5,579 9 9			
Oil, waste, water, and stores	719 2 10			
Repairs, etc., of buildings and plant	1,577 1 8			
		9,036	7	8
	Distribution of Electricity.			
Wages	161 7 11			
Repairs of mains, meters, etc.	731 1 11			
Clothing	14 10 5			
		907	0	3
Repairs and maintenance of public lamps		445	6	9
	Management and General Charges.			
Salaries	1,050 10 5			
Rents, rates, and taxes	789 1 9			
Insurances	159 8 0			
Auditors' fees	23 2 0			
Law charges, etc.	28 14 4			
Loss on tower wagon	25 0 0			
Printing, stationery, and advertising	108 8 6			
General establishment charges	176 11 8			
Management of stock	167 1 4			
		2,527	18	0
		12,916	12	8
Balance (being gross profit for the year)		7,983	17	6
		£20,900	10	2

Cr.	£	s.	d.
Sale of energy—Private consumers	12,736	18	6
Corporation tramways	6,028	19	11
Public lighting	1,759	19	5
	20,525	17	10
Meter rents	272	10	5
Miscellaneous receipts	102	1	11
	£20,900	10	2

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Southampton Corporation stock	107,057	7	8
Sundry creditors	3,100	14	11
Capital and Counties Bank, Limited	20,756	11	4
Surplus account	12,128	12	2
	£143,043	6	1

Cr. Assets.	£	s.	d.
Land, buildings, machinery, etc.	125,940	10	6
Sundry debtors	5,153	17	0
Stocks as per valuations	405	3	1
Sinking fund investments	11,543	15	6
	£143,043	6	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			1,856,216
Quantity sold: Private consumers by meter	588,932		
Quantity sold: Private consumers by contract	110		
Quantity sold: Public lamps	117,701		
Quantity sold: Corporation tramways	723,479		1,430,222
Quantity used on works			56,421
Total quantity accounted for			1,486,643
Loss in distribution			369,573
Percentage of loss			19·910
Number of public lamps			166
Total maximum supply demanded (kilowatts)			1,143

CHESTER ELECTRICITY ACCOUNTS.

The accounts of the county borough of Chester electricity department for the year ended March 25, 1902, show a total expenditure on capital account to date of £92,469. We give herewith abstracts of the revenue account, general balance sheet, etc.:

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	83,000	0	0
Sundry creditors	874	15	11
Balance at credit of net revenue account	1	11	5
Sinking fund account	8,574	2	1
Reserve fund account	4,658	14	7
Balance due to treasurer	10,619	11	4
	£107,728	15	4

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	92,469	14	1
Stores on hand	349	2	4
Sundry debtors for current supplied	6,620	7	5
Securities held (cost price) and cash in hand	8,289	11	6
	£107,728	15	4

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal or other fuel	£1,963 4 3		
Oil, waste, water, and stores	311 4 9		
Wages at generating stations	1,016 2 5		
Repairs and maintenance	810 13 0		
	4,101	4	6
Distribution of electricity	167	6	9
Attending and repairs of public lamps	1,346	2	7
Rents, rates, and taxes	287	16	2
Management expenses	893	3	6
Special charges—insurance, etc.	127	7	0
Total expenditure	6,923	0	6
Amount carried to net revenue account	5,845	9	3
Balance carried to next account for bad debts	1	11	5
	£12,770	1	2

Cr.	£	s.	d.
Balance from last account, less debts written off	119	11	8
Sale of current per meter, less discounts	8,669	8	6
Public lighting	3,504	8	8
Rental of meters	362	13	4
Sale and repairs of lamps	15	16	4
Sale and repairs of other apparatus	47	6	8
Repair and maintenance of market lamps	50	16	0
	£12,770	1	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			1,024,046
Quantity sold: Public lamps	319,197		
Quantity sold: Private consumers by meter	521,763		840,960
Quantity used on works			123,892
Total quantity accounted for			1,024,046
Total maximum supply demanded (kilowatts)			587

Number of public lamps: arcs, 173; incandescents, 392.

SALFORD ELECTRICITY ACCOUNTS.

From the accounts of the Salford Corporation electricity works it appears that the total expenditure on capital account to March 31, 1902, amounts to £386,382. Appended are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal or other fuel	£4,481 13 0		
Oil, waste, water, and stores	725 8 7		
Wages at generating stations	2,198 1 6		
Repairs, etc., of buildings and plant	1,274 15 10		
	8,679	19	9
Distribution of Electricity.			
Wages and other remuneration	726 5 5		
Repairs, etc., of mains, etc.	666 19 11		
Repairs, etc., of transformers, etc.	3,252 10 8		
Repairs, etc., of apparatus	67 18 6		
	4,713	14	6
Attending and repairs to public lamps	50	3	5
Rents, rates, and taxes	634	7	7
Management expenses	2,349	16	11
Special charges—insurances, etc.	44	0	11
Total expenditure	16,472	3	1
Amount carried to net revenue account	1,255	16	8
	£17,727	19	9

Cr.	£	s.	d.
Sale of current, less discount	17,106	0	4
Rental of meters and sales	331	15	3
Royalties, licenses, etc.	180	0	0
Amount of damage by fire recovered	85	4	2
Premium paid by engineer's pupils	25	0	0
	£17,727	19	9

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	388,655	9	7
Sundry creditors	17,785	9	9
Sinking fund account	10,278	9	4
Deposit for securing electric current	103	15	4
Cash due to bank	18,992	5	1
	£435,815	9	1

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	386,382	8	10
Stores on hand	5,970	6	9
Sundry debtors for current supplied	7,342	2	5
Other debtors	22,194	11	2
Balance at debit of net revenue account	13,214	17	9
Cash in hand	711	2	2
	£435,815	9	1

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,861,454
Quantity sold { Public lamps	19,271	1,272,758
Quantity sold { Private consumers by meter	1,253,487	
Quantity used on works		106,286
Total quantity accounted for		1,379,044
Quantity not accounted for		482,410
Number of public lamps		108
Total maximum supply demanded (kilowatts)		1,200

OLDHAM ELECTRICITY ACCOUNTS.

From the accounts of the Oldham Corporation electricity department for the year ended March 25, 1902, it appears that the total expenditure on capital account to that date amounts to £108,308. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel	£3,063 8 10	
Oil, waste, and stores	97 1 2	
Wages at generating station	1,109 15 3	
Repairs and maintenance	803 6 3	
		5,074 1 6
Distribution.		
Wages of linesmen	44 13 9	
Repairs, maintenance, etc., of mains	560 7 9	
Repairs, maintenance, etc., of meters	143 16 9	
		748 18 3
Rents, rates, and taxes		844 12 3
Management expenses and salaries		816 19 6
Other law expenses and commission		78 5 9
Insurance		34 19 6
Bad debts		35 0 6
Balance		5,875 17 11
		£13,508 15 2

Cr.	£ s. d.
Sale of current—Per meter	10,231 4 0
Public lighting	207 18 3
Traction purposes	2,641 10 9
Rental of meters and indicators	381 5 9
Sale and repairs of lamps and other apparatus	46 16 5
	£13,508 15 2

GENERAL BALANCE-SHEET.

Dr.	£ s. d.
Capital account—amount received	101,468 8 0
Sundry creditors	2,197 0 11
Balance at credit of net revenue account	832 7 2
Balance at credit of sinking fund account	4,640 12 7
Balance at credit of reserve fund account	4,778 3 0
Deposits	73 0 0
Balance—cash due to treasurer	1,254 2 3
	£115,243 13 11

Cr.	£ s. d.
Capital account—amount expended for works	108,308 13 2
Stores on hand	2,420 11 0
Sundry debtors	4,514 9 9
	£115,243 13 11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated Board of Trade units		1,242,570
Quantity sold { Public lamps	19,960	1,042,055
Quantity sold { Private consumers by meter	709,127	
Quantity sold { Traction purposes	312,968	
Quantity expended in distribution		92,879
Quantity used on works		97,371
Total quantity accounted for		1,232,305
Quantity not accounted for		10,265
Total maximum supply demanded (kilowatts)		1,187
Number of public lamps		25

WOLVERHAMPTON ELECTRICITY ACCOUNTS.

From the accounts of the Wolverhampton electricity department for the year ended March 31, 1902, it appears that the total expenditure on capital account amounts to £154,833. We give herewith abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr.		£ s. d.
Expenditure.		
Generation of Electricity.		
Coal	£2,094 1 5	
Oil, waste, water, and engine-room stores	447 12 9	
Wages at generating station	1,283 10 0	
Repairs, etc., of buildings and plant	416 9 11	
		4,241 14 1
Distribution of Electricity.		
Changing over system	405 6 4	
Repairs, etc., of mains	216 19 0	
Repairs, etc., of meters, switches, etc.	9 11 6	
Repairs, etc, of apparatus	9 16 2	
		641 13 0
Attending and repairs of public lamps		205 10 6
Rents, rates, and taxes		283 6 10
Management expenses		1,211 13 1
Insurances		151 18 4
Bad debts		10 3 10
		6,745 19 8
Amount carried to net revenue account		6,444 13 0
Balance carried to next account		50 0 0
		£13,240 12 8

Cr. Income.	£ s. d.
Sale of current per meter	11,633 16 5
Sale under contract	0 11 3
Public lighting—street arc lamps	1,275 0 0
Public lighting—street incandescent lamps	8 7 6
	12,917 15 2
Rental of meters, etc.	263 18 8
Work executed on account of customers	58 18 10
	£13,240 12 8

BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Redeemable stock and loans fund	142,913 1 10
Sundry creditors at March 31, 1902	8,117 1 11
Surplus	11,920 2 11
	162,950 6 8
Sundry creditors on revenue account	863 2 8
Sundry consumers—deposits	70 0 0
Interest accrued, but not paid	526 11 9
Cash balance	4,899 5 1
Reserve for bad debts and allowances	50 0 0
Net revenue account—balance	1,195 9 8
	£170,554 15 10

Cr. Assets.	£ s. d.
Capital expenditure, as per capital account	112,985 5 4
Costs of issue of stock, ditto	8,625 4 9
	121,610 10 1
Sundry debtors at March 31, 1902	40 12 3
Cash balance due from treasurer	41,299 4 4
Stores on hand	1,567 2 6
Sundry debtors for current and other debtors	6,037 6 8
	£170,554 15 10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,028,949
Quantity sold { Public lamps	79,352	746,318
Quantity sold { By contract	23	
Quantity sold { Private consumers by meter	666,943	
Quantity used on works		73,425
Total quantity accounted for		819,743
Quantity not accounted for		209,206
Percentage generated		72·53
Maximum load observed (kilowatts)		772
Number of 32-watt lamps connected		40,953

Number of public lamps: 51 arcs, 3 incandescents.

NEW COMPANIES REGISTERED.

Minehead Electric Supply Company, Limited.—Capital, £2,000. Objects: to establish electrical systems in the county of Somerset, and, generally, to carry on business as electricians and electrical engineers, etc

London Electric Mobile Syndicate, Limited.—Capital, £6,000. Objects: to adopt a certain undetailed agreement, and to acquire and turn to account any improvements in electric and other motorcars, cycles, machinery, and other mechanisms; as producers and suppliers of electricity for any purpose, etc.

Trafford Motor Manufacturing Company, Limited.—Capital, £1,000. Objects: to acquire and carry on the business of a motorcar builder and manufacturer carried on by F. W. Hatton at Christ Church-square, Hulme, Manchester.

British United Tramways, Limited.—Capital, £100. Objects: to construct, maintain, and work tramways, light railways, electric and other railways, motors, accessories, and appurtenances; to supply electricity for and purpose. etc.

British Eastern Electric Power Company, Limited.—Capital, £1,000. Objects: to carry on the business of electricians, suppliers of electric light, proprietors of tramways, light railways, etc.

Imperial Electric Lamp and Battery Syndicate, Limited.—Capital, £2,000. Objects: to adopt an agreement with P. Plater and E. Munk, and to carry on the business of vendors, patentees, or manufacturers of electric lamps and batteries, etc.

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LEGAL INTELLIGENCE.

BOURNEMOUTH TRAMWAYS.

The Corporation's Powers Determined.

A case of extreme importance, not only to the parties immediately concerned, but to the tramway industry generally, was decided on the 15th inst. by the Court of Appeal, composed of Lords Justices Vaughan, Williams, Romer, and Stirling. The action was brought by the Attorney-General, at the relation of the Poole and District Electric Traction Company, claiming an injunction to restrain the Corporation of Bournemouth from constructing certain tramways on the ground that the statutory powers of the Corporation had determined. The matter came before the Court of Appeal on the appeal of the plaintiffs from the decision of Mr. Justice Swinfen Eady that the works had been "substantially commenced" within the period specified in the provisional order held by the Corporation. Shortly stated, the facts of the case were that on Aug. 6, 1900, an Act of Parliament was passed to empower the traction company to construct and work tramways between Christchurch and Bournemouth. On the same date an Act was passed confirming, among other provisional orders, an order authorising the Bournemouth Corporation to construct tramways in their borough. One of the tramways (No. 2 in the Act) authorised by the traction company's Act was the same in position as one (No. 6 in the order) authorised by the Corporation's provisional order. But the company were prohibited from commencing at once to construct this tramway, and their right to construct it at all was to cease if the Corporation constructed their tramway (No. 6) within two years from the confirmation of the provisional order. The plaintiff company contended that the Corporation had not "substantially commenced" the works within the period prescribed in their order, because nothing had been done on the ground, no work had been done on the street towards making the actual tramway, and no buildings had been commenced for a generating station or other purpose in connection with the working of the tramway The Corporation, however, had acquired a site for works and offices, and had contracted with the British Thomson-Houston Company for dynamos and machinery, to be put in hand immediately by agreement actually executed April 18, 1901, and by agreement dated May 10 had contracted with the British Westinghouse Company for the supply of tramcars to be put in hand at once. Preliminary work in the preparation of plans of buildings had been also made, and steps taken to procure the necessary loan. As stated above, Mr. Justice Swinfen Eady gave judgment for the Corporation, and the plaintiffs now appealed.

Lord Justice Vaughan Williams, in giving judgment, said he was sorry that he was obliged to deliver the judgment he was about to deliver, and if he could see any way out of it he would take it with satisfaction, for he could not help seeing what the actual result would be. It was said that the works in question had not been "substantially commenced" within one year from the date of the provisional order; that no prolongation of the time had been obtained from the Board of Trade; and that, therefore, it was *ultra vires* for the Corporation to continue the works authorised by the provisional order, and an injunction ought to be granted to restrain them from so doing. As to the question whether the works had been "substantially commenced" within the year within the meaning of Section 18 of the Tramways Act, in his judgment, the "substantial commencement" of the works meant the execution of physical works. In the particulars which the defendants had furnished were mentioned a contract for the supply of dynamos and another contract for the construction of electric cars. It was admitted that no works forming part of the works of the tramway had been actually executed before the expiration of the year. But it was said that the giving of the orders comprised in these contracts constituted a "substantial commencement" of the works. His lordship could not satisfy himself that this was so. The giving of an order to do a thing was only an attempt to get the thing done by someone else instead of doing it yourself. It could not be said to be anything more than a manifestation of an intention to do the thing. Under these circumstances his lordship could see no alternative but to hold that the powers of the Corporation had ceased, except so far as any works had been completed before the expiration of the year, unless the time had been prolonged by the Board of Trade. This had not been done. His lordship could see no choice but to reverse the decision of Mr. Justice Swinfen Eady, on the ground that it was plain upon the evidence that there had been no "substantial commencement" of the works within the year. His lordship would be very glad if any way could have been found by which the Board of Trade could have put right that which was a mere slip. The Corporation knew much better than any private individuals what were the wants of the town, and, moreover, they had expended a large sum of money in relation to these tramways. But he was sorry to say he could not see how the Board of Trade could do anything in the matter. The appeal must be allowed, with costs, and the injunction must be granted.

Lord Justice Romer and **Lord Justice Stirling** concurred.

The Court suspended the operation of the injunction for three weeks to enable the Corporation to consider their position, and, in particular, whether they would appeal to the House of Lords.

MANCHESTER TRAMWAYS PURCHASE.

The action of the Manchester Carriage and Tramway Company *v.* the Corporation of Manchester came before Mr. Justice Bigham in the High Court on the 17th inst., on a special case stated by Sir Frederick Bramwell, the arbitrator appointed to assess the amount which the tramways company were entitled to receive for the purchase of their undertaking by the Manchester Corporation and various outside local authorities.

Mr. Fletcher Moulton, K.C., who appeared with Mr. Eldridge and Mr. Sanders for the plaintiffs, said that the Manchester Carriage and Tramways Company in conjunction with their own particular system worked certain other lines which they leased from the local authorities. The leases having fallen in, the authorities took possession of their own tramways, and, under their statutory powers, they called upon the company to sell the lines which they had constructed. In order to work both their own and the leased lines the company had to build, at their own expense, certain depôts, and one of the questions was whether the local authorities in taking over the tramways had to purchase these depôts. The statute provided that the company should receive the value of the tramways, buildings, works, materials, and plant of the company suited to and used by them for the purposes of their undertaking. Before the arbitrator the company contended that the whole of the depôts, horses, and cars were used by them for the purposes of the undertaking. On the other hand, the local authorities submitted that they were only bound to purchase or pay for such portion of each depôt for horses, cars and other things as was actually required by them. The arbitrator found in favour of the company, and awarded them £496,068. In the event of the contention of the local authorities being correct, however, he assessed the sum payable by them at £229,553. The learned counsel submitted that the finding of the arbitrator in favour of the company was perfectly sound in law, and ought to stand.

Mr. Balfour Browne, K.C., who, with Mr. Lawson Walton, K.C., and Mr. Rhodes, appeared for the defendants, contended that the second finding of the arbitrator was correct, and that the company was not entitled to foist upon the authorities depôts, cars, and horses which were not necessary for the working of the lines by the local authorities.

His Lordship reserved judgment.

DISTRIBUTION BY SECONDARY BATTERIES.

The case of the National Company for the Distribution of Electricity by Secondary Batteries *v.* Gibbs and others came before the Court of Appeal on Monday, on the appeal of Madame Ruelle, one of the defendants, against the decision of Mr. Justice Cozens-Hardy. The action was for a breach of warranty contained in a contract for the sale by Messrs. Gibbs and Gaulard to the company of English and foreign patents. The appellant is the representative of M. Gaulard, and on her behalf it was contended that the matter in question was *res judicata* by reason of some proceedings in the French courts. Mr. Justice Cozens-Hardy held that the cause of action before him had not in fact or in substance been dealt with before the French tribunals, and that there was no *res judicata*; and he directed an enquiry as to damages.

The Court dismissed the appeal.

BROMPTON AND PICCADILLY-CIRCUS RAILWAY.

On Saturday last at the Mansion House the Brompton and Piccadilly-circus Railway Company applied to the Lord Mayor for a certificate under the Lands Clauses Consolidation Act to enable the company to put its compulsory powers of purchase into operation.

Mr. Sheldon, in support of the motion, stated that the company could not get the money from the public, and had entered into an agreement with the Metropolitan District Electric Traction Company to construct the line in consideration of the capital and debenture stock being issued to the company, which took over the railway company's liabilities, made the line, and provided the cash. The object of the section under which this application was made was to prevent a man being bound to sell his land compulsorily until there was some definite guarantee that the line would be constructed and the land not left derelict. Of course, evidence was required of the financial soundness of the contractor. The contract had been assigned to the Underground Electric Railways Company, which had taken over the Metropolitan District Electric Traction, and had a capital of five millions sterling. Of this £1,200,000 had been paid up, and there was another £400,000 to come in August. The applicant company was a very responsible one, having very wealthy people behind it, was in every way in a most solvent position, and had large interests in tube railways. The line was actually in course of construction by Messrs. Walker and Reeves, and what was now wanted was powers to acquire station sites.

Documentary evidence was handed in in support of the application, and the Lord Mayor granted the certificate asked for.

COMPANIES' MEETINGS AND REPORTS.

EASTERN TELEGRAPH.

The report of the directors for the six months ended March 31 last states that the revenue amounted to £617,525, from which are deducted £149,650 for the ordinary expenses and £39,795 for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £6,784 for depreciation of spare cable, £217 for sundry differences in exchange, and £11,024 for income tax, there remains a balance of £410,053, to which is added £24,533 brought from the preceding half-year, making a total available balance of £434,586. From this balance there has been paid interest on mortgage debenture stock, dividends on preference stock, and an interim dividend of 1½ per cent. on the ordinary stock, leaving a balance of £320,039, out of which the directors have placed

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£10,000 to the reserve fund for maintenance ships, and £175,000 to the general reserve fund. The directors now recommend the declaration of a final dividend on the ordinary stock, for the year ended March 31, 1902, of 1¼ per cent. and a bonus of 2 per cent., amounting together to £130,000, both payable on the 24th inst., free of income tax, and making, with the three previous payments on account, a total distribution of 7 per cent. for the year. The balance of £5,039 is proposed to be carried forward. Revenue includes £27,193 dividends for the half-year upon the Company's investments in other telegraph companies. This Company, in conjunction with the Indo-European Telegraph Company, have entered into an arrangement with the Indian Government for the reduction of the tariff between Europe and British India on the basis of a partial guarantee of revenue, and of a "standard revenue" somewhat similar to that already adopted in connection with South Africa and Australia. The tariff with India was reduced from 4s. to 2s. 6d. per word on March 1 last. The tariffs between Europe and the Straits Settlements and Dutch Indies have also been reduced as follows: for Straits Settlements, from 4s. 6d. to 3s. 6d. per word; for Dutch East Indies—Java, from 5s. to 4s. per word; for Dutch East Indies—Sumatra and other islands, from 5s. 5d. to 4s. 5d. per word. These reductions came into operation on April 1 last. Under a tentative arrangement made with the Government of the Commonwealth of Australia, the tariffs between Great Britain and the colonies of Victoria, Queensland, and New Zealand were reduced from June 1 last as follows: Victoria, from 4s. 10d. to 3s.; Queensland, from 5s. 1d. to 3s.; New Zealand, from 5s. 2d. to 3s. 4d. These terms place the three above-named States during the continuance of the tentative arrangement in the same position as the other States of the Commonwealth. The section of cable between Perth and Adelaide, referred to in the last report, was successfully established by the Eastern Extension Company in March last, thus completing the direct telegraphic cable communication between Great Britain and Australasia *vid* South Africa.

The half-yearly meeting of the Company was held on Wednesday at River Plate House, Finsbury-circus.

Sir J. Wolfe Barry, who presided, moved the adoption of the report. It was very satisfactory, he thought, to find such a small reduction in the gross revenue. The commercial traffic with South Africa was now showing distinct signs of recovery. The result of the half-year's working was that, after paying the interest on their preference and debenture stock and meeting ordinary expenses, they were able to declare the same dividend and bonuses as usual. It would have been noticed that nearly every country was experimentiug with wireless telegraphy, and they all had their own particular system; but nothing had transpired since he last addressed the shareholders which justified them in believing that ætheric telegraphy could be utilised for the receipt and transmission of any paying traffic over long distances. This belief was also shared by the home and foreign Governments, as would be seen by the submarine cables which were now being laid and were in contemplation by the British, French, German, and Dutch Governments.

Sir J. Denison-Pender seconded the motion.

In reply to a question, the **Chairman** said the directors had come to the conclusion that it would be to the interest of the Company to make some experiment on the Company's behalf in regard to wireless telegraphy, and they had set to work to make an installation near their station at Porthcurnow.

The motion was then agreed to unanimously.

CHILI TELEPHONES.

Presiding over the thirteenth ordinary general meeting of the shareholders in this Company at Winchester House on the 17th inst., **Mr. Geo. Keith** observed that the business had been going on very favourably. The result was a net improvement in the income in Chili of 57,605dol., or about 17 per cent. more than it was in the preceding year. A large part of this gain had been required to adjust the business to the lower sterling value of the currency ruling during the year. The net income, when converted into sterling came out at £24,340, showing an increase for the year of £1,050. Turning to the balance-sheet, he stated that the loss on the valuations owing to the fall of exchange amounted to £986, which was taken from the reserve, but last year £800 was added to it, the exchange then having risen. On the other side capital expenditure showed an increase for the year of £948, and the investments were higher by £9,549. A large number of improvements and extensions had been carried out in connection with the property during the year. About 163 miles of new wire had been put up and equipped. The new multiple switchboard referred to last year had since been erected and installed at Santiago. This enabled an improved service to be given there, and it would, no doubt, lead to an increase of business. Arrangements were being made to put their wires underground in the central part of the city of Santiago. During the past year several serious accidents were caused in the streets by overhead wires coming into contact with the electric tramway trolley wires. In order to obviate this public danger the Government had introduced a Bill for regulating electric services, and telegraph and telephone wires were required to be put underground. The Bill had already been favourably reported on by a commission of the House of Deputies, and it now awaited the approval of Congress. The past year was not very favourable for successful business in Chile. The difficulties with the Argentine Republic concerning the boundary question and the postponement until 1905 of the metallic conversion of the currency had a depressing effect on the Chilian money market and on business generally. Lately the international difficulties had disappeared. The exchange had risen, and now stood at 15⅞. Their prospects for the present year, however, were good. He concluded by moving the adoption of the report and accounts.

Mr. Frank W. Jones seconded the motion, which was carried unanimously

EAST LONDON RAILWAY.

Presiding over the half-yearly meeting of this Company at the Cannon-street Hotel on Tuesday, **Mr. A. E. Gathorne-Hardy** stated that the Metropolitan and District Companies had withdrawn from their Bill for the present session their proposals to introduce electricity as a motive power on the East London Railway. These companies proposed that the other leasing companies should join them in bearing the cost of the electrical installation on this Company's system on which the District and the Metropolitan Companies desired to run trains by electricity, but the South-Eastern, the Great Eastern, and the Brighton Companies had declined to consent to this. They had agreed, however, to allow the District and Metropolitan Companies to introduce electricity providing that it did not interfere with steam traffic, and on the understanding that if at any time any one of those companies made use of the electrical installation they should share the expense of it. As representing this Company's interests, he was not concerned in the question who bore the costs of "electrifying" their system, but, speaking as a private person, it seemed to him that it was only reasonable that the persons bearing the cost should be those who desired to use the system electrically. They themselves could afford in this matter to watch and wait, and the Metropolitan and District Companies had nearly two years in which to make up their minds about it. He, however, thought that those companies could not afford to disconnect themselves with the traffic south of the Thames, and to provide access to it independently would cost them an amount to which the outlay they would incur on the electrical installation would be infinitesimal. The leasing companies were bound collectively to work the East London line, any loss on which the Metropolitan and the District Companies would bear a proportion of. His belief was that, on reflection, the latter would decide on "electrifying" the East London Railway.

The report was adopted.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD.

An ordinary general meeting of the proprietors of this Company was held at the offices, Madeira-road, Brighton, on Friday, under the chairmanship of Mr. E. J. W. Sang.

The report, with abstract of accounts for the year ending Dec. 31, 1901, was adopted. It referred to the successful application to Parliament for powers to construct a line on a viaduct from the borough boundary of Brighton to Rottingdean under the cliff, and expressed the hope that the necessary capital would be raised and that the line would be constructed ready for the summer season of next year. The authorised capital is £35,000.

Mr. Magnus Volk (deputy-chairman) stated, with regard to the new Act, that their powers were now much greater than they had been; in fact, they were practically the same as the powers possessed by the great trunk railways. The Brighton Town Council had met them very fairly with reference to the boundary.

Mr. J. J. Clark, who retired by rotation, was unanimously re-elected a director.

CALCUTTA ELECTRIC SUPPLY.

An extraordinary general meeting of the shareholders in this Company was held last week at Salisbury House, Colonel A. G. Filgate presiding, to consider a resolution for increasing the capital to £500.000, by the issue of 60,000 additional shares of £5 each, to rank in all respects *pari passu* with the existing shares.

The **Chairman,** in proposing the resolution, said that the Company's business had increased very rapidly, and the result was that the Board had had to order a considerable amount of machinery and main materials. They had put off the issue of further capital as long as possible, but now that the Company were committed to a great deal of expenditure the matter must be faced. The Board's present intention was to issue only about £100,000 of the new capital, but it was thought advisable, when increasing the capital, to make the amount sufficiently large to meet all probable demands for a considerable time.

Mr. Boulnois, M.P., seconded the resolution.

In reply to questions, the **Chairman** stated that the Company had 840 customers and 7,062 lamps connected to their mains, and their agents reported that they found great difficulty in supplying the requirements of customers.

The resolution was carried.

CITY AND SOUTH LONDON RAILWAY.

The full report of the directors for the half year ended June 30 is now available. It states that the receipts from all sources have amounted to £80,363, and the cost of working has been £35,957, leaving a profit of £44,405. Inclusive of the balance brought forward from Dec. 31 last, the net revenue account shows an aggregate total of £45,830. After making provision for the debenture stock interest, and the transfer to the renewal fund of £2,000, a balance remains available for dividend of £34,200. Out of this sum the directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, 1896, and 1901, and that a dividend at the rate of 3 per cent. per annum be paid upon the consolidated ordinary stock for the half-year, leaving a balance of £1,750 to be carried forward to the next account. The number of passengers, exclusive of season-ticket holders carried for the half-year ended Dec. 31, 1901, was 7,008,842, and the receipts, including season tickets, amounted to £59,734, the dividend being at the rate of 2½ per cent. per annum. For the past half-year the number of passengers, exclusive of season-ticket holders, was 9,192,120, the receipts were £76,843, including season tickets, and the dividend, as stated above, is at the rate of 3 per cent,

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The totals since the opening of the line are: passengers (exclusive of season-ticket holders), 88,980,570; receipts (including season tickets), £695,721. The railway was opened for traffic Dec. 18, 1890. The extension to Moorgate was opened Feb. 25, 1900. The extension to Clapham Common was opened June 3, 1900. The extension to Islington was opened Nov. 17, 1901. The working of the railway since its completion to Islington has resulted in a large increase of traffic, and this, coupled with a considerable decrease in the percentage of working expenses, has enabled the directors to recommend the payment of the largest dividend that has been earned since the opening of the line. The subways at the Bank and London Bridge have been extensively used, and fully justify the cost of their construction. The directors regret to say that the Bill for the extension to King's Cross, St. Pancras, and Euston was, for some reason for which they are quite unable to account, rejected by the House of Lords' Committee. As this extension will be of great public utility, and is supported by all the public bodies and the large railways concerned, it is proposed to reintroduce the Bill in the next session of Parliament. The Bill promoted by the City and Brixton Railway for the abandonment of a portion of their undertaking, in accordance with the agreement with this Company already sanctioned by the proprietors, has passed most of its parliamentary stages, and should shortly be ready for the Royal assent. The arbitrator's award in respect of St. Mary Woolnoth Church came before the Court, and the directors, not being satisfied with the terms of the decision, have decided to take the matter before the Court of Appeal. The agreement with the Great Northern and City Railway Company for the joint ownership and working of the Old-street Station has been finally settled, and that company has paid its agreed share of the cost.

NATIONAL TELEPHONE.

The directors' report for the half-year ended June 30 last states that the income accrued in respect of the business of the half-year amounts to £821,743, as compared with £774,714 for the corresponding period of 1901, being an increase of £47,028. The working expenses for the half-year amount to £479,122, as compared with £453,913 for the corresponding period of 1901, being an increase of £25,209. The net result for the half-year (after deducting the Post Office royalties, amounting to £75,577) is a profit balance of £267,043, as compared with £247,645 for the corresponding period of 1901, being an increase of £19,397. The rentals carried forward for unexpired terms of running contracts amount to £821,397, as compared with £784,755 at the corresponding period of 1901, or an increase of £36,641. Out of the available balance of £209,838 shown by the net revenue account, the Board will recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred shares and preferred stock, and 4½ per cent. per annum on the deferred stock, being equivalent to 5 per cent. per annum on the ordinary shares now divided into preferred stock and deferred stock, less income tax in all cases. The Board also propose to transfer £70,000 to the reserve fund, and to carry forward the balance of £8,588. The sum of £303,029 has been expended on capital account during the half-year in the erection of 9,600 additional exchange and private lines and in the construction of underground works. At the general meeting four directors retire, and, being eligible, offer themselves for re-election—viz., Mr. Charles Swain Agnew, the Right Hon. Lord Harris, Mr. George Hunter Robertson, and Sir Albert Kaye Rollit, M.P. Sir James Thomas Woodhouse, M.P., has been elected to fill the vacancy caused by the resignation of Mr. James Staats Forbes.

DIRECT UNITED STATES CABLE.

The report of the directors for the six months ended June 30 last states that the present statement of accounts, together with that at Dec. 31, 1901, shows the financial result of the past year's working. The half-year's revenue, after deducting out-payments, amounted to £46,610, as compared with £50,650 for the corresponding period of 1901, showing a difference of £4,040 against the half-year under review. The working and other expenses for the same period, including income tax, amounted to £21,516, leaving a balance of £25,094 as the net profit, making, with £3,350 brought forward from the previous half-year, a total of £28,444. For the corresponding period of 1901, the working expenses and other payments amounted to £21,125. Three quarterly interim dividends of 3s. each per share, amounting to £27,319, have been declared and paid during the financial year, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, making, with the three interim dividends, 3¼ per cent. for the year, being a total distribution of £39,461. After transferring £5,000 to the reserve fund account, the balance of £2,196 on the revenue account is proposed to be carried forward. The reserve fund account, after being credited with interest on the investments and amount transferred from revenue account, now amounts to £460,383, taking the investments at cost price.

CROMPTON AND CO.

Directors: John Trotter, Esq. (chairman); Lieut.-Colonel R. E. B. Crompton, C.B. (managing director); Lionel H. Hanbury, Esq.; Bernard Gibson, Esq.; Carleton F. Tufnell, Esq. Francis R. Reeves, general manager.

Fourteenth report of the directors (with abstract of accounts) to be presented at the annual general meeting of the shareholders at Salisbury House, London-wall, E.C., on 30th inst. at 12 noon:

The net profit for the year amounts to £22,456. 7s. 6d., and after providing for debenture interest, the payment of the interim dividend, and other items set out in the net revenue account, there remains, with the sum brought forward from last year, a balance of £9,852. 1s. 4d. The directors propose to pay a final dividend at the rate of 6 per cent. per annum for the half-year, free of income tax, making, with the interim dividend paid in January last, 6 per cent. for the year, and to carry forward a balance of £2.202. 1s. 4d. The reduction in the net profits is accounted for by the fact that during the second half of the financial year the competition for orders for electrical plant was keen, and consequently prices ruled lower than usual. The new arc lamp and instrument shops are completed and occupied, and it is confidently expected that the result will be increased economy and efficiency in these departments. The old works have been let on lease to responsible tenannts. The accounts of the Chelmsford Electric Lighting Company show a satisfactory increase of profits. Mr. Ivor Bevan, owing to the pressure of other business engagements, has retired from the Board of directors, but has accepted the trusteeship of the debenture holders rendered vacant by the death of Mr. Samuel Pope, and Mr. Lionel H. Hanbury has been elected a director in his stead. Mr. Hanbury's election requires confirmation by the shareholders. In accordance with the articles of association, Mr. Carleton F. Tufnell retires from the Board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election.

STATEMENT OF LIABILITIES AND ASSETS.

Dr. Capital and Liabilities.	£	s.	d.
Authorised issue, 100,000 shares at £3 each	300,000	0	0
Issued—85,000 shares, £3 per share, paid up	255,000	0	0
5 per cent. first mortgage debenture	100,000	0	0
Sundry creditors	52,968	8	8
Debenture interest accrued	1,177	1	8
Doubtful debts and contingencies account	1,719	3	11
Unclaimed dividends	98	13	1
Reserve fund	12,354	10	2
Contingency fund	5,000	0	0
Revenue account balance	9,852	1	4
	£438,169	18	10

Cr. Property and Assets.	£	s.	d.
Freehold land and premises	55,969	15	11
Plant, tools, furniture, and fixtures	78,048	3	1
Stock-in-trade and work in progress	157,717	8	3
Trade debtors	71,166	9	7
Chelmsford Electric Lighting Company investments	46,966	17	5
Investments in other companies	3,147	18	9
Cash at bankers and in office	9,221	17	7
Patents account	10	0	0
Goodwill	10,000	0	0
Reserve fund investments	5,921	8	3
	£438,169	18	10

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Trading expenses (steam and electric power, etc.)	25,635	12	9
Administration and head office expenses, rents, salaries, etc.	12,402	17	2
Repairs to buildings, plant, and machinery	1,395	16	4
Depreciation of plant and machinery, patents, etc.	4,011	4	2
Net profit to revenue account	22,456	7	6
	£65,901	17	11

Cr.	£	s.	d.
Gross profit from trading account, pupils' premiums, and dividends on investments	65,901	17	11
	£65,901	17	11

Dr. REVENUE ACCOUNT.	£	s.	d.
Interest on debentures	5,000	0	0
Interest on temporary advances	87	2	9
Directors', managing directors', and other fees	1,987	16	0
Income tax	990	3	0
Interim dividend paid Jan. 15, 1902	7,683	2	6
Balance March 31, 1902	9,852	1	4
	£25,600	5	7

Cr.	£	s.	d.
Balance from last year	3,143	18	1
Net profit from profit and loss account	22,456	7	6
	£25,600	5	7

GENERAL ELECTRIC.

In the report to be submitted to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel, E.C., on July 31 at 12 noon, the directors state that the net trading profits and income from investments, etc., amount to £85,947. 10s. 11d. After deducting depreciation and debenture interest, amounting to £20,800. 4s. 5d., there remains a balance of £65,147. 6s. 6d., out of which the dividend on the preference shares at the rate of 5 per cent. for the year ended March 31, 1902, has been paid, absorbing £12,500, leaving an available balance of £52,647. 6s. 6d., which the directors recommend should be appropriated as follows: payment of managing directors' and employés' bonus, £5,264. 14s. 8d.; payment of dividend on ordinary shares at the rate of 10 per cent. for the year ended March 31, 1902, £26,416; to reserve account, £20,966. 11s. 10d. The reserve account stands in the accounts at £18,084. 10s. 2d., being the amount of undivided profits

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as at March 31, 1901; and the proposed appropriation of the undivided profit of the year ended March 31, 1902, amounts to £20,966. 11s. 10d., giving a total of reserve account of £39,051. 2s. Considerable portions of the new works at Witton, Birmingham, including the engineering shops, power-house, and carbon works, are now in operation: and the foundry and tube works are expected to be in working order within the next few months.

Dr. Abstract of Profit and Loss Account.	£	s.	d.
Debenture interest and depreciation	20,800	4	5
Balance carried down	65,147	6	6
	£85,947	10	11
Dividend on preference shares at 5 per cent.	12,500	0	0
Balance for proposed appropriation	52,647	6	6
	£65,147	6	6

Cr.	£	s.	d.
Profits from trading account	81,626	2	3
Income from investments	4,290	16	2
Transfer fees	30	12	6
	£85,947	10	11
Balance brought down	£65,147	6	6
	£65,147	6	6

DUBLIN AND LUCAN ELECTRIC RAILWAY.

The report of the directors for the half-year ended June 30, 1902, shows that after providing for debenture interest there remains a balance of £857. 8s. 3d. Out of this it is proposed to pay the usual half-yearly instalment of £100 due to the electrical contractors, to allocate £200 towards the payment of balance due on electrical equipment, to pay a dividend at the rate of 5 per cent. per annum on the preference shares amounting to £475, carrying forward £82. 8s. 3d. to next half-year. The directors are glad to be able again to report an increased revenue and a decreased expenditure for the half-year. The receipts from all sources show an increase of £125, and the expenditure a decrease of £24. The ordinary expenditure shows a decrease of £182 for the half-year, but unfortunately compensation for an accident has cost the Company £158 over the amount insured for. The decrease in expenditure is spread over several items, but is largely due to the lower cost of coal. With the exception of the amount for accident compensation (£158. 11s. 11d.) the accounts contain only items of a routine character, and do not call for any special remark.

DUBLIN UNITED TRAMWAYS (1896).

The directors in their report for the half-year ended June 30 last state that they have declared dividends for the half-year at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent. per annum on the ordinary shares. These dividends will absorb £31,912, leaving a balance of £2,015 to be carried forward, after writing off £552, the balance of preliminary expenses and providing £1,000 in respect of the action of Fitzgerald against the Company, the appeal in which is now pending in the House of Lords. The amount claimed against the British Thomson-Houston Company has been debited to capital account. The directors are advised that this will not prejudice the Company's claim, and if any sum is recovered it will be credited to capital account in due course.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Warrington.—The Corporation invite tenders for tramway cables. Tenders by Aug. 6. See advertisement.

Calarasi-Stirbey (Roumania).—The Municipality require tenders for public electric lighting. Tenders by Sept. 3.

Trujillo (Spain).—The Municipality require tenders for public electric lighting for 20 years. Tenders by Aug. 10.

Pontypridd.—The Urban District Council invite tenders for cables and dust destructors. Tenders by July 31. See advertisement.

Barking Town.—The Council invite tenders for construction of tramways in their district. Tenders by July 31. See advertisement.

Manchester.—The Tramway Committee invite tenders for the supply of quick-break switches. Tenders by Aug. 2. See advertisement.

Rochdale.—The Corporation invite tenders for the supply and delivery at the car depot, Rochdale, Lancs., of three tramcars, complete with trucks, motors, and equipment. Tenders by Aug. 4. See advertisement.

Ware.—The Urban District Council invite tenders for lighting certain streets in the town of Ware for the period of two years from Aug. 8, 1902. Full particulars may be obtained on application to the Clerk. Tenders by 3 p.m. on Aug. 7.

Hendon.—The Urban District Council invite tenders from companies and others for the sale or lease of their provisional order authorising the supply of electricity in the urban district of Hendon. Tenders by July 28. See advertisement.

Anzuaga (Spain).—The Municipality require tenders for lighting the town by electricity for 25 years; 3,600 10-c.p. lamps are required for public lighting. The town authorities will contribute 9,975 pesetas per annum. Tenders by July 27.

Nisch (Servia).—The Municipality invite tenders for electric lighting of the town estimated at 202,132·47 dinars, and for plant estimated at 366,841·75 dinars. Tenders by Aug. 13. Particulars may be obtained on application to above.

Coventry.—Tenders are invited for the supply of electric motors, to be let out on hire by the Corporation. Motors to be single or two phase at 50 periods, and single-phase at 87 periods; voltage, 200 in all cases. Tenders by Aug. 5. See advertisement.

Hapton (Lancs.).—Tenders are invited for lighting Hapton township with electricity from Sept. 1, 1902, to April 30, 1903. Full particulars on application to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, 16, Hammond-terrace, Padiham. Tenders by July 31.

Malvern.—The Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work); engines, alternators, exciters, and switchboard; high and low tension concentric cables; and transformers. Tenders by Aug. 23. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1. The Government also propose to lay a cable between Punta-Arenas and Puerto-Montt.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Stratton St. Margaret (Wilts).—The Swindon and Highworth Board of Guardians invite tenders for a complete installation of electric lighting at their workhouse and infirmary at Stratton St. Margaret, Swindon, Wilts. Tenders by 9 a.m. on 29th inst. See advertisement.

Dundee.—The Gas Commissioners invite tenders for machine tools, etc., to be supplied and erected at the electrical power station, Dudhope-crescent-road, Dundee. Specifications, etc., may be had on application to Mr. Walter H. Tittensor, electrical engineer, Dudhope-crescent-road. Tenders by Aug. 1.

Farnworth (Lancs.).—The Urban District Council invite tenders for supply of a 400-h.p. enclosed high-speed engine, direct coupled to a 250-kw. lighting and traction generator, together with the necessary extensions to switchboards, pipework, foundations, condensing plant, etc. Tenders by July 31. See advertisement.

Ilford.—The Urban District Council invite tenders for a combined track watering and sweeping car on maximum traction truck with complete electrical equipment. Specification, etc., may be obtained at the offices of Mr. John W. Benton, clerk to the Council, Town Hall, Ilford. Tenders by 12 noon on Aug. 19.

Bexley (Kent).—The Electric Lighting and Traction Committee invite tenders for tramway and lighting cables, including trenches, and for switchboards, accumulators, motor-boosters, rotary converter, and motor. Specifications, etc., can be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster. Tenders by Aug. 9.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

Madrid.—The Public Works Department invite tenders for the extension of electric tramways in the east of Madrid, and also for a new line and working of the same for not more than 60 years. A preliminary deposit of 3,368 pesetas and a final deposit of 16,844 pesetas is required, also the repayment of 3,189 pesetas and interest to the Sociedad del Tranvia del Este for preparation of the scheme. Particulars may be obtained from the above. Tenders by Aug 26.

King William's Town (South Africa).—The King Electric Lighting and Cold Storage Company invite tenders for supply of plant, boilers, wrought-iron smokestack, high speed enclosed engines, single-phase alternator, direct-driven exciters, surface condenser, main switchboard, transformers, copper mains, etc. Specifications, etc., can be obtained from the London agents, Messrs. A. E. Booth and Co., 16, New Union-street, Moorfields, London, E.C. Tenders by Aug. 7.

London, S.W.—The London County Council invite tenders for the supply and delivery of seven tubular fuel economisers, of not less than 320 tubes each, complete with scraper gear, and seven motors with their starting gear for driving the same; for erection of above-named plant in the Council's electricity generating station at Greenwich; and for supply and delivery at the station of dampers and frames for flues and chimney openings to be erected and fixed by the Council. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Aug. 15.

Leicester.—The Tramways Committee invite tenders for electric tramway works and materials, under the following sections, each comprising a separate contract. For supply and delivery of steel girder tramway rails and fishplates; supply and delivery of bolts, nuts, and tiebars; supply and delivery of points, crossings, and special track work; supply and delivery of stoneware pipes and conduits; supply and laying of feeder cables, telephone and test wires, and supply and delivery of roadway frames and covers; supply and erection of overhead electrical equipment, and the supply of copper bonds; supply and erection at the power station of steam-raising plant; supply and erection at the power station of engines, generators, battery, boosters,

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switchboard, overhead travelling crane, etc.; supply and delivery of electric tramcars. Specification, etc., may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., engineer, Town Hall, Leicester. Tenders by Sept. 3.

Selangor (Malay States).—The Crown Agents for the Colonies invite tenders for certain plant and materials in connection with the electricity supply scheme for the town of Koala Lumpur, in the protected native state of Selangor, Federated Malay States: (Contract A, Section 1) supply, delivery, and erection of a generating station, consisting of two 600-h.p. high-pressure turbines, with pipes, two 400-kw. three-phase alternators, switchboard, and sundries. (Section 2) The supply, delivery, and erection of a sub-station plant, consisting of three 150-kw. motor-generators, two balancers, switchboards, and sundries. (Contract B, Section 3) The supply and delivery f.o.b. at a European port of steel poles, cross-arms, insulators, copper wire, &c., for the high-pressure transmission line. (Contract C, Section 4) The supply and delivery f.o.b. at a European port of arc lamps, iron posts, controlling apparatus, incandescent lamps and fittings. Tenders may be sent in for any or all of above three contracts. Specifications, drawings, general conditions, and forms of tender may be obtained from the Crown Agents for the Colonies, Downing-street, London, S.W., on and after 7th inst., on payment of £2 for Contract A, £1 for Contract B, and £1 for Contract C. Sealed tenders, endorsed "Selangor Electric Lighting Contract," and addressed to the Crown Agents for the Colonies, are to be delivered at Downing-street, London, S.W., by 12 noon on Aug. 21. All information regarding above contracts is to be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

RESULTS OF TENDERS.

Bath.—The Corporation have placed a contract for 149 meters with Messrs. Geipel and Lange, Parliament-mansions, Westminster, at £558. 12s. 3d.

Swansea.—The Corporation have accepted the tender of Callender's Cable and Construction Company for supply of the cables required in connection with the tramways.

Warrington.—The Corporation have accepted the tender of the British Thomson-Houston Company for 11 tramcars, with motors and electrical equipment complete, at £5,996.

Walsall.—The Town Council have accepted the tender of Crompton and Co., at £322, for supply of a reversible booster and switchgear to be erected at the Hospital-street sub-station.

Worthing.—The Corporation have accepted the tender of Myles and Warner, Stalybridge, at £679, for erection of a circular brick chimney shaft for their electric generating station, High-street, 140ft. high from the ground level and 7ft. 6in. inside diameter at the top.

Dundee.—G. H. Nicoll and Co., of Bank-street, Dundee, are the successful contractors for the erection of the electric generating and lighting plant at the new Dundee sanatorium at Auchterhouse, the contract amounting to about £1,000. The firm has also received the contract for the electric lighting of the municipal buildings, Broughty Ferry.

West Ham.—The Council have accepted the tender of Witting Bros. for the supply of 50 tramcars, at £518 per car. The sub-contractors for the different parts are as follows: G. F. Milnes and Co., car bodies; Brush Engineering Company, trucks; British Thomson-Houston Company, controllers. Messrs. Witting Bros. will supply the motors themselves.

Fulham.—The Guardians have accepted the tender of the Hart Accumulator Company for a storage battery required at the union electric lighting installation.—The Borough Council have accepted the following tenders in connection with the electric lighting extension scheme: New Conveyor Company, coal conveyor and bunker, £987; H. Windsor and Co., boiler seatings, £695.

London County Council.—The Council have accepted the following tender for the work of laying the necessary stoneware ducts for the electric cables between the temporary electricity generating station to be erected at Loughborough Junction and the Tooting, etc., tramways: J. A. Ewart, Paddington, £6,173. 5s. Mr. Ewart proposes to sub-let to Messrs. Hayward Bros. and Eckstein, Limited, the manufacture of the cast-iron materials required in connection with the work. The Council have also accepted the tender of C. B. Roberts and Co., Redhill, at £1,900, for the carrying out of certain alterations of and the making of additions to the present car-sheds at the tramways depôt, Balham, in order to fit them for the accommodation of electrical cars.

Brighton.—The Town Council have received the following tenders for installing electric light in the new wholesale vegetable market, and the performance of other works in connection therewith:

C. G. Reed and Sons, Limited, North-street (accepted) ...	£137	10	0
H. J. Galliers, 21, St. James's-street	140	17	6
Scholes and Son, 85, Corporation-street, Manchester	147	0	0
W. Holmes, 39, Gayville-road, Wandsworth Common, S.W.	153	10	0
E. P. Allam and Co., 11, Hatton-garden, London, E.C....	157	0	0
G. A. Purnell, 70, Warwick-road, West Ham, E.	175	0	0
H. S. Roberts, 12, Alexandra-road, Walthamstow, Essex	185	0	0
G. Hignett and Co., 2, North-street Quadrant.....	209	11	0

Rochester.—Mr. A. R. Bennett has made a report on the proposal to establish a municipal telephone system for Rochester, Chatham, and Gillingham. He recommends a scheme of 600 lines, to cost £13,800, for the three places, estimated on the basis of £18 per line, and £3,000 for extra pipes and pole accommodation. The following tariffs he considers would meet the requirements of the case: £5. 7s. 6d. per annum for unlimited use, and £3. 10s. per annum with a toll of 1d. per call. This is estimated to give a total annual revenue of £3,269, as against working expenses amounting to £2,820. 19s. 8d.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Norwich.—The Corporation are making arrangements for taking over the electric light undertaking in the town.

Glasgow.—A profit of £434 has been made on the past year's working of the municipal telephone undertaking.

Salisbury.—New lightning conductors have been fixed to the spire and chief points of the roof of Salisbury Cathedral.

Wombwell. — The Provincial Electric Supply and Traction Company are applying for powers to supply electricity in the district.

Rawmarsh.—The Board of Trade have deferred consideration of the question of the revocation of the electric lighting order for six months.

Electric Light Acts.—On the 22nd inst. the Electric Lighting Acts Amendment (Scotland) Bill was read a second time in the House of Lords.

Dingwall.—A special meeting of the Town Council is to be called to consider the question of the proposed installation of electric light in the town.

Stafford.—The output of electricity for the last month showed an increase of 68·2 per cent. on the output for the corresponding period last year.

Cheshunt.—The Urban Council is negotiating with the British Insulated Wiring Company as to the feasibility of lighting the town by electricity.

Belfast.—Mr. P. C. Cowan held an enquiry on Tuesday into the application of the Council for sanction to a loan of £20,000 for electric lighting purposes.

Rontgen Rays.—The *British Medical Journal* is informed that complete Röntgen ray apparatus have been ordered at a cost of £68 a set for all flagships.

Farsley.—The Provincial Electricity Supply and Traction Company propose to apply for powers to supply electricity within the District Council's area.

Sevenoaks.—The Kent Electric Power Syndicate, Limited, intend to apply for a provisional order to supply electricity for lighting purposes in this district.

Harrogate.—The Corporation have reduced the charge for electricity for lighting purposes to 3d. per unit after the second hour on the demand indicator system.

Rugby.—It is expected that an enquiry will be held soon with reference to the Urban District Council's application to borrow £9,000 for electric lighting purposes.

Chester.—It is proposed to extend the electric light mains for supplying energy for public and privating lighting in Filkins-lane, Boughton, at an estimated cost of £134.

Tunbridge Wells.—The municipal telephone system has made a profit on last year's working of £130. It has over 700 connections, and the maximum charge is £5. 17s. 6d.

North Metropolitan Electric Supply.—In the House of Commons this week the Lords' amendments to the North Metropolitan Electric Power Supply Bill were considered and agreed to.

Fulmer.—The Uxbridge Electric Supply Company have given notice of an intended application for a provisional order extending their area of supply to Fulmer and Gerrard's Cross.

Bournemouth.—The Telephone Committee of the Town Council have been authorised to obtain a report and estimate of the expense involved in establishing a municipal telephone exchange.

Bingley.—The Town Council have refused their consent to the proposed application of the Provincial Electric Supply and Traction Company to obtain powers to supply electricity in Bingley.

Outing.—On Saturday last the employés of the Hart Accumulator Company held their annual outing at Epping, Essex. The weather was exceptionally fine, and a very enjoyable day was spent.

Manchester.—The total cost of buildings and machinery at distributing stations and of subways for carrying mains from the Stuart-street generating station is estimated at about £250,000.

Grangemouth.—Messrs. Crompton and Co. have addressed a letter to the Corporation enquiring whether they are prepared to enter into an agreement for the introduction of electric lighting into the town.

Loughborough.—In the matter of the exercise or transfer of the electricity powers of the Corporation the Electricity Sub-Committee have been instructed to take the matter into further consideration and report.

Coronation Illuminations.—With reference to the forthcoming Coronation, Messrs. Johnson and Phillips inform us that they have a stock of searchlights which may be hired for the occasion or purchased outright.

Bideford.—Notices have been received of the intention of the Electric Supply Corporation and the Electric Supply and Traction Company to apply for provisional orders for lighting Bideford by electricity.

Stourbridge.—The Ratepayers' Association has adopted a resolution asking that before a destructor or electric light works are laid down, a public meeting shall be called to elicit the views of the ratepayers on the subject.

The National Telephone Fire.—We are informed that the ful telephone service in connection with the London-wall exchange, which was recently burnt out, will probably be available by the end of the present week.

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Huddersfield.—The Town Council last week again discussed the *pros* and *cons* of municipal *versus* national telephones, and after a four hours' discussion did not come to any final conclusion with regard to the matter.

Westminster Electric Supply Co.—The directors of the Westminster Electric Supply Corporation, Limited, have declared an interim dividend for the half-year ended June 30 last at the rate of 11 per cent. per annum.

Share Market.—At the beginning of the week electrics were fairly steady, but yesterday there was a much improved investment demand in the shares, and the tone was better all round, without, however, quotably altering prices.

Maidstone.—An application is to be made to the Local Government Board for sanction to borrow £6,567 for electric lighting purposes. The electric light mains are to be extended from Tonbridge-road to Cornwallis-road at a cost of £112.

Bath.—The Baths Committee have decided to ask the Council at their next meeting to sanction an expenditure of £1,300, this to include the introduction of electric baths, the cost of renovations, and the installation of electric lighting.

Watford.—The Urban District Council have decided to apply for a provisional order for the further enlargement of their area of electricity supply. The surveyor is now engaged in preparing plans for the erection of a new generating station.

Burslem.—The Potteries Electric Traction Company, Limited, have given notice of an intended application to the Board of Trade for a provisional order authorising the company to supply electrical energy for public or private purposes in Burlem.

Cleckheaton.—An estimate prepared by Mr. Baker of additional money required for electrical purposes, amounting to £6,000, has been approved by the District Council, who have decided to appoint a manager of the works at a salary of £200 a year.

Wigan.—A sub-committee has been formed to appoint a new borough electrical engineer in succession to Mr. H. Collings Bishop, who, as noted last week, has been appointed borough electrical engineer and tramways manager at Newport (Mon.).

Hull.—A brief and informal discussion took place at the last meeting of the Hull Guardian Society with respect to the telephone question, reference being made to the fact that the Postmaster-General has promised the Corporation their license.

Swanage.—Notice has been received by the Urban District Council of the intention of a company to be formed to apply to the Board of Trade for a provisional order to supply electricity for all public and private purposes within the urban district of Swanage.

Bexhill. — Application is to be made to the Local Government Board for permission to borrow £16,000 for electric light works, including new dynamos, switchboard, building for housing dynamos, and for extensions of mains, which have already been made.

South African Telegrams.—The Postmaster-General announces that the restrictions on telegrams in code and cipher to and from Rhodesia, British Central Africa, Orange River Colony, Transvaal, Cape Colony, Natal, and St. Helena have now been withdrawn.

Anglo-American Telegraph Co.—The directors of this Company announce an interim dividend for the quarter ended June 30 last of 15s. per cent. on ordinary stock and 30s. per cent. on preferred stock, placing £6,000 to credit of renewal fund, and carrying forward £2,727.

Bray.—On Thursday last an enquiry was held into the proposed expenditure of a sum of £7,000 in connection with the electricity undertaking of the Urban Council. The proposed extensions were explained by Mr. Robert Hammond, the consulting engineer to the scheme.

Midsomer Norton.—The Urban District Council have received notice of the intention of a syndicate to apply to Parliament for powers to establish an electric power station for the Radstock coalfields, and to supply power to districts within a 75-mile radius of Radstock.

Huddersfield Telephones.—The Corporation have abandoned their original idea of establishing a municipal telephone exchange, and have decided to enter into an agreement with the National Telephone Company for the laying of underground wires within the borough for a period expiring in 1911.

Wireless Telegraphy.—A station for wireless telegraphy is to be established shortly at Gottingen, in the grounds of the Geo-Physical Institute on the Hainberg. Experiments are to be made in connection with the observatory at Uslau, and with another station to be erected at the summit of the Brocken.

South London.—At the directors' meeting held on the 17th inst. of the South London Electric Supply Corporation, Limited, the accounts were submitted for the half-year ended June 30 last, and showed a profit of £2,548—against a loss of £791—for the corresponding six months of last year.

Beckenham.—Notices by the Blackheath and Greenwich Electric Light and the Lewisham and District Electric Supply Companies, Limited, of their intention to apply to Parliament for provisional orders to supply electricity within the district of Beckenham have been submitted to the Urban District Council.

Sandbach.—A public meeting was held on Friday to consider the desirability of establishing a telephone exchange. After some discussion, it was decided to communicate with the Postmaster-General informing him of the number of probable subscribers, with a request that an exchange might be opened at the earliest possible date.

Worsley.—The Lancashire Electric Power Company has asked the Urban Council if they are prepared to treat for the supply of current in bulk, promising that they can place the Council on terms of equality with Manchester and Liverpool without risk of loss. An Electricity Committee has been formed to interview the company's representative.

Aylesbury.—The Board of Trade have decided to grant an extension of the Aylesbury electric light order of 1899 for a further period of 12 months from June 29, but if on the expiration of that period substantial progress has not been made in carrying out the order, the Board state that they will not be prepared to grant any further extension.

London Gazette.—The partnership existing between F. S. Thomas and R. H. Stimpson, trading as the Saxonia Electrical Wire Company, engineers and electricians, Roan Works, Roan-street, Greenwich, has been dissolved by mutual consent. The business will in future be carried on by F. S. Thomas and S. T. Smith at the same address and under the same name of firm.

Kensington.—With reference to the proposed extension of the electric lighting in the borough, the Council have come to an agreement with the Kensington and Knightsbridge and Notting Hill Electric Lighting Companies, under which provision is made for the supply of electrical energy for public purposes for a period of five years at the rate of 2½d. per unit.

Dawlish.—We understand that the Urban District Council are favourably considering a proposal from Messrs. Crompton and Co. to pay the Council £200 towards the cost of obtaining a provisional order for lighting the town by electricity, and to make an annual payment of £25, the Council to have the option of taking over the undertaking at the end of a term of years.

Morpeth.—In the House of Commons on Monday the examiners of Standing Orders had before them several local Bills, including those confirming electric lighting provisional orders granted to Morpeth, Ashington, Newbiggin, and Morpeth (rural). The examiners found that the forms of the House had been complied with, and ordered the Bills to be reported for second reading.

Carlisle.—The Electricity Committee has recommended the Corporation to vary the scale of rebates to consumers as under: lighting—up to 1,000 units per year, 5d. per unit; above 1,000 and under 3,000, 4½d.; above 3,000 and under 6,000, 4½d.; above 6,000 and under 12,000, 4½d.; over 12,000, 4d. Power—up to 50,000 units per year, 2d.; above that number, special terms to be agreed upon.

Margam.—The Electric Lighting Committee reported having discussed the proposed electric lighting scheme with Mr. Prussman, electric engineer, Swansea, and that they had instructed Mr. Prussman to prepare a scheme (leaving out the districts of Penycae from Tydraw Hill, Port Talbot) for submission to the Local Government Board, with an application for sanction to borrow the amount required.

Grimsby.—The report of the electrical engineer on the first year's working of the electricity undertaking since the tramway company commenced regular service shows that on the year's working expenses there was a gross profit of £16,000, or 3⅜ per cent. on the average capital expended. On the capital account, however, there was a net deficit of about £2,000, with another £1,700 for preliminary charges.

Boston.—A letter was read from the British Electric Traction Company at the last meeting of the Town Council stating that they had given the whole question of electric tramways and lighting for the borough careful consideration, and had come to the conclusion that the undertaking in Boston would not be a remunerative one. It was accordingly resolved that no further steps be taken in the matter.

Cricket.—A cricket match was played on Saturday last at Clifton Junction betweeen the Chloride Electrical Storage Company's Cricket Club and the Tudor Accumulator Company Cricket Club, which ended in a win for the Chloride, the result being Chloride 42, Tudor 34. After the match the Chloride Club entertained the visitors at tea, when hearty good wishes were exchanged between the teams.

Electrically-Driven Machinery.—The Great Northern Railway Company have recently made provision at their locomotive works at Doncaster of a new locomotive erecting shop, which is 580ft. long and equipped throughout with electrically-driven machinery of the most approved types. The overhead electric cranes are capable of lifting a weight of 35 tons. For riveting and similar operations pneumatic tools are extensively used.

Oban.—Mr. J. M. MacGown, Glasgow, has been appointed assistant electrical engineer at the Corporation electricity works. In connection with the electricity undertaking, the Council have decided to purchase sundry testing instruments at an estimated cost of £100. The agreement between the Council and the British Power, Traction, and Lighting Company, Limited, with reference to the electrical storage batteries contract, has been signed.

Brentwood.—The Provincial Electric Supply and Traction Company having given notice of intention to apply for a provisional order authorising the supply of electricity for electric lighting and other purposes in Brentwood, the Urban District Council have come to the conclusion to apply themselves for a provisional order with the same object. A public meeting is to be held early in August to take the opinion of the district on the subject.

Dundee.—The electric light mains are to be extended to Magdalen Green. A proposal was made at a meeting of the Tramways Committee this week to furnish extensive coal storage accommodation at the electrical generating station. After discussion, it was remitted to the convener, the manager, and the city architect to examine the site and to report. It is stated that the smoke nuisance at the electricity works has been largely abated by the use of a mixture of coal and coke as fuel.

St. James's and Pall Mall Electric Light Co.—The directors have declared the following interim dividends for the half-year ended June 30, 1902: at the rate of 7 per cent. per annum on the preference shares and at the rate of 10 per cent. per annum on the ordinary shares. The amount of electricity sold for the quarter ended Mid-

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summer, 1902, is returned at 1,420,683 units, estimated to produce £24,270, as against 1,115,593 units, which produced £19,383, for the corresponding period of last year.

Tadcaster.—A Bill to confirm provisional orders granted by the Board of Trade to the Tadcaster Electricity Supply Company and to the West Riding Tramways and Electricity Supply Company to supply electricity for lighting purposes respectively to Tadcaster and district and Pontefract and district has passed the examiner of the House of Commons, before whom proof of compliance with further Standing Orders was given. The Bill, which has already passed the Lords, will consequently be read a second time in the Commons.

Cardiff.—The electrical engineer has informed the Lighting Committee that the Ely Paper Works Company have reported themselves to be well satisfied with the electric lighting of their premises, and that they found it to be better and cheaper than gaslight. The engineer further reported that the proprietors of the *South Wales Daily News* were prepared to work their printing machines with electrical power, conditionally on the Corporation undertaking to run a short independent main to avoid risk of a general breakdown.

Bermondsey.—It was officially stated at the last meeting of the Borough Council that the provisional order sanctioning the extension of the Council's electric lighting undertaking to other parts of the borough in addition to the parish of Bermondsey, has passed the committee of the House of Lords. It was resolved to charge consumers using penny-in-the-slot meters 6½d. per unit for electric light, to include meter rent. The Electric Lighting Committee report that since the opening of the undertaking 6,011 tons of refuse have been consumed, being the total amount available.

Society of Model Engineers.—On Thursday, July 17, a party of this society paid a visit to the Rugby works of Messrs. Willans and Robinson, Limited, the well-known makers of high-speed engines. The opportunity of inspecting such a well-organised and up-to-date establishment was fully taken advantage of by the members, who evinced great interest in the tools and methods adopted to secure the accuracy of workmanship and interchangeability of parts for which this firm has so excellent a reputation. The party were subsequently received by Mr. Lazenby on behalf of the firm, and entertained to tea.

London County Council.—At their usual weekly meeting on Tuesday the County Council agreed to the Battersea Borough Council contracting a loan of £6,000 for electric lighting purposes. Notice under the Electric Lighting Acts of intention to lay high-tension mains along portions of Black Horse-yard, Rathbone-place, Oxford-street, Newman-street, Castle-street East, Wells-street, and Marylebone-passage, was received from the Metropolitan Electric Supply Company; and of intention to lay low-tension mains along portions of Willowbrook-road and Sumner-road from the County of London and Brush Company.

Longton.—The Electricity Committee have reported that the electric lighting station has secured 50 consumers, and that the maximum demand has reached 56 kw., against an output capacity of 150 kw. This compares very satisfactorily with the commencement of other stations. The working profit for the half-year amounts to £382. 7s. 5d., the interest on capital £357. 4s. 4d., and the proportion of sinking fund £274. 5s. 6d., leaving a deficiency of £249. 2s. 5d. To this must be added the accumulations of interest previous to the starting of the station, amounting to £177. 9s. 3d., making the balance to carry forward £426. 11s. 8d.

Lowestoft.—The staff of the Corporation electricity works had their annual outing on Wednesday, the 16th. The steam yacht "Atalanta" was chartered for the day, and conveyed the party up the Broads as far as Buckingham Ferry, where various sports were held. Luncheon was served aboard, and after a most enjoyable time the return journey was made, the party arriving home early in the evening. The electrical engineer reports that there are now connected to the mains 256 consumers, representing a total of 12,285 8-c.p. lamps. The number of 8-c.p. lamps connected during the last month was 500. This includes a 7½-h.p. motor connected.

City of London.—The electrical engineer, Mr. Voysey, has submitted a report to the Court of Common Council relative to the assistance required for carrying out the work of meter testing, under the agreements made between the Corporation and the undertakers under the City of London electric lighting orders. As a result the Streets Committee have been authorised to appoint one assistant at £200 a year, and seven men whose wages will not amount to more than £600 per annum. These amounts will be refunded to the Corporation under the agreement. A proposal to expend £700 on the installation of electric light at the City schools has been referred back to committee.

Electrical Enterprise in Roumania. The German Chamber of Commerce for Roumania announces that a number of important contracts for the establishment of electrical installations in Roumania have just been concluded. In addition to several private plants of a comprehensive character, agreements have been entered into for the erection and equipment of municipal electric lighting stations at Constantza, Bacau, and Tirgovist, whilst the conclusion of a similar contract for the town of Roman is impending. The largest share of the work has been placed with German firms, but notwithstanding this, complaints are being made that the German companies pay little attention to the conditions prevailing in Roumania.

Tiverton.—An offer has been received by the Town Council on behalf of a company to take a lease of the Council's electric lighting provisional order. A notice has also been given by a company of intention to apply to the Board of Trade for the grant of a provisional order for the purpose of supplying electricity in Tiverton. With a view to presenting a report to the Council as to the best method of providing an installation in the town, the Electric Lighting Committee recommend that the borough surveyor should visit some towns where various methods of generating electricity have been tried, and at the same time to interview the Board of Trade and explain what the Council are now doing in order that the Board might not cancel the provisional order granted to the Council in favour of any company.

Heckmondwike.—Mr. F. H. Tulloch, an inspector of the Local Government Board, held an enquiry at Heckmondwike on Tuesday respecting an application by the District Council for sanction to borrow £6,500 for extending their electric plant. The evidence showed that the Council have an agreement with the tramway company serving the district to supply them with energy. It was also shown that the demand is already such that an extension of plant is indispensably necessary apart from the requirements of the electric traction company, the power of the present works being only sufficient to supply current to 5,927 lamps. To supply a total of 9,000 lamps required, it is proposed to instal another 150-kw. generator, this making a complete installation of 300 kw. There was no opposition.

Hampstead.—An electric light main is to be laid in Dunboyne-street at a cost of £175. With reference to the lighting of High-road, Kilburn, by arc lamps, the committee report having considered the plan submitted by the Willesden Urban District Council showing the position of the suggested lamps to be erected upon the Willesden and the Hampstead sides of the High-road. The committee have conferred with Willesden upon the subject, and they recommend that, subject to a proper agreement being entered into between Willesden and Hampstead, the Hampstead Council do light with arc lamps the whole of the Hampstead side of the High-road, Kilburn, Shoot-up-hill, and Cricklewood, from boundary to boundary. The work will involve a capital expenditure of £3,086. Tenders for the necessary plant and works will shortly be invited.

Stock Exchange.—The Stock Exchange Committee has appointed Aug. 7 as special settling day in the following concerns: the Bournemouth and Poole Electricity Supply Company's provisional certificates for 7,500 6 per cent. cumulative second preference shares, Nos. 15,001 to 22,500; and the Charing Cross and Strand Electricity Supply Corporation's 40,000 City undertaking 4½ per cent. cumulative preference shares of £5 each fully paid, Nos. 1 to 40,000. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the Colombo Electric Tramways and Lighting Company's 5 per cent. first mortgage debenture stock; and the Urban Electric Supply Company's 30,000 5 per cent. cumulative preference shares Nos. 50,001 to 80,000, and 30,000 ordinary shares Nos. 8 to 30,007 (renewed application).

Twickenham.—The electric light station, which has been erected off the Edwin-road by Edmundsons' Electricity Corporation, for the supply of electricity in Twickenham was formally opened on Monday this week. The electrical plant installed at present consists of two 150-h.p. engines, but these will subsequently be supplemented by a 300-h.p. and a 600-h.p. engine. The equivalent number of 8-c.p. lamps connected to the mains is 3,000, and the first installation is amply sufficient to meet present requirements. The boilers, which are of the water tube type, are installed in a building at the back of the engine-room. The company's mains are laid in almost all the principal streets of the parish from Strawberry Hill to Richmond Bridge, and branch roads will be connected as soon as applications are received from the residents for the wiring of their premises. The town hall is also connected.

Edinburgh.—The installation of the electric in the Museum of Industrial Arts and Science in Edinburgh has just been successfully completed. H.M. Board of Works entrusted the preparation of the specification and supervision of the work to their electrical advisers in Scotland—Messrs. Buchan and Hogarth, of Edinburgh—and we understand it is one of the most complete installations in the country. For lighting the great halls 92 lamps of 1,000 c.p. each are suspended from the roofs. The floor lighting of these halls is supplemented by 32 inverted-type arc lamps, suspended from under the first-floor galleries. These have been specially designed, and are also used for the illumination of the various floors of the east and west wings, in which other 40 are used, and have proved very successful. Besides about 600 incandescent electric lamps of ordinary type for workshop, store, office, and police service, about 50 lamps of the new Nernst 1902 pattern have been installed for the illumination of the main corridors. The contract was carried out by the National Electric Wiring Company.

Brighton.—Electric light mains, involving a total cost of £234, are to be laid in the neighbourhood of Kensington-street. The Telephones Committee will shortly submit a full report to the Council on the subject of municipal telephones. In the meantime the Tramways Committee have been requested to prepare their specification for laying the tramway lines on the Old-steine and London-road to include provision for the laying of telephone cables on such routes. The statement of accounts for the electricity undertaking for the year ended March 31 last shows that before deducting the interest and sinking fund on (1) the capital expended on the new power station being erected at Southwick (£28,162); (2) part of the capital expended in building the new storehouse in Bedford-street (£150); and (3) the fees of the consulting engineers in superintending the Southwick works (£400)—the result of the year's trading was a net profit of £1,412. The effect of the Town Council's decision that the above charges should be paid out of the year's revenue, instead of being debited to capital, has been to turn the above profit into a deficit of £168.

Newton Abbot.—The Electric Supply Company have written th Urban District Council to the effect that they have provided for a main for supplying all the houses in Courtenay-park with electricity and are arranging to supply Devon-square. Practically they will be prepared to supply any premises within a reasonable distance from the centre of the town. As to public lighting, they are prepared to offer the Council considerably more light for the same money that they are paying at present, or to give practically the same light at a reduced cost. They enclosed tracing showing position of 15 arc lamps, which

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they suggest would light the centre of the town. In the rest of the streets they offer to erect 25-c.p. incandescent lamps, increasing 20 of them to 50 c.p. in points to be selected by the Council. Of these the whole of the 50-c.p. and 50 of the 25-c.p. would be alight all night. The others would be kept alight half the night. The total cost would be £781 per annum. For this amount, which they believe is about what the Council are at present paying, the company will undertake to supply 21,500 c.p. illuminant, as against 5,000 c.p., the estimate of the illuminating power of the present lamps. The subject was referred to the Lighting Committee.

Liverpool.—On Wednesday Major C. E. Norton, R.E., held an enquiry on behalf of the Local Government Board into an application by the City Council for sanction to borrow £300,000 for the purposes of the electric lighting undertaking. The deputy town clerk explained that the money was required for providing plant and extending the works in connection with the electric lighting. At the time of the transfer of the undertaking in 1896 to the Corporation the output was 1,352,000 units; and in 1900 it had increased to 11½ million units; and in 1901 20 million units, while this year the estimate was put at 22½ million units. In order to keep pace with the demands considerably capital expenditure was yet to be incurred. The total expenditure to date was £1,200,000. Since the time of the transfer the charges for electric lighting had been considerably reduced. At the outset the price for lighting was 7½d. per unit and for power 5d. per unit. The charges for lighting now were 3½d. per unit up to 3,000 units per quarter, and for supplies beyond that 3d. per unit. As regarded power the present charge was 2d. up to 3,000 units, and beyond 1½d. per unit. They commenced with 1,300 consumers, and the number now was 4,058. The number of lamps supplied when the undertaking was transferred was 52,490, and at present it reached 190,041. Mr. A. B. Holmes, electrical engineer, submitted drawings and schedules of the proposed new stations. He stated that they would not have to purchase land, as the proposed sites were already in the possession of the Corporation. There was no opposition to the application, and the enquiry closed.

Mid-Wales Telephones.—A week or two ago a deputation waited upon the Postmaster-General to ask for further concessions in regard to the proposal for the establishment of the trunk telephone through Mid-Wales from Welshpool to Aberystwyth. The chief requests were that the guarantee, amounting to an annual charge of £655, should be reduced, and that in consideration of the thin population of the district the local free areas should be extended. A reply has now been received from Lord Londonderry. As regards the suggestions named, the Postmaster-General regrets that he is unable to meet the wishes of the deputation, and points out that the conditions of the guarantee are similar to those in operation in other parts of the kingdom, and that the proposed circuits entail an unusually heavy cost, which makes a loss to the Exchequer almost inevitable. The area proposed for Newtown, Montgomery, and Welshpool comprises about 70 square miles, whilst that for Machynlleth, Towyn, and Aberdovey is larger than most existing areas. If, however, the guarantee should cover extensions to Llanfyllin, Corris, Aberllefenf, Barmouth, and Dolgolley, the Postmaster-General would be prepared, if desired, to rearrange the proposed new areas as follows: (1) Welshpool, Montgomery, and Llanfyllin; (2) Newtown and Llanidloes; (3) Machynlleth, Aberdovey, Towyn, Corris, Aberllefenf, Dolgolley, and Barmouth. He would not enlarge the Oswestry or Aberystwyth areas. The extension to Corris and Aberllefeni would be from Machynlleth. The Machynlleth-Corris section would require a guarantee of £30 per annum, and the Corris-Aberllefeni section a guarantee of £10. A direct circuit between Welshpool and Oswestry would require a guarantee of £125 per annum.

Swansea.—Mr. Prussman, the electrical engineer, submitted a report to the last meeting of the Town Council showing that the number of consumers now on the books is 227, the number of lamps 27,571, number of consumers actually connected to the mains 196, number of consumers applying since last report five, the number of equivalent 8-c.p. lamps applied for since 480. The progress made is entirely satisfactory, and three more motors have been applied for. The incandescent street-lighting still gives a certain amount of trouble, and the cost of maintenance of the automatic switches is somewhat high. The whole of the Coronation installations in the town were entirely satisfactory. The engineer advises the Council to hire or purchase temporary plant until the completion of the new machinery. The Westinghouse Company had sent drawings, but these are being constantly amended. The foundations cannot be done until certain information from the Westinghouse Company is forthcoming. He believes that the company will not be able to fulfil their contract by Aug. 31. At last week's meeting of the Telephone Committee, a letter was read from the Postmaster-General regarding the notice sent out by the Corporation stating that subscribers to the municipal exchange before March 31, 1902, should have the use of the telephone free for three months after the establishment of the exchange. The letter pointed out that this course was inconsistent with the terms of the license. With regard to this matter, Mr. Bennett, who had been consulted as to the establishment of an exchange, said the Post Office allowed free service until the exchange was an effective one. The committee decided to conform to the Postmaster's regulations, and not charge the subscribers prior to the formal opening of the exchange, which would take three months from the start of the work. It was also decided to get the plans and specifications out at once, so that tenders can be advertised for.

Premier Electric Lamp.—A visit was recently made to the works of the Premier Electric Lamp Company at Huyton Quarry, Liverpool. From a description of the same appearing in one of the local papers we gather that the following is the process adopted in the manufacture of the Premier lamp. A very fine paper, which is obtained from Sweden, is first reduced to pulp by immersion in a chemical solution. The pulp is then placed in a glass vessel with an exhaust pump attached. Here the air and gases are extracted, after which the pump is reversed, and the pulp is forced through a very thin hole in the bottom of the vessel. It emerges as a thread of clear gelatine. This thread is passed round a drum, on which it dries, thereby reducing itself to about half the size. It is then ready for conversion into filaments. The threads are made up into bundles of 25 of uniform length. Each bundle is fixed on a carbon frame in such a way that no thread overlaps another. They are then packed in plumbago crucibles, and carbonised at a heat of about 1,200deg. C. When they come out of the crucibles they are easily detached from the frames. The filament at this stage is ready for fixing into the base of the lamp. This process, which is effected by the aid of platinum, is well known, and need not be described here. The lamp is next treated in a vessel containing hydrocarbon gas—a beautiful little instrument—which automatically secures that the lamp should glow just long enough to take up the required quantity of carbon from the gas to offer the proper resistance to the electric current. Each lamp in the later stages is made to glow, a wonderful flood of light being thereby thrown upon the fantastically shaped glass tubing. When the vacuum is complete a gas jet is brought to bear on the tube immediately below the bulbs; this closes the tube. After the necessary testing and classification according to voltage and candle-power have been done, the lamps are ready for the market.

Fulham.—The borough electrical engineer reports that from June 30 to July 14, 1902, applications equivalent to 261 8-c.p. lamps have been received, making a total in all of 34,250 8-c.p. lamps; and 456 services have also been completed and connected to the mains, representing an equivalent of 19,584 8-c.p. lamps. Requirements to the amount of £238 are to be obtained for the electric lighting and dust destructor works. At the last meeting of the Borough Council the consulting engineer submitted a satisfactory report on the difference between the estimated and actual cost of destroying refuse. In his report dated March, 1896, he estimated that the destructor should burn the refuse at a cost of 1s. per load. The weight of the loads at that time averaged about 21cwt. He has carefully examined Mr. Ferguson's analysis of the cost of cremation, and he finds that his figures include a sum of £1,085. 13s. 3d., which was not included in the consulting engineer's estimate. This sum is made up of £326. 14s. 5d., being the wages of the clinker-shifting gang, and £758. 18s. 10d., being the cost of barging away the clinker. In his report in 1896 he recommended that the clinker should be disposed of by hydraulically pressing a part of it into paving blocks and grinding up the remainder into mortar in a mortar mill. He still thinks that these operations should be carried out, and he is certain that the result would be a great saving of expense to the Council. Again, it should be borne in mind that, without any increase in wages, the present destructors are capable of burning rather more refuse than is at present supplied to them. Further, a proportion of the wages should be debited to the cost of the electric lighting scheme, because, undoubtedly, the destructor could be worked with less men than it is at present being worked if it were not necessary to keep up a steady supply of steam as well as to burn the refuse. He has not the least doubt but that if the cremation of the refuse were the only work of the destructors, it would be possible to burn the refuse at a cost not exceeding 1s. per load of 21cwt. When the destructor was taken over by the Council he reported that the cost of wages for working the destructor somewhat exceeded the maximum generated by the Horsfall Company, but that the steam raised by the destructor exceeded the guarantee by a very much larger amount, so that the net gain was considerably in favour of the Council. The saving in coal by the Council owing to the superior steam-raising capabilities of the destructor is not less than £700 per annum, so that taking everything into consideration it cannot be questioned but that the Council's destructor and boiler installation is a great success from the financial point of view. The above report was supplemented by one from the borough engineer, in which he stated that since the last meeting of the committee he had taken out three of the destructor furnace fronts and had put in new ones with the special firebrick blocks supplied by the Horsfall Company, and he hoped to have the whole of the new ones fitted during the next two months. All the boilers had been opened up and thoroughly cleaned. They had been inspected by the National Boiler and General Insurance Company, and they were all found in order.

TRACTION.

Naples.—An electric railway is in course of construction up Mount Vesuvius.

Rotherham.—The work of construction of the new electric tramways at this place has been commenced.

Hastings.—On Monday in the House of Commons the Hastings Tramways Bill was considered, and ordered for third reading.

Birmingham.—The Corporation have approved the clauses in the General Purposes Bill in favour of municipalising the local tramways.

Morley Light Railway.—We are informed that the British Electric Traction Company have not yet called for tenders for the construction of the above light railway.

Accrington.—A conference of representatives from the three Corporations of Accrington, Rawtenstall, and Haslingden will be held soon with regard to the question of the tramway purchase.

Doncaster.—Since the municipal electric tramways have been open—*i.e.*, from June 2 last to July 12—the number of passengers carried has been 223,562, the receipts amounting to £929.

Cleckheaton.—A draft agreement has been drawn up providing for the supply of electrical energy by the Corporation for the working of the British Electric Traction Company's lines in the district.

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Darlington.—The Town Council have approved the plans for the proposed tramways. The plans have been drawn up in accordance with Prof. Kennedy's scheme which the Corporation have adopted.

Camberwell.—The Borough Council have decided to apply to the Board of Trade for a declaration that the powers of the London, Camberwell, and Dulwich Tramways Company, Limited, are at an end.

Brentford.—The District Council have resolved that steps be taken to enter opposition to the Bill of the London United Tramways Company in the House of Lords if found necessary in the interests of the Council.

Corea.—A British consular report from Chemulte, the capital of Corea, states that the electric tramway there now embraces a large portion of the city and suburbs, and the principal thoroughfares are lit with electric light.

Metropolitan Railway.—The Company have announced a dividend at the rate of 2¼ per cent. for the past half-year, carrying forward £20,000. The dividend on the surplus lands stock is at the rate of 2¾ per cent. per annum.

Central London Railway.—The Company have declared a dividend a dividend at the rate of 4 per cent. per annum for the half-year on the undivided ordinary, preferred ordinary, and deferred stocks, carrying forward £25,600.

Rawmarsh.—A petition against the Mexborough and Swinton Tramway Bill has been approved by the District Council, and a deputation has been appointed to give evidence when the Bill comes before the House of Commons.

Compensation.—The Under-Sheriff of Middlesex has awarded the freeholders of the Hermitage, Hampton Court, a property which has been compulsorily acquired by the London United Tramway Company, compensation to the tune of £3,300.

Farsley.—A deputation from the District Council has been appointed to interview the Tramways Committee of the Bradford Corporation with the object of inducing them to reduce the fare from Thornbury to Stanningley from 2d. to 1d.

Carlisle.—During the three weeks just ended, during which the races, the Coronation celebrations, and the Royal Show took place, the number of passengers carried by the electric trams in the city was over 251,000, the highest number carried in one day being 26,869.

Motor 'Buses.—At the present time the London Road Car Company are negotiating with an Anglo-American syndicate for the supply of electric motor 'buses, and should the trials prove satisfactory the Car Company will put a number of these vehicles on the streets.

Shields.—In the House of Commons on Tuesday the North and South Shields Electric Railway Bill was considered, and a new clause was moved requiring the company to provide accommodation for the conveyance of bicycles. On a division the clause was carried by 219 votes against 48.

Beckenham.—The District Council in committee have decided to promote a Bill in the next session of Parliament to authorise them to lay down and work electric tramways in the district, and the surveyor has been instructed to prepare a scheme with an estimate of cost in accordance with that resolution.

Cardiff.—Although Sir Frederick Bramwell has been chosen to act as arbitrator between the Corporation and the company owning the tramways between Spotlands and Grangetown, all hope is not yet abandoned that a settlement may be effected by private negotiation between a sub-committee of the Tramways Committee and the owners.

Leeds.—A start has been made in the relaying of the rails for the electric tramways in Briggate. It is not expected that Briggate will be without its cars for more than a few days, but the present opportunity has been seized to have all in readiness for the approaching Yorkshire show at Roundhay, when record traffic is anticipated on this section.

Wigan.—The question of constructing the Library-street tramway has been referred to a sub-committee, with power to accept tenders for the necessary materials. The same sub-committee was appointed to consider and report upon constructing a tramway along Warrington-lane and School-lane, and any other extensions they may think desirable.

Presentation.—A presentation, consisting of a handsome marble timepiece and a pair of bronzes, has been presented by his late colleagues to Mr. T. Tyson, for the past six years chief electric engineer to the Hartlepools Electric Tramway Company, and who has been recently appointed chief engineer to the Great Grimsby Tramway Company.

London United Tramways.—A committee of the House of Lords on Wednesday began consideration of the proposals contained in the Bill of the London United Tramways Company, who seek powers to construct about 15 miles of new tramways in Surrey. The measure has already passed a House of Commons committee with but slight amendment.

Electricity on Steam Lines.—In regard to the report that the Lancashire and Yorkshire Railway Company are contemplating electrifying certain portions of their system in both Lancashire and Yorkshire, the secretary to the company has written, in reply to a Press representative, to the effect that no information whatever can be given on the matter.

Blackburn.—During the week ending July 11 the passengers carried on the Corporation tramways numbered 152,214, and the receipts amounted to £860. 11s. 1d., compared with 162,731 passengers and £742. 10s. receipts the corresponding week of the previous year—a decrease in passengers of 10,517, but an increase of £118. 1s. 1d. receipts.

Paisley.—The annual report of the tramway company for the year ending June was issued on Saturday. The year's revenue was £2,082, leaving a balance, which was put to reduce the amount at the debit of revenue, which now amounts to £381. Last year fewer passengers were carried than the preceding, but the expenditure was cut down. No dividend is recommended.

Malaga.—We understand that the Municipal Council of Malaga have authorised the introduction of electric traction on the tramway system in the town. The present length of the system is about eight miles, but concessions have been granted for various extensions. The company owning the tramways is a joint-stock company with headquarters in Brussels, Belgium.

Battersea.—A recommendation from the Highways Committee was received at the Borough Council meeting on Wednesday in favour of the Council's consent being given to the construction of the proposed tramway in Battersea Bridge-road, but recommending that the County Council should be informed that this Council cannot see their way to contribute towards the cost of the street widening.

Bury.—A visit was paid to Wolverhampton last week by the whole of the members of the Tramway Committee, accompanied by the borough engineer and the borough electrical engineer, for the purpose of inspecting the Lorain system of surface contact for electric tramways, which is in operation in that town. The foundation stone of the new tramcar depôt in Rochdale-road was laid on Wednesday.

Ossett.—Some time ago the Light Railway Commissioners refused to grant the Wakefield and District Light Railway Company permission to run electric trams from Ossett Market-place to Dewsbury, and as a result the Ossett Town Council have now entered into an agreement with the company to support an application to be made by them to Parliament for the purpose of obtaining powers with the same object.

Walsall.—The Town Council have been asked to give the notices required by the Act of their intention to carry out the extensions of the trams to the surrounding districts. They have already settled with the County Council and other authorities their contributions towards the widening of bridges, etc., which are involved. The station at Bloxwich for supplying additional current to the tramways is now completed and at work.

Sheffield Corporation Tramways Employes' Annual Excursion.—The annual excursion of the Corporation tramways employés took place on Wednesday to Edwinstowe. After tea the party adjourned to an adjacent field, where sports were held. Councillor Fenton presented the prizes, and expressed the pleasure it gave him to be present. The party, which numbered 300, left Edwinstone at 9.10, arriving in Sheffield an hour later.

Stockport.—The Corporation tramways are now completed beyond Woodley to the Hyde boundary, and cars are running to the Hyde boundary at a fare of 3d. The agreement between the Hyde and Stockport Corporations and the other parties concerned has been approved, and the Gee Cross tramway scheme is to be completed not later than Oct. 13. This length—a little over a mile—will complete the tramway route between Hyde and Stockport.

Brighton.—The Tramways Committee recommend that after the Royal assent has been received to the Provisional Order Bill, advertisements be issued inviting tenders for the construction of the proposed tramways in York-place, London-road, and Old-steine, including the paving of the tracks with wood, subject to the condition that the execution of the work should not commence before Jan. 1, 1903. The total estimated cost of the new lines is put at £18,700.

Dudley.—In reference to the prosecution at Dudley, referred to in our last issue, in regard to the use of double-decked cars, we understand that the regulations refers to light railways only and not to tramways. The Board of Trade had agreed to eliminate the objectionable clause before this prosecution was instituted, so that it will be impossible again to proceed even against the light railways on this score, and it has never had any application to tramways.

Liverpool Overhead Railway.—Subject to final audit, the accounts of the Company for the past half year show an available balance of £9,293, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares and 1 per cent. per annum on the ordinary shares, against 2 per cent. per annum on the ordinary shares for the corresponding period last year. The balance carried forward is £3,793.

Padstow.—Colonel Boughey, C.S.I., and Mr. H. A. Steward, Light Railway Commissioners, held an enquiry at Padstow on Tuesday, an order having been applied for by private landowners in the district to construct a light railway for the development and accommodation of the north coast of Cornwall from Padstow to Tregurrian. At the conclusion of the evidence Colonel Boughey said the Commissioners would be happy to submit the order to the Board of Trade for their confirmation.

Barking.—The Light Railway Commissioners held an enquiry last week into the application of the Urban District Council for an order to extend and amend the Barking and Beckton light railways order. The extension is proposed in order to enable the Council to join up with the electric systems at East Ham and Ilford. The line will be 1½ miles in length, and is estimated to cost £46,000 inclusive. The Commissioners stated that they were prepared to recommend the granting of the order.

Dewsbury.—Several sections of the new tramways in Dewsbury and district are nearing completion. The double line in Halifax-road has been completed up to Healds-road, and the work of laying the line on the Heckmondwike side is well in hand. The lines from the Batley boundary to the bottom of High-street, Heckmondwike, are completed, and further operations have been commenced at the Liversedge boundary with Heckmondwike at Flush, proceeding on to the far side of Littletown.

Portslade.—The Urban District Council at a meeting on Tuesday considered the tramway question, and the respective merits of Hove and the tramway company for support. It was decided, after a lengthy deliberation, to postpone consideration of the matter until a later date.

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while the sub-committee, who presented a report at the meeting on the conference which recently took place at Hove, were instructed to obtain whatever further information they could derive as to the proposals of both Hove and the company.

Bermondsey.—The London County Council have written the Borough Council asking whether they are in a position to supply electrical energy to the extent of about 3,000 h.p. for the purpose of driving certain sections of the London County Council tramways. The power would be required for temporary purposes only, and would not be taken for a longer period than 18 months. The town clerk has been instructed to reply that the Council have no energy to spare at present, but would be prepared to supply electrical energy on agreed terms for a permanency.

Private Bills.—In the House of Lords the following Bills have been read a third time: North Metropolitan Tramways Bill, Croydon and District Electric Tramways Bill, Metropolitan Railway Bill, Greenock and Port Glasgow Tramways (Extension) Bill, and Central London Railway Bill. On the 22nd, in the House of Lords, the Metropolitan District Railway Bill was read a third time, and the London United Tramways Bill a second time. In the Commons the Medway and Thames Canal Bill was read a third time, and the Aberdeen Suburban Tramways Order Confirmation Bill a second time.

Tube Vibration Reduced.—The two trains propelled by the multiple-unit system now in use on the Central London Railway are said to have given entire satisfaction, the vibration having been almost completely done away with. Many more trains would by now have been working, but the Liverpool tunnel fire demonstrated the necessity for the driving part of the cars to be absolutely fireproof. In consequence the "tube" directors had to reconstruct several trains. It is hoped that a number of new trains on this system will be running by October. The cost of the transformation will, it is expected, be about £150,000.

Birkenshaw.—There is some doubt as to whether the Bradford Corporation intend to defer the extension of their tramways to this place. Enquiry, however, has been made, and the fact appears to be that the Corporation have not decided what to do. It was stated at the last meeting of the District Council that if the Corporation are not willing to proceed, the British Electric Traction Company are willing to extend in the opposite direction to the city boundary. The feeling of members, however, appeared to be in favour of being served by the Corporation, and a deputation was accordingly appointed to interview the Tramways Committee on the subject.

Swansea.—The question of the form of electric traction for tramway extension came up at the last meeting of the Electrical Committee. The chairman said, as one of the committee who visited the Tramway Exhibition in London, he had been impressed with the Kingsland surface-contact system, and he suggested that a trial section of that system in Walter-road be laid. The electrical engineer wanted to know something definitely, as it was no use going on with the specifications of the overhead system if it was likely to adopt the Kingsland system. Eventually it was decided that the engineer proceed with the overhead specifications, reserving Walter-road for the Kingsland system.

Amesbury.—A public enquiry has been held by the Light Railway Commissioners as to the expediency of granting an application by the London and South-Western Railway Company for an order to authorise an extension from Amesbury to Bulford Camp of the Amesbury and Military Camp Light Railway, already constructed, which branches off from the ordinary line of the London and South-Western Railway between Porton and Grateley. The line will be of ordinary gauge, and is to be worked in the first instance as a steam railway, but with the consent of the Board of Trade the motive power can be changed to electricity. The total cost of the scheme is estimated at £25,000.

Longton.—At the last meeting of the Town Council it was decided that it is desirable that clauses should be inserted in the North Staffordshire Tramways Bill now before Parliament providing for the joint purchase by the authorities interested of the company's generating stations, and that such purchase shall be optional only. The Council further decided to ask the British Electric Traction Company to continue the double line of tramways to be constructed at the Foley to the existing loop in Church-street. The company are now making experiments with different types of lifeguards, and in a few weeks they hope to be in a position to finally decide which is the most suitable guard to adopt.

Wolverhampton.—Last week the electric cars commenced to run over the newly-constructed lines between Willenhall and Bilston. As a possible solution of the difficulty with the British Electric Traction Company with reference to the construction of a short length of line connecting the tramways in the town with certain outlying districts, the Town Council on Monday resolved that a single line of track be forthwith constructed upon the Lorain system along that portion of the Bilston-road between Ettingshall-lane and Stowheath-lane, which is situate within the borough of Wolverhampton, provided that the Lorain Steel Company agree to the same conditions as at present apply to the other lines laid down by them in the borough.

Nelson.—At the last meeting of the Tramways Committee it was decided to delay for the present the work of constructing the tramway from Nelson to Barrowford and from Nelson to Colne. So far as the Nelson Corporation and the Barrowford District Council are concerned, the question of terms has been practically settled, the only point at issue being as to the amount to be allowed Nelson in respect of the construction of the car-shed and the provision of cars. This point, however, has been referred to an arbitrator, with whose award both authorities have agreed to abide, so that there is nothing in the way of the agreement between the two bodies being signed, though the fact that it had not yet been signed is said to be the chief reason for the postponement of the scheme.

New Issues.—The National Electric Traction Company, Limited, is offering for sale shares of the City and Surrey Electric Railway Company, Limited, which has a capital of £150,000 in £10 shares. The prospectus states that the company is formed with a view to carrying out Acts of Parliament already obtained authorising a London electric railway into Surrey. The company incorporated by those Acts has secured the use of the terminus in King William-street, and about a mile of approach railway, including a tunnel under the Thames already constructed. It is intended to apply for parliamentary powers to extend the route by lines running through Dulwich and Tooting and Norwood, Streatham, Croydon, Caterham, Westerham, and Redhill and Reigate. During the construction of the line 5 per cent. interest and a guaranteed bonus of 17½ per cent. are payable by the National Electric Traction Company, the contractors.

Electric Signalling.—The electro-pneumatic signalling system, erected for the North-Eastern Railway Company at Tyne Dock by Messrs. McKenzie and Holland, of Worcester, has now been formally brought into use. The plant consists of two electro-pneumatic frames one of 71 levers and the other of 35 levers. The work of pulling over or throwing back the switches is done by a small air motor fixed close to the signal or switch operated, whilst the valves controlling the supply of air to these motors are opened by an electromagnet. Hence the levers in the cabin are really electric switches, and the signalman is thus relieved of the heavy manual labour involved in pulling over the signals. The principal duty of the signalman is merely to set the power in operation. He pulls from a frame 4ft. high by 5ft. wide a small slide for a distance of about 5in. This movement lets into a pipe connected with the machinery a current of air out of a reservoir, which sets the machinery in motion.

Huddersfield.—As an outcome of the recent fatal tramway accident at this town, the Tramways Committee have made several alterations in the tramway regulations. Among other things, it is decided that drivers of cars shall undergo a medical examination as to bodily fitness; that a driver instructor shall be appointed; and that a magnetic slipper brake of the kind recently tested on the Outlane section be fitted to all the new cars on order. The financial statement of the tramways for the three months ended June 30 last shows that on the sections worked by steam the receipts were £2,554 for 47,817 miles run, or 12·82d. per mile, and the expenditure £3,022, or 15·17d. a mile, thus showing a loss of £467, or 2·35d. a mile. Included in the expenditure are sums for sinking fund, interest, depreciation, and compensation. The receipts on the electrical routes were £10,947 for 224,203 miles run, or 11·72d. a mile, and the expenditure £11,275, or 12·07d. a mile, a loss of £327, or ·35d. a mile. In this case also sums have been set aside for interest and other charges. The total income from all sections was £4,834—£774 more than in the corresponding month of 1901.

Aston.—A conference was held on Thursday last between representatives of the Tramway Committee of the Birmingham Corporation and the Aston District Council. The object of the meeting being to ascertain whether the Birmingham authorities would be prepared to transfer to the Aston Council the powers at present possessed by the Birmingham and Aston Tramways Company, and also whether, in the event of this being agreed upon, they would permit electric traction to be adopted throughout the line of route from the Old-square to the terminus of the Aston section. It is an open secret that the British Electric Traction Company are anxious to acquire the tramways in Aston. After a considerable time the representatives dispersed without coming to any final decision. It is understood, however, that they will resume their deliberations at an early date, and that the British Electric Traction Company, assuming they are able to acquire the Aston route, will approach the Erdington District Council with the object of working the lines in that area also. The ultimate object of this is to secure a through route to Sutton Coldfield, and then to work a light railway from the agricultural district lying between Sutton and Lichfield.

Electric Launch.—An interesting trial run of an electric launch took place on Sunday, the 13th inst. This launch was built by the Thames Valley Launch Company, Limited, whose chief offices and works are at Weybridge, and is a very smart-looking pinnace, 32ft. long, intended for use in the Bay of Naples. She is fitted with a "Beevor-Edwards" motor, and a battery of 44 Leitner cells, manufactured by the Accumulator Industries, Limited, Woking, and is also fitted with W. Rowland Edwards single-lever launch gear. With this gear a single lever, coming up through the floor of the boat, is the only visible machinery. It is an extremely simple arrangement, and the following are the claims made for it: (1) the motor always running in one direction, the irritating trouble with the brushes is completely avoided; (2) there being only one contact necessary, a complicated switch is not required, therefore there is no chance of trouble from burnt contacts; (3) the cells being always in series are worked perfectly evenly, and cannot suffer, as cells usually do in electric launches, from having to be put in parallel for half speed. The launch is designed to run 40 miles on one charge at seven miles per hour, and in the trial run on the 13th she did this very comfortably. A number of the company's and private boats are now fitted with this gear, and we understand the company have nearly completed a 32ft. pinnace for the Natal Government.

Rowley.—A conference has been held of representatives of the Brierley Hill, Quarry Bank, and Rowley District Councils with reference to the proposal to construct a light railway from Brierley Hill to Cradley Heath. A resolution was passed agreeing to the advisability of providing the light railway, and it was further decided that the cost of the application, construction, and maintenance should be borne jointly by the local authorities in proportion to the mileage; that the joint body for working the same should have representation according to the same proportion; and that the profits should be similarly divided. The committee had approved of the resolution,

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The British Electric Traction Company have addressed a letter to the Rowley District Council, stating that an application is now pending to the Board of Trade for permission to operate light railways with upper-decked cars, so that the tramways and light railways might each be served with the same type of cars. The Council have decided to oppose the application on the ground that double-decked cars would be dangerous in Rowley, and it was further decided to communicate with the traction company with a request for the trams to travel at about four miles an hour on market days at Cradley Heath, the present rate of speed being considered dangerous.

Aberdeen.—The return of the traffic on the Corporation tramways for the week ended July 12 shows that the receipts amounted to £1,109, compared with £940 for the corresponding week last year, an increase of £160. The Corporation tramway accounts for the year, from May 31, 1901, to May 31, 1902, show a revenue of £37,931. 17s. 9d. The average income per mile is given at 10·24d. for horse traction and 12·85d. for electric. Against this income of £37,931. 17s. 9d. the working expenses amounted to £26,577, which leaves a profit on the actual working of £11,354. 16s. 2d. to be carried to the net revenue account. This total of £26,577. 1s. 7d. for working expenses includes £8,874. 3s. 6d. for traffic expenses, salaries, clothing, tickets, and the like, and £9,817. 6s. 9d. the cost of horse traction. The average cost per mile for horse traction is given at 4·65d. and for electric traction at 2·28d. The £11,354. 16s. 2d. of profit carried to the net revenue account is disposed of as follows: interest on mortgages, loans, etc., £6,111. 11s. 1d.; depreciation, £1,599. 18s. 1d.; amount written off preliminary and parliamentary expenses, £734. 3s. 4d.; carried to credit of sinking fund, £1,201. 2s. 2d.; and to credit of renewal account, £1,708. 1s. 6d. A very interesting table embodied in the report gives the details of the traffic returns week by week for the year to May 31 last The high-water mark was reached in the week ending July 27 of last year, when the weekly receipts amounted to £1,064. 8s. 8d., representing 245,621 passengers carried. The totals given are: mileage covered in the year was 794,641, and number of passengers 9,099,715; 506,574 miles were covered by horse traction and 288,067 by electric traction, and of the 9,099,715 passengers carried, 4,133,807 were by horse traction, bringing in £21,614. 1s. 4d.; and 4,965,908 by electric traction, bringing in £15,421. 16s. 6d. The receipts work out at an average of something over £715 per week, but the weekly receipts fluctuated greatly between £550 and £750 in the winter time to from £750 to £900 in the summer.

Subways and Tramways.—The London County Council Subways and Tramways Bill was before the Select Committee of the House of Lords presided over by Earl Yarborough on Monday. There was only one petition against the Bill, that of the Great Northern and Strand Railway Company. Mr. Erskine Pollock, K.C., for the London County Council, explained that the Bill was promoted to authorise the construction of a subway for an underground shallow tramway from the tramway junction at Southampton-row and Theobald's-row, under High Holborn and the proposed new street to the Strand-crescent. The subway could also be used for laying pipes, electric light, and other mains, and so do away with the constant tearing up of the streets to get at the pipes. This in itself would be a great advantage when it was remembered that the loss occasioned by pulling up the streets in London was estimated at over two millions annually. The subway would be constructed at the same time as the new street. Although such a scheme was a new one in London, it had been tried with very great success in Paris, New York, and Boston, U.S.A. The figures with regard to Paris were very startling. In that city the subway was 8½ miles long, and had only been opened about 10 months. During that period it had carried over 40½ million passengers. At Boston, where five miles of subway was opened, at one station alone—Park-street Station—27½ million passengers had been deposited within the year. That was very nearly approaching the total number of passengers who were deposited at Waterloo Station. Evidence having been given in support of the Bill, Mr. Balfour Browne, K.C., said he did not appear for the purpose of really opposing the Bill. Under an Act of 1899 the Great Northern Railway Company had power to construct a tube along the same route as the proposed subway, but the London County Council had the power to prevent its construction until the new street was completed. The London County Council refused to give up that power unless a large sum of money was handed over. That, he submitted, was unfair. The Great Northern Company did not ask Parliament to refuse its sanction to the construction of the subway, as it was in the interests of the public. What it asked was that the London County Council should give up their veto. Eventually the committee found the preamble of the Bill proved.

Tramways and Improvements in London.—The Bill promoted by the London County Council authorising the construction of electric tramways in London and various street improvements came before the House of Lords Committee presided over by the Earl of Yarmouth this week. Mr. Erskine Pollock, K.C., in opening the case for the Council, explained the nature of the powers sought. The only opposition, which came from frontagers and property owners, was to tramways numbered 5 and 15. The first-mentioned would begin near the Broadway and proceed down Fulham Palace-road, cross Putney Bridge, and terminate in a bay in the Lower Richmond-road. It would be a double line 2 miles 5 chains in length, and would be worked by the conduit system. As a part of the scheme it was proposed to widen a certain portion of Fulham Palace-road and Church-street, Fulham, and towards these improvements the Fulham Council had agreed to contribute £30,000, that being about a third of the estimated total cost. For about 200 yards the line would come within the 9ft. 6in. limit from the footway. From the entire cost the surveyor estimated a recoupment of £37,000 from the sale of surplus lands. Tramway No. 15 would begin from the existing line down Camberwell-road, run down Denmark-hill and Grove-lane, and terminate in Lordship-lane, near the existing lines of a company which had powers to run to the Crystal Palace. This new line, with the short spur line 15 A, was promoted at the direct request of the Camberwell Borough Council, who had represented the advantage it would offer to a large artisan population at East Dulwich. The route crossed Dog Kennel-hill, which had a gradient so steep that it was impossible for horse traction. In connection with this tramway, widenings of Denmark-hill and Lordship-lane would be necessary at a cost of £78,900, to which the Camberwell Council would contribute a third. The petition of the frontagers and owners contained allegations of a general character that property would be depreciated, and that the semi-rural character of Denmark-hill would be destroyed. No doubt the latter allegation had some foundation, and it was the inevitable result of the growth of population. Mr. Benn, chairman of the Highways Committee, described the routes to be followed, and said it was not the usual experience that electrical tramways depreciated the value of property, and certainly such lines were accompanied by less noise and dirt than omnibus traffic. Mr. M. Fitzmaurice, C.E., Mr. A. Baker (tramway manager for the London County Council), and various officials of the local authorities concerned gave evidence in support of the Bill. After hearing evidence for the opposition and speeches of counsel, the Chairman announced that they had come unanimously to the conclusion that the preamble of the Bill was proved.

The London County Council and Tube Railways.—The Parliamentary Committee of the London County Council submitted a report at the meeting on Tuesday referring to the action they have taken in respect to the Bills already passed, and to the action they propose to take in respect to the schemes now before Parliament. The report stated that the committee would endeavour to assist the committees on the Bills by placing at their disposal such information as they possessed bearing on the questions under consideration. This was particularly the case with regard to questions of finance arising on the scheme for a proposed through route from Hammersmith to Palmer's Green, comprised in the London United and Piccadilly, City and North-East London Bills. In the London United Bill provision was made for raising capital amounting to £3,375,000 and £1,125,000 on mortgage, making a total of £4,500,000. In the Piccadilly, City, and North-East London Bill capital was provided for to the extent of £5,160,000, with the addition of £1,720,000 on mortgage, forming a total of £6,850,000. The total for the whole scheme was, therefore, £8,538,000 capital and £2,845,000 mortgage. The length of line to be constructed was rather more than 19 miles in all, (about 2¼ miles in the open)—namely, slightly over 15 miles from Hammersmith to Palmer's Green and four miles from Marble Arch to Clapham Junction. Counsel, in his closing speech for the promoters, stated that in estimating the financial possibilities of the line they (the promoters) had calculated on carrying 145,250,000 passengers annually, one-sixth of whom would be workmen at cheap fares; 123,000,000 of these would be carried on the line from Hammersmith to Palmer's Green, and 22,250,000 on the line from Marble Arch to Clapham Junction. From these traffics they estimated to receive £702,778 and £185,416 respectively. In the case of the first-mentioned line the amount (£702,778) was approximately represented by an average ordinary fare of 1½d., and an average workmen's fare of ¾d., but in the returns from Marble Arch to Clapham line it was not clear from the proceedings before Lord Windsor's Committee how the sum of £185,416 was arrived at. Even maximum fares (2d. ordinary and 1d. workmen's) for the journeys for the promoters' estimated number of passengers would only amount to £169,791. Taken on the promoters' basis of 1½d. and ¾d., the figures would be £127,343, or £58,073 less than the estimate given above. From the complete returns based on the promoters' figures, and amounting to £888,194, counsel deducted £444,000 odd, or 50 per cent., for working expenses, leaving an estimated net profit of £444,097. On a total capital (including money borrowed on mortgage) of £11,380,000 this showed a return of 3·9 per cent. They were advised that it was open to question whether this was not taking a too sanguine view of the prospects of the scheme, and they had given instructions for the attention of the committee on the Bills to be specially directed to the matter, and for expert evidence to be put forward on behalf of the Council. The question obviously had an important bearing on the raising of capital by the promoters, and the carrying out and working of the undertaking, and although, as far as concerns the route to be traversed, they viewed this scheme favourable, they had thought it right to take this action in order that they might discharge any responsibility that rested with the Council, and to enable the Select Committee before giving their decision on the Bills to be fully possessed of the facts from an independent source. When the report was reached at Tuesday's meeting, Mr. Radford, the chairman of the committee, refused to move its adoption, as he did not agree with it. Mr. McKinnon Wood thereupon moved an amendment referring the report back to the committee for further consideration, on the ground that the committee had overstepped its rights in taking the course proposed. Mr. W. W. Bruce argued that it was not for them to say whether the railway would pay the shareholders. Eventually the report was referred back to the committee.

Tube Bills in Parliament.—On Friday the Court of Referees of the House of Commons sat to consider applications for *locus standi* against several of the London underground railways which have been referred to two Select Committees. The London County Council was the petitioner against the Great Northern and City Railway Bill, and also, with the Central London Railway Company, against the Bill of the London United Electric Railways Company. In the case of the Brompton and Piccadilly-circus Railway (New Lines, etc.) Bill, the petitioners, all of whom were objected to, were the Metropolitan Railway Company, Hyde Park Hotel Company, London United Electric Railways Company, and the promoters of the Piccadilly, City, and North-East London Railway Bill. Mr. Freeman, K.C.,

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supported the petition of the Metropolitan Railway Company, who claimed the right to be heard against the Brompton and Piccadilly-circus Railway Bill both as landowners and proprietors of a competing system. The committee allowed the *locus*. Mr. Talbot, for the Hyde Park Hotel Company, said the substantial part of his petition arose on Clause 11, which provided, not for any additional compensation to the frontagers, but for their protection by an alteration in the procedure for claiming compensation to meet the peculiar circumstances of the case. Sir Ralph Littler objected that, if the *locus* were granted, it would have to be allowed wherever one tube railway crossed another. The *locus*, however, was allowed in regard to Clause 11 only. Mr. Balfour Browne, K.C., in asking for a *locus* on behalf of the London United Electric Railways Company, said he claimed it on the ground of competition, his line and that of the Brompton and Piccadilly-circus Company following the same route for some distance. The committee decided to hear the application of the Piccadilly, City, and North-East London Railway Company before giving their decision. Mr. Vesey Knox, on behalf of this company, said the route of their line and that of the Piccadilly-circus Railway was the same for a distance of about a quarter of a mile. So far as any new lines were concerned there was no question of his being entitled to a *locus*. Sir Ralph Littler said he should not object to a *locus* where the two companies scheduled the same land or where the two lines crossed. The committee, after further argument, allowed a general *locus* in each case. Mr. Pember, K.C., for the London County Council, asked for a *locus* against the London United Electric Railways Bill on the ground that the Council was the central governing body of the county of London, and as having an interest, therefore, in all that went on in London. The chairman said the committee had decided to allow the County Council a general *locus*. Mr. Honoratus Lloyd appeared in support of the petition of the Central London Railway Company, who desired a *locus* against the proposed railway from Clapham Junction to the Marble Arch, part of which came within the limits of deviation of his company's tunnel. Mr. Balfour Browne objected to the application, urging that the claim of the petitioners was too vague to justify the granting of a *locus*. The committee, by a majority, disallowed the *locus*. Mr. Moon, K.C., intimated that the promoters of the Great Northern and City Railway had given the London County Council a clause which satisfied their objections, and that the Council had, therefore, withdrawn their petition against the Bill. The Court adjourned

London County Council.—A number of matters relating to the conversion of the London County Council's tramway system were brought up for consideration at the usual weekly meeting of that body on Tuesday. In the first place, the Council unanimously approved of the expenditure of £105,000 for lines and rolling-stock, and £9,000 for alterations and reconstruction of bridges, for electrical traction of the tramways between New Cross-gate and Greenwich, the report of the Highways Committee in respect to which appeared in our last issue. It was further agreed to sanction the expenditure of a sum not exceeding £73,800 for electrical traction of the tramways between Camberwell Green and near Vauxhall Bridge, between St. George's-circus and the junction of Kennington-road with Westminster Bridge-road, and Kennington Park-road and Brixton-road. The contractors for the reconstruction of the Westminster to Tooting lines now in progress are Messrs. J. G. White and Co., and they have offered to enter into a new contract for the reconstruction of the three pieces of line above specified, which are in close connection with the Tooting lines, at prices based upon those under their existing contract, and the Council have accepted this offer. A recommendation of the Highways Committee was also approved authorising the expenditure of a sum not exceeding £600 in the making of openings in the carriageway of Battersea Park-road, York-road, and Nine Elms-lane for the purpose of ascertaining the position of water and other mains which would be interfered with in connection with the reconstruction, for the underground conduit system of electrical traction, of the tramways in those roads. A further report was presented by the Highways Committee submitting revised estimates of the cost of converting the Westminster and Tooting lines, and of establishing a generating station at Greenwich, and sub-stations at Brixton, Clapham, and near the Elephant and Castle; car-sheds at Clapham and at Balham; and a temporary generating station near Loughborough Junction. The estimate for these works, approved by the Council in February, 1901, amounted in all to £623,500. The committee have carefully revised these estimates, and find that the total amount now required is about £981,497. Almost all the additional cost is, however, in respect of works not provided for in the original estimates, the principal items of excess being (*a*) for the erection at Greenwich of a much larger generating station than that which was proposed to be placed at Camberwell, the larger station being intended to serve the whole of the Council's southern tramways and possibly some of those on the north side of the river, and (*b*) the provision of a large new car-shed at the Clapham depôt and land adjoining, not contemplated at the time the original estimates were prepared. The committee accordingly recommended that the larger estimate of £981,497 be approved. Consideration of this report was adjourned for a week. A recommendation will also be considered at next week's meeting in favour of an application to Parliament for powers to run omnibus services along the routes of any of the Council's tramways while under reconstruction for electric traction. Having now got the arrangements for the conversion of the existing tramways to electric traction fairly well in hand, the Council are turning their attention to a number of new lines which the Highways Committee recommend them to apply for powers to construct. Next week the Council will consider a long report from that committee on the subject. A preliminary report dealing with the proposals to construct new tramways was presented by the committee the last week in June, in which the total length of the new lines contemplated was given as 33 miles. In the new proposals this figure has been reduced to 26 miles 2 furlongs 6 chains, and similarly the estimated cost has decreased from £1,738,857 to £1,307,915. Of this amount the construction of the tramways will be responsible for £971,450, and the erection of cars and car-sheds £209,300, the balance of £127,165 being in respect of street widenings in connection with the scheme. The following are the routes of the new tramways proposed: Hampstead-road tramways terminus to a point in Tottenham Court-road near Oxford-street; Edgware-road to Harrow-road, *via* Sutherland-avenue; Hammersmith-broadway to and across Hammersmith Bridge, *via* Bridge-road; Greenwich to East India Dock-road, *via* the Blackwall Tunnel; Westminster Bridge-road to the Victoria-embankment; Harlesden to Hammersmith-broadway; Shepherd's Bush-road to a point near the Marble Arch; Marble Arch to Cricklewood; Deptford to the Herbert Hospital, Woolwich; New Cross to the South-Eastern Metropolitan Tramways in Lee High-road; Battersea Park-road to a point near the Grosvenor Hotel, *via* Chelsea-embankment, Commercial-road, and Buckingham Palace-road; Tooting-broadway to Tooting Junction Station; Garratt-lane, Wandsworth, to the county boundary, *via* Wimbledon-road; Rushey-green to Bromley-hill, *via* Bromley-road; a point near the terminus of Woolwich and South-East London Tramways to the county boundary, *via* Wickham-lane.

PROVISIONAL PATENTS, 1902.

JULY 11.

15454. Improvements in electrical switches. Frederick Harold Hall and Constance Hall, 24, Temple-row, Birmingham.

15455. Improvements in electrical switches. Frederick Harold Hall and Constance Hall, 24, Temple-row, Birmingham.

15456. Improvements in brush gear for dynamos and electro-motors. The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

15458. Improved means of mounting or carrying the brushes of electrical switches, dynamos, motors, and the like. Arthur Henry Hickley, 10, St. George's-crescent, Liverpool.

15463. Improved electric pendant. Charles Thomas Arnold Henshaw, Milton House Works, Edinburgh.

15465. Improved lifeguard for electric cars and other mechanically-driven vehicles. John McKay, 73, Watts-street, Broom-lane, Levenshulme, Manchester.

15470. An improved clip for electric lamp shades, candle shades, and the like. Charles Holdgate and Philip George Commin, 64, Bridge-street, Manchester.

15488. Improvements in controlling devices for electric motors applicable for elevator and like work. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company (Incorporated), United States.)

15511. Improvements in electrical measuring instruments. Edmund Wigley, Norfolk House, Norfolk-street, Strand, London.

15527. Improvements in or relating to wireless telephony. André Blondel, 111, Hatton-garden, London.

JULY 12.

15555. Improvements in joint-boxes for electric cables. Robert Elson, 4, St. Ann's-square, Manchester.

15591. An improvement in electric stoves. Herbert John Dowsing, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JULY 14.

15618. Improvements in or connected with splicing cars used on trolley wires of electric tramways. John Ramsey, 29, Sidlaw terrace, Gathorne-terrace, Roundhay-road, Leeds.

15651. An improved trolley for electrically-driven tramcars and the like. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Léon Chapius et Cie., France.)

15674. Improvements in electric motors. Albert Barnhard Holson, 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 15, 1901, being date of application in United States.) (Complete specification.)

15677. A bond for making an electrical connection between the hub and the felloe and tyre of railway and the like wheels having a wooden or other non-conducting body portion. Arthur Henry Johnson, 70, Palace-chambers, Westminster, London.

15696. Improvements in electric furnaces. Jean Bouneau, 40, Chancery-lane, London.

JULY 15.

15714. Improvements in and connected with electrical fuse boxes or cut-outs. Charles Douglas Burnet, 15, Water-street, Liverpool.

15715. Improvements in or connected with electric cable junction, terminal, and like boxes. Charles Douglas Burnet, 15, Water-street, Liverpool.

15716. Improvements in or connected with electric cable or conductor junction and like boxes. Charles Douglas Burnet, 15, Water-street, Liverpool.

15722. Improvements connected with up-and-down swinging brackets, arms, rods, holders, carriers, and such like, particularly applicable for gas, oil, and electric light fittings, and for displaying articles in windows. Edmund Townshend, 11, Burlington-chambers, New-street, Birmingham.

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15747. **Improvements in or relating to electric storage batteries.** Malcolm Sutherland and Elias Marcuson, 61, Chandos-street, Strand, London.

15753. **Improvements in electricity meters.** The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

15764. **Improvements in the control of electric lifts.** John Sanders Stevens, Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens, Janus Works, Queen's-road, Battersea, London.

15772. **Improvements in electric batteries.** Alfred Lyster Shepard, 18, Southampton-buildings, Chancery-lane, London.

15777. **Improvements in telephone instruments.** Frederick William Golby, 36, Chancery-lane, London. (Bertil Brander, at present residing abroad.)

15784. **Improvements in and relating to thermo-electric couples and generators.** Charles Burton Thwing, 77, Chancery-lane, London. (Complete specification.)

15795. **Improvements in means for transmitting electricity to vehicles on electric railways.** Attio Beer, 47, Lincoln's-inn-fields, London.

JULY 16.

15807. **Improvement in or relating to electric accumulators.** Constantin de Sedneff, 111, Hatton-garden, London.

15813. **Improvements in life-saving or accident-preventing devices, chiefly applicable for electric tramcars.** Ernest Bunting and Wilson and Bennett, Limited, 62, Market-street, Manchester.

15814. **Improvements in or relating to dynamos and electro-motors.** Robert Frederick Hall, 24, Temple-row, Birmingham.

15815. **Improvements in or relating to electric fuse boxes for street mains and analogous uses.** The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

15823. **Improvements in or connected with electrical fuse boxes or cut-outs.** George Hinde Nisbett, 15, Water-street, Liverpool.

15824. **Improvements in electric railway rail bonds.** George Hinde Nisbett, 15, Water-street, Liverpool.

15825. **Improvements in electric railway rail bonds.** George Hinde Nisbett, 15, Water-street, Liverpool.

15832. **Improvement in automatic repayment electric calling apparatus for use with telephones and other instruments.** H. L. P. Boot and H. J. Dawes, 12, Limehill-road, Tunbridge Wells.

15842. **Improvements in electric switches, applicable for electrically-driven hoists or other machines.** John Charles Etchells, 6, Bank-street, Manchester.

5168A. **Improvements in and connected with interrupters for induction coils.** Julio Cervera (Baviera), Norfolk House, Norfolk-street, Strand, London. (Date claimed under Patents Rule 19, March 6, 1902. (Complete specification.)

5168B. **Improvements in electric switches, specially applicable for use in connection with wireless telegraphy.** Julio Cervera (Baviera), Norfolk House, Norfolk-street, Strand, London. (Date claimed under Patents Rule 19, March 6, 1902.) (Complete specification.)

JULY 17.

15926. **An improved form of detachable link chain for electric light fittings.** Thomas McIntyre, 27, Rossie-place, Edinburgh.

15935. **Sadler's electric tramcar life-saving guard.** Joseph Henry Sadler, 22, Falconar-street, Shieldfield, Newcastle-on-Tyne.

15944. **Improvements in electrical brushes for dynamo-electrical machines, electrical motors, and other electrical machines and apparatus where brushes for collecting an electrical current are or may be employed.** The Tangye Tool and Electric Company, Limited, and Alfred Hewson Bate, 7, Staple-inn, London.

15949. **Improvements in brushes for electric generators and motors.** Samuel Jevons, 77, Colmore-row, Birmingham.

15952. **Improvements in systems of electric motor control.** William Symes Andrews, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 25, 1901, being date of application in United States.) (Complete specification.)

15953. **Improvements in controllers for electric motors.** Robert Hamilton Read, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 26, 1901, being date of application in United States.) (Complete specification.)

15954. **Improvements in electric switches.** Caryl Davis Haskins, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 27, 1901, being date of application in United States.) (Complete specification.)

15955. **Improvements in electrically-operated switches or circuit breakers.** Edward Marriott Hewlett and Theodore Edwin Button, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 7, 1902, being date of application in United States.) (Complete specification.)

15956. **Improvements in electric indicating instruments.** Richard Fleming, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 21, 1901, being date of application in United States.) (Complete specification.)

15963. **Improvements in and relating to the manufacture of lead plates for secondary electric batteries.** Carlos Vellino, 45, Southampton-buildings, Chancery-lane, London.

15977. **Improvements in electric lifts.** John Bush and Matthew Thomas Medway, 24, Southampton-buildings, Chancery-lane, London.

JULY 18.

15981. **Improvements in mechanical rail scrapers for grooved and other rails used on electric railways.** Edward May Munro and Hugh Innes Rogers, Thrissell-street, Bristol.

16014. **An improved form of wattmeter for the measurement of electrical power.** Charles Vickery Drysdale, Morpeth, Hadley-road, New Barnet.

16015. **Improvements in and relating to electrolysing apparatus.** Edgar Leslie Thorp, 139, Queen Victoria-street, London.

16041. **Improvements in electrical resistances.** Alphonse Constant Reyrolle, 46, Lincoln's-inn-fields, London.

16042. **Improvements in electric switches.** Alphonse Constant Reyrolle, 46, Lincoln's-inn-fields, London.

16048. **Improvements in dynamo-electric machinery.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

16062. **Improvements in electric railways.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16063. **Improvements in and relating to third-rail contact shoes for electric railways.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16064. **Improvements relating to electric railways.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

JULY 19.

16072. **Improvements in electric motors for ceiling fans.** William John Rollo, 121, West George-street, Glasgow. (Peter Smith Swan, India.)

16092. **A lifeguard for electric tramcars.** Edward Hughes and Matthew Read, 45, Princess-street, Miles Platting, Manchester.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 7.

1901.

7524. **Electrical heating and apparatus therefor.** Quain.

15427. **Process for the electrolytic deposition of metals and alloys.** Marino, Marino, Marino, and Ratchkowsky.

15474. **Systems of telegraphic distribution.** Justice. (Rowland Telegraphic Company.)

16121. **Electricity meters.** Hookham.

16276. **Electric automobile motors.** Richter and Eschler.

16277. **Electric traction motors.** Richter and Eschler.

16677. **Manufacture of electrodes for galvanic batteries.** Pörscke.

17425. **Circuit-breaking apparatus for electrical circuits.** British Westinghouse Electric and Manufacturing Company, Limited. (Stilwell.)

17641. **Dynamo-electric machinery.** Hobart.

17766. **Electric cut-outs.** Oppenheimer. (Actiengesellschaft Mix und Genest.)

18273. **Vehicle to be used in electric traction on railways.** Cawley.

19554. **Overhead electric fittings of electric railways and tramways.** Estler.

25201. **Recording apparatus for use with electric and other power meters and speed indicators.** Newton. (Keiley.)

1902.

1684. **Method for producing electrodes for electric accumulators.** Jungner. (Date applied for under International Convention, Jan. 22, 1901.)

5914. **Telegraph system.** Wise. (Peirce.)

7188. **Means for the control of electrically-driven reversible rolling-mills.** Ilgner.

7736. **Extinguishing electric arcs.** Read. (Date applied for under International Convention, April 3, 1901.)

7792. **Electric cooking and heating apparatus.** Lütz.

7809. **Electric arc lamp.** Scott, Tyzack, and Wright.

8583. **Pincers particularly adapted for the use of electricians.** Haddan. (Bergmann Elektricitäts-werke Aktiengesellschaft.)

10457. **Storage batteries.** Redding and Deering.

16594. **Cleats for fastening electric wires or cables in casing or other carrying arrangement, temporary or otherwise, or for permanent fixing to walls, ceilings, roofs, and the like.** Riley and Rowing.

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it is seen that while the management expenses have increased 3·9 per cent. of the total, the cost of manufacture had decreased 9·3 per cent. This speaks well for the efficiency of the engineering staff, and is a striking argument in favour of securing the services of competent men by offering sufficient inducement.

Central Technical College.—At a meeting of the council of the City and Guilds of London Institute on Monday the diploma of "Associate of the City and Guilds Institute" was awarded to the following matriculated third-year students of the Central Technical College, who have completed a full course of instruction as prescribed by the council: Civil and mechanical engineering—J. A. Esnouf (Siemens medal), W. A. Burton, E. Chappell, M. N. Crawford, J. A. Ellis, F. V. Elsden, E. V. Firmston, S. M. Folk, R. G. Hardy, A. E. Hubbard, A. J. A. Leclexio, L. G. Madge, T. H. Mann, F. P. Manson, G. H. Maxwell, H. Moran, W. E. Napper, L. T. Payne, L. M. Rampal, H. G. Saxby-Thomas. Electrical engineering—J. D. Griffin (Siemens medal and premium), H. F. Bayley, L. Calisch, A. B. Duncalfe, L. T. Edwards, C. H. Finnis, C. G. Friedeberg, E. L. Gosset, C. J. Hopkins, C. B. Kinnes, E. M. Langley, E. de Lautour, J. E M. McGregor, W. J. Percey, W. G. T. Pope, C. T. Wilkinson. Chemistry—J. Marsh, F. G. Smith, L. V. Turner, H. Waumsley. In addition to the above, certificates have been awarded to 21 matriculated third-year students who have completed a full course of instruction at the Central Technical College, and to 47 students who have completed a full course of instruction at the Technical College, Finsbury.

Institution of Junior Engineers.—The summer meeting of this institution commences on Aug. 11, the North-East Lancashire district being the locality to be visited, with Blackpool as headquarters. The meeting opens with an excursion to Barrow to inspect the works of the British Griffin Chilled Iron and Steel Company, the Barrow Hematite Steelworks, and the Kellner-Partington Paper-Pulp Works. On Tuesday, after being received by the Mayor of Blackpool, the power station of the Blackpool and Fleetwood Tramroad Company and the Lancashire and Yorkshire Railway grain elevator at Fleetwood are to be seen. On Wednesday an excursion will be made to Furness Abbey, Lake Windermere, etc., and on the following day the members travel to Preston to visit the cotton-spinning and weaving works of Messrs. Horrocks, Crewdson, and Co., the Electric Tramway and Railway Carriage Company's works, and those of the English Electric Manufacturing Company. Friday will be devoted to an inspection of the engineering features of the Blackpool tower, etc., and in the evening the summer dinner of the institution takes place at the Queen's Hotel, South Shore, Blackpool. Mr. F. S. Pilling, M.I.E.E., 39, Victoria-street, Westminster, has been appointed hon. local secretary of the meeting.

Batteries for Telephones.—Mr. A. E. Dobbs, in the *American Telephone Journal*, gives the results of a three months' test of batteries of all kinds for telephones. There is a considerable difference of opinion as to whether the dry or the wet battery is the more economical, and the results set out in our contemporary are especially interesting as showing the relative economy of the two types of battery. The test consisted in connecting all the batteries to a clock, which cut them in for five minutes and cut them out for 15, through a resistance of 350 ohms during the entire 24 hours. At the end of the three months some of the best makes of dry batteries showed up better than the majority of the wet batteries. Most of the dry batteries had an initial E.M.F. of 1·53 volts, and stood the test longer than any except the very best of the wet batteries, while their first cost was only about one-third as much. This is further confirmed by the results obtained by some local exchanges, which could only obtain about four months' life for the best wet batteries, but could get about eight months' work from dry batteries. It is plain from these tests, therefore, that the dry battery is the more economical, even if it has to be thrown away after, say, nine months' use, especially in view of the cost of renewals in the wet battery.

An Electromagnetic Rectifier.—Mr. G. H. Morse describes in the *Electrical World* an apparatus arranged to his suggestion by Mr. C. R. Cushman, in the electrical engineering department of the University of Nebraska. The object of the experiment was to see if an alternating current could be divided up into two uni-directional fluctuating currents by means of an electromagnet. The action of the apparatus is not quite clear, but the experimenter used an arc between three carbons. Two of the carbons were placed side by side, and the third carbon opposite them. Across this space, where the arc played, a strong magnetic field was established by means of an electromagnet. From the diagram of connections, we gather that the connections were such that the current in one direction passed only through one of the carbons of the pair and in the opposite direction through the other carbon. That this was so was ascertained by means of ammeters and by altering the strength of the field, which was done by varying the position of the magnets. A point was reached at which the current in each of these alternative circuits was just half of the alternating current in the main, and had no reversal. We presume that the electromagnet made the arc jump from side to side according as the direction of the alternate current varied. We are afraid, however, that this interesting experiment has no commercial application on a large scale.

Power Transmission in California.—Some highly interesting results have been obtained recently from tests of a single-pole switch, which the Bay Counties Power Company are introducing into their system for the transmission of power at high voltages over long distances in California. In the first test the switch was connected directly across the 40,000-volt 'bus bars that were receiving current from generators having a rated capacity of 7,500 kw. through transformers of equal capacity. This switch was closed and opened 10 times in the space of two minutes, and it opened the dead short-circuit each time safely and easily, and without damage to the switch, transformers, or lines. From an account of the tests in our San Francisco contemporary, the *Journal of Electricity, Power, and Gas*, it would seem that one of the two company lines that were in parallel was then cut out at Colgate, but left in parallel with the other at a station 120 miles from Colgate. The switch was connected across this line, thus giving 240 miles of line between the switch and the 'bus bars. The switch was closed and opened 15 times in the space of three minutes, and it opened the short-circuit each time with the same successful result as in the first case. Indeed, the switch was not damaged by the extremely severe test of opening a dead short-circuit at 40,000 volts with generator and transformer capacity of 10,000 h.p. behind it 25 times.

High-Speed Trials in America.—Rivalling almost the Berlin-Zossen tests in their importance, we understand that experiments in very high-speed electric traction will shortly be commenced in America on the new Aurora, Elgin, and Chicago Railway. This line, which is now nearing completion, is designed for a continuous maximum speed of 70 miles per hour, but arrangements have been

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made whereby the General Electric Company will be enabled to carry out a series of tests with special apparatus in the hope of obtaining data on trains operating at speeds of 100 miles per hour and over. The great distinction between the recent Berlin-Zossen trials and those contemplated in America will be that in the European tests polyphase motors were used, whereas the General Electric Company propose to run their experimental trains with direct current motors supplied from the 100lb. third rail with which the railway is equipped. It is to be expected, however, that the values obtained for train resistance at the high speeds in view will be of equal importance in the two cases. It is said that the Aurora Railway is peculiarly adapted to experiments of this character. It is laid with 80lb. track rails, has many long tangents, a solid road-bed, and its few curves are made with a view to high speeds. The experimental apparatus is now in course of preparation, and although all expectations may not be fulfilled, we may expect to obtain some valuable data as to high-speed working from these trials.

Electric Lighting in New York.—The New York Edison Company has just announced a large reduction in the price for electrical energy, which amounts to 25 per cent. In other words, whereas the consumers in New York City had to pay 10d. per Board of Trade unit, they are now to be supplied at 7½d. We would commend these figures to the editors of the halfpenny papers in London, who are so absolutely sure that in America everything electrical is done so much better than in this country. We are convinced that if any company, let alone a municipal undertaking, were to attempt to charge 7½d. per unit in England, the halfpenny contemporaries in question would raise a great outcry. Another fact of interest in the reduction of the rates in New York is that the company is adopting a demand system, in order to allow of low charges to long-hour consumers. For instance, the new charge of 7½d. per unit will be for the first and second hours' use of the maximum consumption per day. For the third and fourth hours' use the charge will be 5d. per unit, falling to 3½d. per unit for the fifth and sixth hours, and to 2½d. per unit for all over six hours. While these reductions are in the right direction, we may fairly claim that they are made imperfectly, as the right system is to make a good reduction after the first hour's average use. The result would be a much more simple system and one least likely to cause friction between the company and its consumers.

The American Pacific Cable.—The United States Government is still busy negotiating with the Commercial Pacific Cable Company with reference to the proposal to lay a cable from San Francisco to Manila, in the Philippines. The latest offer which the company have made is to the effect that if the Government will place at their disposal the soundings taken by the United States boat "Nero," they will agree to have the entire cable laid and in operation by June 1 next year—*i.e.*, in less than 11 months from now. This is just about 1½ years sooner than it was originally estimated it would take to lay the cable. There are several opponents in the State to the company being allowed to embark on the enterprise. Chief among these is the Western Union Company, who are in favour of the United States Government themselves putting down the line, in which case that company would get a part of the land-line business on messages between the United States and Asia. That proposal, however, has been defeated, and the Asiatic business will go to the Commercial Cable Company and the Postal Telegraph Cable Company. The administration at Washington, it is pretty safely assumed, will grant the request of the former company, and throw open the soundings to the public, as they have done in other cases. It is announced that the rates which will be charged the United States Government by the new Pacific cable will be 2s. per word, which is more than 4s. less than the present rate paid by the Government.

Electric Traction in New Zealand.—The spirit of tramway enterprise in New Zealand is spreading, and to-day we find a number of the larger towns in that colony going in for electric tramways, who a few years back had not even given a thought to this form of traction. The latest Municipality to decide upon an electric tramway scheme is that of Christchurch, and a Bill is to be submitted to Parliament soon on the following lines. It is proposed to constitute the city of Christchurch and a number of boroughs in the locality a special district for the purpose of tramways, and to incorporate a Tramway Board in the same way as has been done in this country in the case of the Stalybridge, Hyde, Mossley, and Dukinfield districts. The Board is to be a local authority under the Tramways Act of 1894, with sole power to construct tramways in the district, and is also to have power to borrow up to £250,000 for the first system, and to raise a further sum of £100,000 for purposes of extensions. By constituting a Board of the whole district affected by the scheme of the Christchurch Corporation, many difficulties of arrangement, etc., between different smaller authorities is avoided, and the risk of friction arising is thereby considerably reduced. Where the whole of the bodies are liable for the rate and interested in the working of the enterprise, there is every reason for common agreement and the ultimate success of the undertaking. In the present case the scheme cannot be taken in hand in any practical form for some months to come, but the main points have already been agreed upon by the delegates of the local bodies concerned.

Electrical Conductivity of Air.—Prof. J. J. Thompson has made some most interesting experiments on the increase in electrical conductivity of air produced by its passage through the water. The air from a large gasholder, of about 350 litres capacity, was bubbled vigorously through water by making the air in the vessel circulate through a water-pump. This treatment increased the conductivity of the air, and when the bubbling had been going on for some time the conductivity of the air was 10 or 12 times the initial conductivity. When once the air has been put in this highly conducting state, it stays in it for a considerable time. A large part of the conductivity produced remains in the air 48 hours after the bubbling has ceased, nor does it disappear when an intense electric force is kept applied to the gas. The effect produced by the passage of the air through water is similar to that which would be produced if the bubbling produced a radio-active "emanation" similar in properties to those emitted by thorium and radium. The conducting gas can be passed from one vessel to another; it retains its conductivity after passing through a porous plug. Passage through a long tube heated to redness destroys the conductivity. It takes, however, a very high temperature to do this, temperatures less than 300deg. or 400deg. C. seeming to produce comparatively little effect. If the gas be passed very slowly through a long tube filled with beads moistened with sulphuric acid, the conductivity is destroyed Unless, however, the stream of gas is very slow, the air retains a good part of its conductivity in spite of the sulphuric acid. Another point of resemblance between the "emanation" from radio-active substances and a gas in this state, is that if a strongly negatively electrified

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conductor be kept in the gas for some time, the conductor becomes radio-active.

Post Office Telephones.—Just five months ago to-day the central exchange of the Post Office telephone system in London was opened, and from that time forward the work of preparing new exchanges for service and connecting up subscribers has gone on unremittingly. Enquiries at the new office of the general manager, Mr. Preston, in St. Paul's-churchyard, have elicited some interesting facts. The exchange was first opened for public use on March 1, and at the present time the number of subscribers connected to the wires stands at 2,000, and the business is still growing—far beyond anything that was anticipated. Another 2,000 subscribers are waiting to be connected, and fresh contracts are being entered into every day. The average rate at which they are being connected up is 100 subscribers per week, and the department expect to increase this number very shortly to 150 and 200 per week. It is not generally known that the Post Office central exchange covers an area which is served by no less than four exchanges of the National Telephone Company, and also portions of two other exchanges of that company. The one obvious advantage of this construction is that a vast amount of junction connections are avoided. As the number of connections grows, of course, the switchboard must be extended, and ultimately it will probably be found necessary to open up an auxiliary exchange in order to efficiently cope with the demand for telephone communication in London. As regards outside districts, the exchanges at Putney and Kingston have been opened with a good number of subscribers to each, and in a week or two the western exchange (which is to serve the district of Kensington), the Victoria exchange (to cover the Westminster and Victoria districts), and the exchange at Wimbledon will all be brought into daily service.

Electricity on Steam Lines.—The first definite proposals for converting steam lines in this country to electric traction, with the exception of the Inner Circle and the Tilbury lines, have come from quite an unexpected quarter—*i.e.*, the North-Eastern Railway Company. The section of its system this company proposes to electrify is in the neighbourhood of Newcastle, where the development of its traffic has been severely arrested by the ever-growing tramway competition. The electric tramways in Newcastle are being gradually extended into the districts adjoining the suburban lines of the railway company, with the natural result that there has lately been a great falling off in the number of passengers using these lines. Apart from the question of the more economical working of electric traction and its many other advantages, therefore, the company are extremely well advised in taking steps to introduce electricity on their suburban system in Newcastle. It will be necessary, of course, to obtain statutory powers before carrying out the change, but it is expected that Parliament will readily grant these in view of the great advance in railway traffic aimed at by the enterprise. That the company is fully determined to carry its scheme through to the end, may be gathered from the fact that tenders for the complete electrification of the lines in question have already been invited. The first section proposed to be converted is about 37 miles in length, mostly double-line, and is in the form of a circle running out to Tynemouth. It is not proposed to use electric locomotives except on one small branch line on a heavy gradient for goods trains. On all the other lines the normal train will consist of two coaches equipped with motors and one trailer coach. To a certain extent the scheme may be looked upon as an experiment, but in the peculiar circumstances of the case there can be little doubt of its ultimate success.

Electrolytic Condensers.—A paper on this subject was read by Messrs. A. Trowbridge and E. R. Walcott at the recent Pittsburg meeting of the American Association for the Advancement of Science, and this paper is abstracted as follows in the current number of the *Electrical World*: The paper contains the results of some interesting experiments on electrolytic cells carrying from 10 to 20 amperes under alternating current pressures of about one volt. The frequencies were 60 cycles and 144 cycles. The electrodes were metallic plates, immersed in the electrolyte, and separated by one or more sheets of paper. The apparent capacity of these cells is enormous by comparison with the capcity of electrostatic condensers, but it is only obtained at the expense of energy loss. The efficiency of good electrostatic condensers is very high, approaching 99 per cent. in some cases; while the efficiency of these electrolytic condensers is quite low, roughly about 50 per cent. in some cases. In other words, the power of an electrostatic condenser is usually very small, and the phase displacement of its current, ahead of the terminal E.M.F., nearly 90deg.; whereas the power factor of these electrolytic condensers was frequently as high as 60 per cent., and the capacity reactance nearly equalled by the internal resistance. It has been due apparently to this large internal resistance, and consequent waste of energy, that the electrolytic condenser has not come into use on alternating-current circuits for the purposes of phase displacement. The apparent capacity of the apparatus is ample, and there is no difficulty in securing the requisite number of microfarads, but the apparatus gets hot under load, and wastes power to a prohibitive degree. For the purpose of artificial lines in experimental telegraphy, where no great precision is desired, and where retardation is sought for without any accuracy as to its adjustment, the electrolytic condenser may become a very useful apparatus. Up to the present time this seems to be its only sphere of application. It is a pity that it cannot be freed from internal waste, because the contrast in bulk and cost between one farad in electrolytic and electrostatic condensers is amazing.

Electricity Supply in Camberwell.—The one question of importance besides the tramway scheme which is at present occupying the attention of the municipal borough of Camberwell is that of the supply of electricity in their area. The Council doubtless think it would be for the benefit of the ratepayers if they were the owners of the electrical undertaking. On the other hand, it seems that the County of London and Brush Provincial Electric Lighting Company, who hold the necessary powers for the supply of electricity in the district, are quite willing to sell. A conference took place one day last week between representatives of the Corporation and of the company, when, we understand, the matter was thoroughly discussed, and a definite offer was made by the company. The present position of affairs is this. The company obtained their order in 1896, and Clause 60 set out the terms on which the Council were to be allowed to purchase the undertaking—*i.e.*, on payment of the total expenditure chargeable to capital account, plus 33 per cent., together with such a sum as should make up to 5 per cent. since the date of the order. Now, the actual sum expended by the company on the undertaking to date is about £158,956, but at the conference last week the representatives of the company stated that if the Council were willing to purchase, they would be prepared to treat on a basis of many thousands of pounds lower than the amount calculated on the basis agreed upon by the above clauses. The company have already laid about 25 miles

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of mains in the borough, and have secured a site for the erection of a generating station. They are willing, however, to undertake not to proceed with the latter work in the interval between now and the end of September next, so that the Council may have a chance of considering their position as to the purchase of the undertaking at its present stage. Naturally, the representatives of the Corporation were not prepared to accept the offer of the company offhand without first having the views of an expert as to the value of the works executed by the company—the present state of the mains, etc. They, however, were strongly in favour of engaging an expert, and they reported their decision to the Works and General Purposes Committee. It has now been left to the Council in full meeting to say whether or not an expert shall be employed to advise them on the question of taking over the company's undertaking and working it as a municipal enterprise.

Wireless Telegraphy: an Electrostatic Effect? Prof. J. W. Gore, in a short article in the *Electrical World*, states that during the summer of 1900 Prof. W. C. A. Hammel and he made some experiments relative to a system of signalling to and from moving trains, when the question arose, How far could a wire the length of a car be placed from a telegraphic circuit, one end being connected with a coherer, so that the inductive effect of the current might still be sufficient to effectively operate the coherer? They tried placing the wire at various angles with the telegraphic circuit, and found that the coherer responded even when apparently at right angles to the circuit. In subsequent experiments due precaution was taken to be assured that the effects were not the result of other than the causes mentioned. The antenna was placed quite accurately at right angles to the circuit. The coherer was effectively operated upon, making and breaking the circuit when the bare end of antenna touched the circuit; when the end of antenna was near or some distance beyond the circuit; when the antenna was doubled around the circuit or doubled back on itself and the end connected with the coherer. The effect is greater when a helix, having a conductor for its axis, is connected to the antenna, either end, the middle, or both ends of the helix being connected to the antenna. Very decided effects were obtained in each of the above cases when one end of an open circuit was connected to a terminal of the secondary coil. In but a few of the cases were earth connections necessary, though the effects were increased by earth connections. The results obtained seem to be due to the same cause that operates the coherer when an insulated conductor, near the end of the antenna, has its potential suddenly changed—namely, electrostatic induction. It may be a hasty, though it seems a legitimate inference from the experiments, that long-distance wireless telegraphy is an electrostatic rather than a Hertzian wave effect; at any rate, Prof. Gore has thought for the past few months that this appears to be the more plausible explanation. An oscillatory electrostatic stress between the conductor (earth) affected æther and the freer æther above the earth, would produce waves that would be propagated around the earth. The better the earth conductor, the greater the electrostatic effect; the smoother the surface of the earth, the less the waves would be distorted and deflected. These are conditions which are found favourable for transmission of wireless telegraphic signals. It seems to us that Prof. Gore mixes up cause and effect.

New Degrees in Engineering.—At the Battersea Polytechnic on Tuesday evening Mr. S. H. Wells, the principal, gave particulars of the new degrees and faculty in engineering, recently instituted by the governors of London University, to the members of the Institution of Junior Engineers who were on a visit to the polytechnic with the special object of having this important matter brought prominently to their notice. The subject is one in which every young engineer should take the deepest interest. The opportunity of obtaining a degree in engineering at the London University has never before been open to the profession, and the facilities now offered for gaining this distinction should be a great stimulus to students to enter for the examinations which have to be passed before the degree is granted. It is indispensable in the first place, however, that students shall matriculate, and to this end the matriculation examination has been so altered as to be much more favourable to engineering students than under the old regulations. The most important reform, as explained by Mr. Wells, is the dropping of Latin as a compulsory subject, and the substitution for it of either mechanics or physics. It is now possible to matriculate at London University by passing in English, in elementary mathematics, in mechanics or physics, and in geometrical and mechanical drawing. There is, however, the restriction that if Latin is not chosen as one of the subjects of the examination, the student must take either French or German. Having matriculated, there is no limit of time which will debar the student from going in for his examination for the engineering degree, but this he cannot obtain in less than three years from the date of his matriculation. The examination for the degree is divided into two parts—*i.e.*, intermediate and final. The subjects included in the first of these are mathematics, applied mathematics and mechanics, electricity and magnetism, or heat, sound, and optics, engineering drawing and design, and the choice of the four following—*i.e*, heat, sound, and optics, electricity and magnetism (if either of these have not previously been taken), geometry and geology. The final examination is divided into two groups—A and B. Group A consists of three subjects, the student being given a choice of four. They are: theory of machines and machine design, theory of structures and structural design, strength and elasticity of materials, and electrical technology. Of Group B two subjects must be taken out of seven, consisting of hydraulics, surveying, theory of heat engines, design of electrical machinery and apparatus, generation, transmission, and distribution of electrical energy, mathematics, and, lastly, advanced theory of machines and structures This being a general outline of the nature of the examinations, Mr. Wells went on to explain that the Central Technical College and King's College have been constituted colleges of the university, and are recognised as such by the Board of Studies. Students going through the engineering courses at these institutions are eligible for the examinations for the degree as what are known as "internal students"; but in order to provide for those engineers who have to work in the shops in the daytime becoming "internal students," the university has decided to recognise certain of the London polytechnics as giving an approved course of study, and which students may attend in the evening. On the other hand, what is known as the "external student" is not required to go through any authorised course of study, and may present himself at any time for examination, but in his case he has to pass an extra examination which is not given to the "internal student." In concluding his address, Mr. Wells emphasised the fact that it is now possible for any young engineer of average ability to gain his practical experience in the daytime and attend evening classes at certain of the polytechnics, and at the end of, say, four, five, or six years, to take his degree as B.Sc. at the London University.

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THE ARC WORKS, CHELMSFORD.

TEST OF 800-KW. DYNAMOS.

On Tuesday last we had the opportunity of again going through the works of Messrs. Crompton and Co., Limited, at Chelmsford. The date was selected so that we might see a Hopkinson test of two large dynamos which had been built by the firm for the Calcutta Electric Supply Corporation. These machines, which have an output of 800 kw. at a speed of 230 revolutions, are to be coupled direct to engines of the Belliss type. It is of interest to note that Messrs. Crompton and Co. have been the contractors of the whole plant and machinery which is now in use in Calcutta. The Electric Supply Company of that place commenced operations in 1897, when some 900 kw. of plant were installed. The demand for electric light and power in Calcutta has, however, increased so rapidly that the stations have now plant on order which, when fixed, will bring the aggregate up to 3,500 kw. The two machines which we describe are included in this total, and we understand that more dynamos of the same output are likely to be ordered in the near future.

supporting gear which carry the carbon brushes can be seen from the illustration (Fig. 1), and we may mention that the brushes were working exceedingly well when we saw the machines last Tuesday, as there was practically no sparking with a 750-kw. load. The weight of each armature is 13 tons, and the total weight of each machine, with outside bearing, is about 30 tons. While the machines are primarily designed for electric light and power supply, they can easily be adapted for the traction load by adding a compound winding.

In Fig. 2 we give the diagram of the connections which were used in making the tests on these machines, and in Fig. 3 will be found the results of the test, which has been carried out in a most thorough way. The result is excellent, as at full load each machine has a commercial efficiency of 94 per cent.—*i.e.*, the electric horse-power at the terminals is 94 per cent. of the brake horse-power put in at the dynamo shaft. As the curve shows, the efficiency is 85 per cent. at quarter load and rises to 90 per cent. at 320 kw. In view of the fact that the machines have to be used in Calcutta, where the temperature of the atmosphere is abnormally high at certain times of the year, great care had to be taken to have cool-running machines. The result

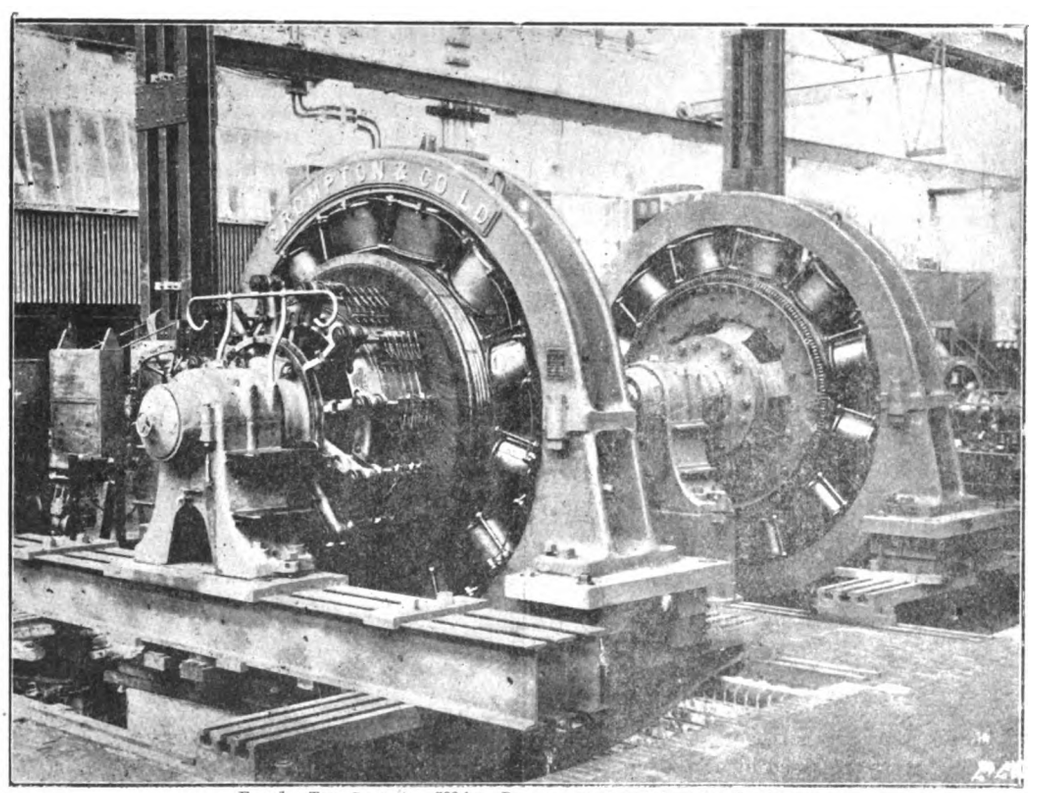

Fig. 1.—Two Crompton 800-kw. Dynamos as Coupled up for Testing.

The dynamos in question are illustrated in Fig. 1, which shows the two armatures on the one shaft for the Hopkinson test. The firm have so arranged the two pits required with the necessary cross girder, that they can test machines up to 2,000 kw. without trouble. The Calcutta dynamos have 12 poles, and, as will be seen from the illustration, the frame is divided into two parts at the horizontal diameter. The yoke rings are of cast steel, and on to these are secured the cast-steel poles. These poles are made in one with the pole-pieces, which serve to support the former for the exciting windings. We understand that in order to keep down the armature reaction, the poles will have slots cut up the centres, which have to be milled out before the machines are dispatched. A somewhat novel feature in the formers for the exciting coils is the use of iron stays, which are carried across from one gunmetal flange to the other in order to support these flanges against the pressure exerted by the winding. Two of these stays, which are of iron pipe, are used on each exciting coil former. Other projections on the back flanges are employed as supports for the insulated terminals of the shunt winding. The armature is of the slotted drum-wound type, 7ft. in diameter, while the outside diameter of yokes is about 12ft. The details of the brush

of six hours' run at full load shows that in the present instance a temperature of the armature at the windings only increases 50deg. F. above the temperature of the air, while the rise at the exciting coils was only 37deg F.

Coming now to the losses, the trial figures as analysed show that the following are the percentage losses at full load in the various parts of the machine:

C^2R in armature	1·76	per cent.
C^2R in shunt	0·35	,,
Frictional loss in brushes	0·71	,,
Frictional loss in bearings and windage	0·47	,,
Iron losses	2·7	,,
Total	6	per cent.

It will be seen from the above that the iron loss is responsible for almost 50 per cent. of the total, and it would be interesting to know how much of this occurs in the armature and field-magnet cores respectively. In this we do not refer to the hysteresis loss so much as to the eddy-current loss. The bearings used in the trial are those which will be employed when the machines are erected in Calcutta, and they are of the self-oiling type. When we were at the works we obtained the following readings of the various instruments used in making the trial, and give them herewith, so that our readers may, if they like, check for

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themselves the efficiency of the dynamos at the loads in question :

Current in main circuit	1,350	.....	1,500
Auxiliary volts	83	.....	81
Motor voltage	490	.....	480
Dynamo voltage	400	.....	408
Current in motor shunt	8·3	.....	8·2
Current in dynamo shunt	7	.....	7·3

Speed, 230 revolutions.

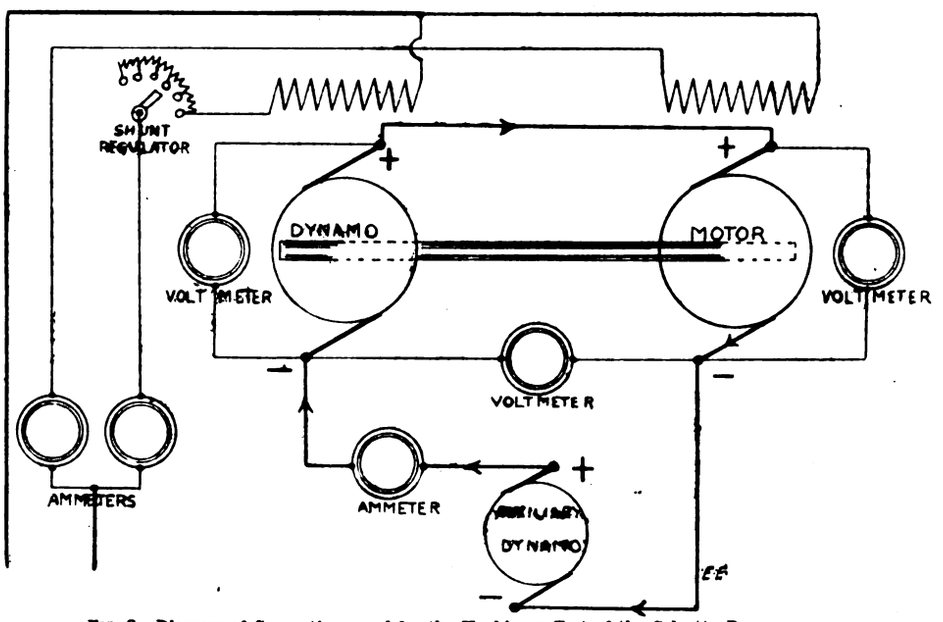

FIG. 2.—Diagram of Connections used for the Hopkinson Test of the Calcutta Dynamos.

In working out these figures a correction is required, which we were unable to ascertain, it is due to the fall of voltage in the leads from the auxiliary dynamo, which drop is included in the auxiliary voltage as given above.

Besides witnessing the above machine trial, we had the opportunity of seeing through the company's works, which have been considerably extended since our last visit. In the main shops we noticed, for instance, a good deal of new plant, including a number of automatic tools for making small parts. The largest extension is, however, the new arc lamp shop and instrument shop, which was only opened for work in February last. Until then Messrs. Crompton and Co. had been making these in their old works at Moulsham. The new place in which this work is now proceeding is laid out wholly on one floor, in the same way as the main shop, and is provided with a north light roof, also of the "weaving shed" pattern, the roof being carried on cast-iron columns. The floor space is 270ft. wide by 160ft. long; the width of 270ft. is the maximum that the ground allows, but the length can be extended almost indefinitely, provision having been made for such extension by constructing the north end of the building of light corrugated iron, the other end and two sides being of substantial brickwork. The height of the building from the floor to the inside of the roof beams is 13ft. over the greater portion and 15ft. at one end, which is used as a packing-room, and is shut off from the rest of the structure by a brick wall and fireproof doors. A space of 40ft. by 160ft. is screened off at the west side of the shop, and forms the instrument department. The rest of the shop, comprising the lamp and switch departments, is quite open. A space of 55ft. in width is reserved across the whole of the north end of the building as a store, and is separated from the working portion of the shop by an open partition. A portion of this store is again fenced off in the centre of the building, and is used as a tool shop. The machine shop occupies a width of two bays and a-half in the centre of the building. The east side is given up to the manufacture of the various types of arc lamps, the construction of switches, switchboards, projectors, etc., being carried on on the west side. On the south side is a range of offices for the shop manager, with his draughtsmen and office staff so placed that effective supervision is maintained over the whole of the shop. The shop is floored throughout with American maple boards, laid on an under floor of deal, with concrete

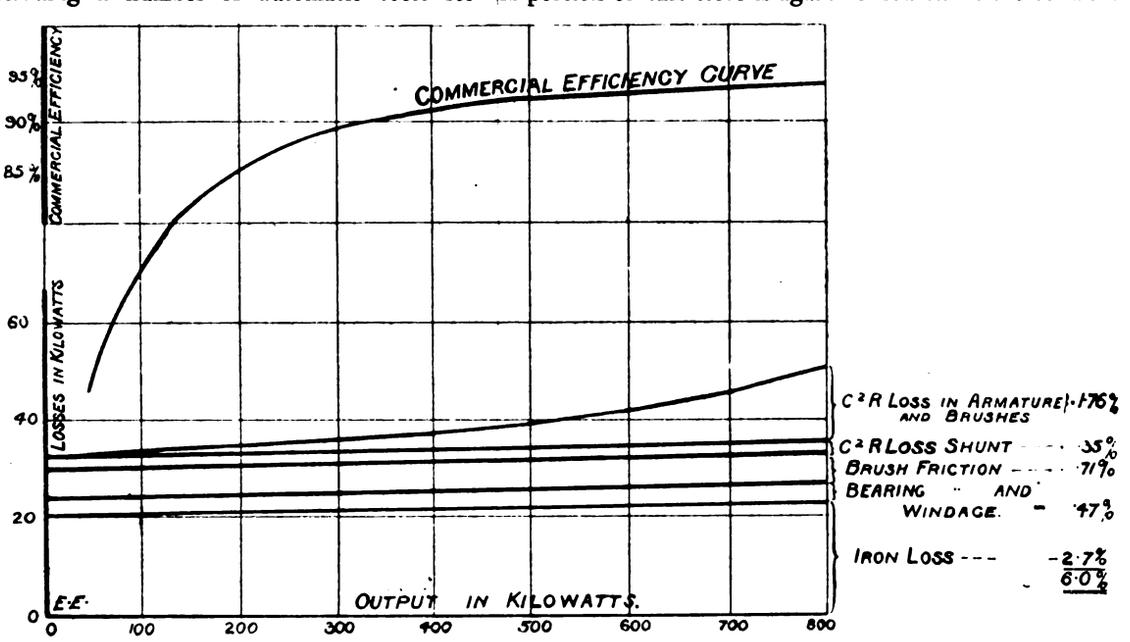

FIG. 3.—Efficiency and Loss Curves of the Calcutta 800-kw. Dynamos as supplied by Messrs. Crompton and Co.

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below. With such a floor, and with light rubber-tyred trucks, the use of rails is entirely unnecessary, and, moreover, machine tools up to any size likely to be required in such a shop can be fixed by simply bolting them down, and without the provision of special foundations. The shop is entirely lighted by arc lamps, the portion devoted to instrument work having the arcs inverted so as to avoid any shadows. Low-pressure steam heating is used throughout, and there is a complete system of fire-mains and of gas-mains for the supply of "Dowson" gas, which is used for brazing, soldering, etc. The whole shop is motor driven, the current for this and the lighting being obtained from the power-house of the dynamo shop. An overhead crane in the packing-room provides for the loading and unloading of goods, and portions of this room are shut off for the storage of castings and other rough material; also for grinding, buffing, dipping, and similar dirty operations. Another travelling crane in the switch department enables the heavy panels of large switchboards to be easily handled.

There are four lines of shafting in the building, each motor driven and running on roller bearings. In both the lamp and switch departments there is a large plant of interesting and up-to-date tools to be seen, notably turret drilling and tapping machines for dealing rapidly with the numerous different sized holes in the arc lamp frames. With such machines it is possible to fix the frame into its drilling jig and drill and tap all the holes before it is removed from the jig, even though there may be many different sizes. There is also a number of most modern capstan lathes by both English and American makers. The tool shop is completely self-contained, including its own tool forge, and both here and in the main shop the system is adopted of having every tool, including all the ordinary lathe tools, ground in the tool shop. Duplicate and triplicate sets of these tools are stocked, so that there is no delay in providing workmen with freshly ground tools. The department is also provided with a testroom in which all lamps are tested before being sent out.

In the instrument department, which is occupied chiefly in the manufacture of measuring instruments, amperemeters, voltmeters, potentiometers, and other high-grade instruments, the firm is also engaged in originating gauges and cutting tools for the system of small screw threads recommended by the British Association Committee in the Bradford report of 1900. These gauges and tools are being made on a system now being worked out in the shops under notice, and it is hoped will give a good degree of accuracy without excessive cost. Except that the parts are roughed out when soft, all the operations are on the hardened steel with emery wheels in a peculiar form of lathe. Irregularities due to deformation by hardening are avoided, and such a degree of finish is obtained from the wheels that no polishing of the surface is required. A high perfection of geometrical form should be obtained in practice. An electrical contact gauge measures easily within $\frac{1}{1000}$mm. Messrs. Crompton attach great importance to the establishment of accurate dimensions and forms for the small appliances in their instrument shop, and are paying a great deal of attention to this subject. Some very interesting and accurate tools are also installed in this shop, including lathes ranging in size from those used by watchmakers to machines with 5in. centres, together with small milling machines, etc, of different types.

In these shops we saw an enormous number of arc lamps in course of manufacturing and testing, and were able to inspect the "Coronation" arc lamp which the firm have introduced this year. This is of the enclosed type, and uses impregnated carbons, which give a light which is exceedingly rich in orange rays, and this is of great service in unfavourable atmospheric conditions, such as fogs. A number of large switchboards we also saw in course of erection which were well worthy of inspection. We noticed that Messrs. Crompton and Co. have abandoned the use of a carbon break on their main switches and use instead auxiliary contacts with a brass wiper, which effectually prevents the arcing at the main contacts, and is, if anything, more reliable than carbon.

We were pleased to see the works in such a healthy condition, as there was a good amount of heavy work in the main shops, and the smaller departments were all well employed. The firm have recently supplied three dynamos of larger type than those we saw to the Glasgow Corporation, and we understand that they are doing good work in that town. Our conclusion from the visit was that Messrs. Crompton and Co. are well able to hold their own against the present keen competition in the economical manufacture of various classes of electrical goods in which they specialise.

UNDERGROUND CABLE LAYING.

BY A. T. STEWART.

There are many valuable articles to be found dealing with the distribution of electricity, but, strange to say, most of these articles abstain from referring to the details of the conductors used and the various methods adopted for fixing them in position. On these methods, however, the practical and economical working of any system largely depends. In the early days of distribution Edison worked out a very complete system, consisting of half-round conductors laid in wrought-iron tubing, which was filled up with a bituminous compound, and having on the outside of the tubes tarred tape wrapped round them to prevent oxidation of the iron. Lack of flexibility led to joints being made every 20ft., this, of course, being a great

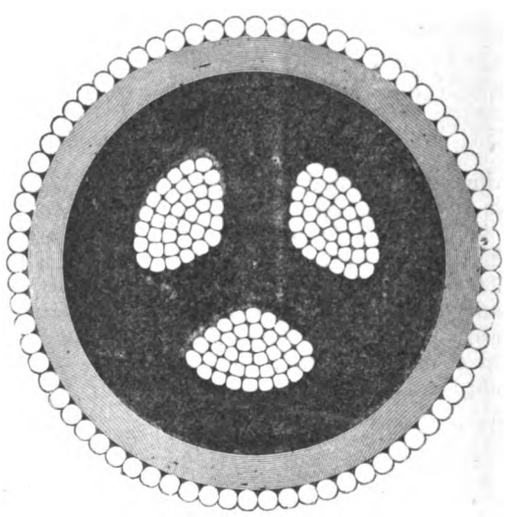

FIG. 1.

objection. For jointing purposes the copper bars protruded about 2in. from every tube, and were connected by means of a U-shaped piece so as to allow for the expansion and contraction of the metal. The whole was then covered up by a metal box filled with insulating compound. With the development of Hopkinson's three-wire system, a change in the arrangement of conductors was found necessary. These consisted of three circular copper rods of the necessary section for the current that was to be carried, each being insulated from the other, and bound together into a bundle by long spirals of jute rope. The copper rods were then placed in cast-iron ducts, patented by the American Section Underground Company. An insulating material was then run in while hot, being in a liquid condition, but solidified when cool.

Having now mentioned the systems first employed for electrical distribution, we will next consider some of the systems presently in use. These may be divided into four classes—viz.: (1) bare copper strip methods, in which the conductors are supported on insulators and laid in specially constructed conduits or subways; (2) armoured or unarmoured cables laid direct in the earth; (3) drawn-in systems, in which the cables are drawn into earthenware conduits or cast-iron pipes; (4) solid systems, in which the cables are laid in wood, iron, or other troughs, and then run in with bituminous compound.

There is much diversity of opinion at present regarding the respective merits of these systems, some proving suitable in one quarter and entirely the reverse in another. This may be occasioned by the fact that until recent date

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the subject of distribution had not received the attention which so important a branch of electrical work was entitled to. In the first place, there are certain localities where the conditions may permit of one system being used successfully, but the same system, if put down in another town, might be found quite useless, and, therefore, it becomes falsely condemned.

For low-tension work a great deal of attention has been given to the first-mentioned system. By the use of this method the expense of covering the copper with expensive insulating material is avoided; but the expense so saved is not always gain, as many additional expenses may be be incurred in other directions. Instead of using stranded-wire conductors, as in the system already mentioned, Messrs. Crompton employed a system in which the conductors were flat copper strips laid on the top of one another until the required section of copper was obtained. These strips were stretched out and supported on glass or glazed porcelain insulators placed about 50ft. apart in an earthenware or concrete conduit. The junction boxes were built of brick with cast-iron frames and covers, the conduits terminated at these boxes, and wherever possible were sloped towards them, so that any water which might find its way into the conduit runs into the box, from where it can be drained away. To ensure the proper working of such a system, it is absolutely essential that levels be carefully studied with a view to drawing the accumulations of water, also for conveying explosive gases to points where they may be removed by ventilation. In small towns where there is plenty of available space under the footways, also if such space be of such a nature that straight runs and the necessary gradients may be obtained, a copper strip system may prove advantageous. This system is now almost obsolete, as owing to the difficulty encountered in large towns with gas, water, and other mains, draw-in and inspection boxes cannot be put down in the required places. On a large distribution system of this kind the continual attention and care required is very costly; further, the increase of working pressures nowadays require a system in which all chances of moisture and gas accumulations are reduced to a minimum.

Where cost is a consideration, the second system is worthy of notice. Armoured cables laid direct in the ground have many advantages. Some towns even lay plain lead-covered cables direct in the ground, and the results have been satisfactory. In Bray, Ireland, this system has been adopted, the cables being laid in clay and covered over with tarred boards 1in. thick. Leith is another example where lead-covered cables have been laid direct in the ground; here steel plates are employed to protect them. It is usual to cover the armoured cables with timber or bricks to indicate their presence, and thereby modify the chance of damage by careless navvies when excavating. The general covering is an ordinary board about 1in. thick by 7in. wide, which is first dipped in boiling tar. The writer, however, prefers a V-shaped trough, as picks are much more apt to glance off a trough of this shape; moreover, they are a better protection to the cable in every way.

In adopting an armoured system, there are many points to consider, the chief one being the nature of the soil. If this be of a sandy nature, then an armoured system may prove serviceable; but should there be the slightest signs of acids in the soil, it will be found that sooner or later the outer layer of jute rots off, exposing the armouring, which also gets eaten away, until, finally, the cable becomes absolutely useless. It is then a question as to whether it will pay to open out the ground so as to reclaim the scrap copper. Laying direct, however, has this advantage: it is cheap, flexible, easy to lay, and the work may be carried out despite bad weather.

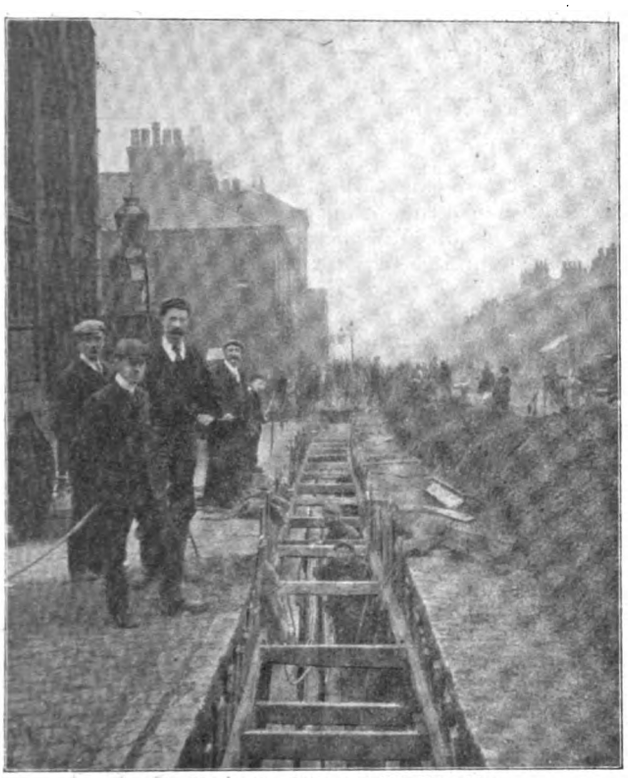

FIG. 2.—Manchester Cables as laid in Troughing.

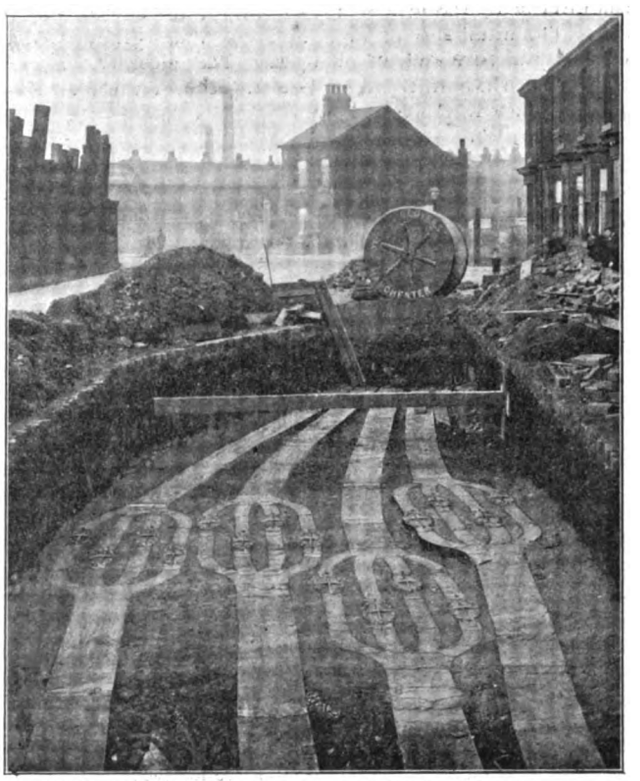

FIG. 3.—System of Arranging Intermediate Points at Manchester.

Let us now consider the "drawn-in" systems, in which the advantages lie in the fact that conductors can be drawn out if necessary and new ones drawn in again without disturbing the streets. The disadvantages entailed are, however, very numerous. The first is cost, the pipe or conduit system being costly to lay. It is by no means flexible, because unless the conduits are laid straight and level, it is almost impossible to get the cables pulled through, and still more difficult to get them out again. Further, they run a serious risk of getting damaged if the conduits are not laid straight. Faults on conduit systems are very expensive to repair, because should a fault occur in a cable which is the centre one in a nest of 20 or 30 others, then the labour entailed in repairing the fault may require many days.

Everyone who has had experience in underground work knows how difficult it is to prevent moisture from entering into or condensing in underground conduits. Yet another and more serious disadvantage is the danger from explosions owing to gas leaking into the conduits or manholes. Drawing-in boxes should

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be placed at intervals not exceeding 100 to 110 yards in straight runs, and at every sharp bend or corner to facilitate the drawing-in of the cables. As the conduits are laid it will be found convenient to thread a wire through them, so as to form a line from box to box. Doing this saves much trouble after in "rodding." As the conduits are laid, each should be very carefully examined to see that no sharp edges or obstructions have been left in them, also that the drawing-in wire is not broken, otherwise the tedious process of rodding already mentioned will have to be employed. Should rods be necessary, they must be of stout cane in lengths of about 5ft., with screw ferrules at the ends for joining together. A good rod should bend at right angles without the slightest overstrain. Boxes should be large and roomy, having a floor work of at least 6in. concrete and walls of 9in. brickwork, and each box should be drained into a sewer through a trap. The lids should be about 2ft. square for road work and about 18in. by 22in. for footway. Cast-iron pipes are much used for drawing-in systems, the chief advantage claimed for them being their mechanical protection. Lead joints are preferable, although cement is frequently used, and when lead are used they require careful caulking, as if any of the lead gets into the interior of the pipe it, is exceedingly difficult to get it out. The usual size of pipe used for underground cable work is 4in. bore and 9ft. lengths. The most convenient way to lay these is to joint two together on the cutting and lay them in the trench, jointing the others as the work proceeds. After all the conduits or pipes have been laid and threaded, the cables are brought to the ground in drums, which are mounted on stands or screw-jacks just behind the draw-in box, from which the cable is to be laid. The end of the cable is then fastened by means of an iron clip or strong twine to a rope or chain, this rope or chain being first pulled through the conduit by means of the draw wire left when they were laid. This rope is then wound on a crab, and the cable is thus steadily drawn through the conduit. It is advisable to use a suitable lubricant, which should be rubbed on the cable as it is drawn in, as by doing so it is pulled much more easily and is less apt to jerk.

When more than one cable is being drawn into the one conduit, it is advisable to tie them together and draw in at the same time. A sufficiently long bite should be left at each manhole to allow of the cable being easily drawn back, if necessary, also for jointing purposes. Where lead-covered or armoured cables terminate with thimbles in section or lighting feeder pillar or manholes, one often finds them sealed up by means of rubber tape, which starts at the thimble and is wrapped round and round until it finishes on the lead sheathing of the cable. This system of terminating conductors is very detrimental, and creeping electrolysis is apt to set up across the tape between the thimble and the lead covering of the conductor to such an extent that through time deterioration of the lead covering will follow, especially in an armoured system, where the metal sheathing may be lying in moisture many yards off. The best way to overcome this difficulty is to abolish all these tape systems, and to terminate the cable ends in an ebonite end connection box, which will enclose the lead sheathing and the thimble or socket, the whole being filled in with compound. For a three-wire network a draw-in system is not advisable; so many branch mains have to be connected to each successive installation that unless special brick boxes are made for each one, the conduit is broken into many pieces and cannot be repaired properly, the result being that water troubles develop, also gas accumulates, and through time the system gives endless trouble.

We will now turn our attention to the latest and most improved system—viz.: "the solid." The "Brooks" semi-solid system, which is little used, consists of a welded wrought-iron tube about 15in. long. These are joined together by an ordinary screw socket, every alternate length being connected by means of a T-coupling, which has a plug, and these are necessary for filling the tubes with the semi-solid oil, which generally is of such a nature as to become liquid at a temperature of about 280deg. to 300deg. F., but when cold is of a plastic nature. The cables used for this system are not necessarily lead-covered, but merely insulated with jute or strong fibrous material, which becomes impregnated with the heavy oil used for filling the tubes. It is most important that the cables and tubes should be thoroughly dry and free from all moisture. The final drying is given by an excessive current being passed through a special wire generally built in the cable for that purpose.

This last system seems to find more favour in this country than the others, although in America this solid system is

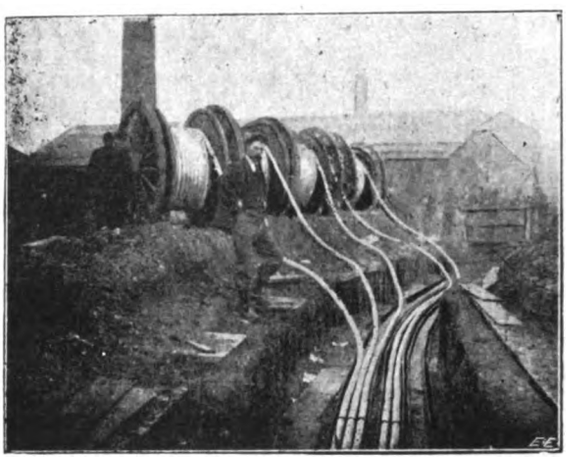

Fig 4.—Laying the Cables in the Troughs.

considered entirely out of date. Its advantages are flexibility and so little liability to be affected by moisture when properly laid. The former advantage is most important, especially in large cities, where there is so little room left owing to numerous gas, water, and other mains. The laying of cables on this principle is usually done at a depth of 2ft. 6in. in footway and 4ft. in the roadway, and wooden, iron, or earthenware troughs can be used. The cables are then laid on bridges, which should be well creosoted and set in position by a little liquid pitch, which soon cools

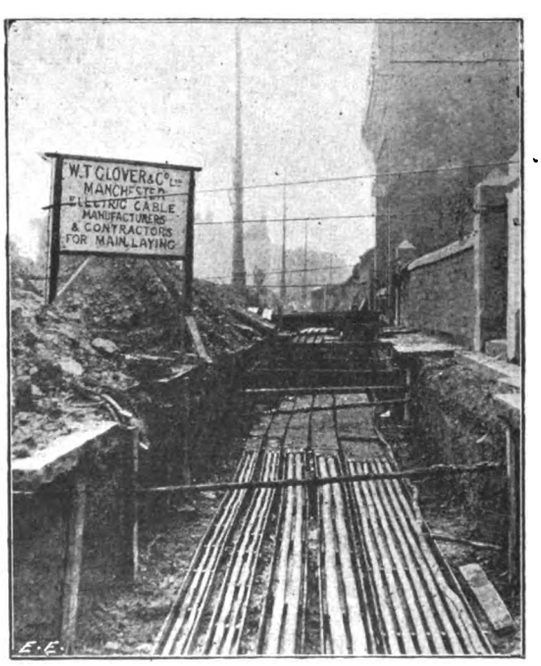

Fig. 5.—Laying Diatrine Lead-Covered Cables on the Solid System in Manchester

and thus fixes the bridge in position in the troughs. The cables may then be rolled along the side of the trench and finally laid into the troughs, after which they are filled in with bituminous compound and suitable covers laid over while the compound is still soft. Thus the trough and cover is sealed together, and encloses the cable in a solid block of compound.

Earthenware troughs have the disadvantage of not being more than 18in. or 2ft. long, thus requiring numerous joints. They are also very liable to get damaged, and are not at all convenient for getting round curves. Wood

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troughs well creosoted are most convenient. They may be made in any lengths, and proper bonds can easily be made at the joints by means of wooden collars placed underneath the joint. Care should be taken to design the trough so that it may be of ample size to allow a sufficient thickness of compound to encircle the cables. This should never be less than ½in. all round. Another important

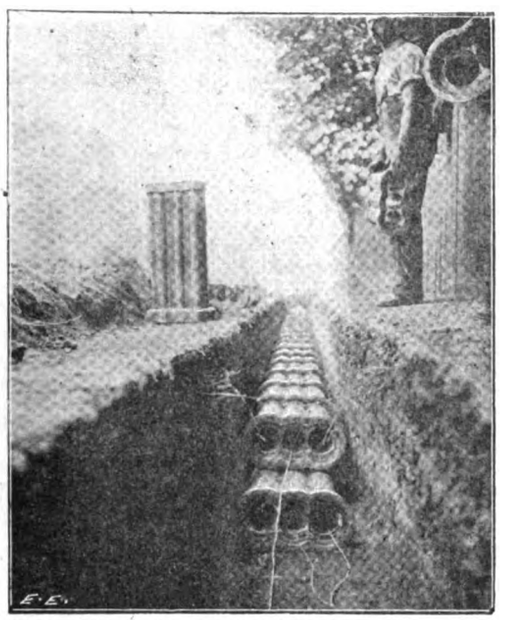

FIG. 6.—View showing the Conduits for the Draw-in System.

point is that the bitumen or compound should get well underneath the cable, and the best way to effect this is to run in a thin layer of compound before the cables are laid.

When laying solid systems in wet weather, care must be taken to see that the troughs and cables are kept dry until the bitumen compound is run in and set. Water causes blow-holes in the compound, and it may be found that through time the water will percolate through the compound into the cable, and eventually develop a fault which will cause endless trouble and annoyance. The compound usually employed is composed of pitch, bitumen, and creosote oil in quantities of about 60, 25, and 15 per cent.

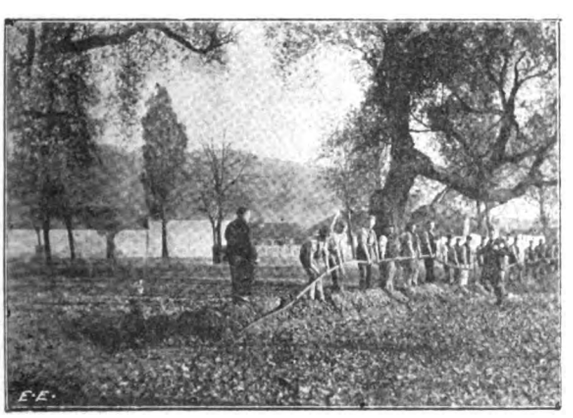

FIG. 7.—Laying Armoured Cable.

respectively. Some firms use pure bitumen only, but this is unnecessarily expensive, because if the compound already referred to is properly mixed, it will be found to last equally as well. The most convenient size of boiler to use for boiling the compound is 300 gallons capacity, mounted on four wheels, with shafts so that a horse may pull it along when required.

It might be as well before concluding our notice on solid systems to mention how extra high-pressure mains for transmitting three-phase currents are laid. Perhaps one of the most interesting systems of this kind is being carried out by Messrs. W. T. Glover and Co., Limited, for the Manchester Corporation. The cables (a section of which is shown in Fig. 1) are triple-triangular, three-core, lead-covered, and, as will be seen, have a sheathing of galvanised steel wire to satisfy the Board of Trade requirements. These cables are made in 150-yard lengths and laid in cast-iron troughs; each trough is 6ft. long, and securely bolted to its neighbour so as to make continuity throughout; iron clips are fixed to each trough by means of screws, and the cables are in turn clipped on so as to effectually earth the lead at each length of trough. Fig. 2 shows the cables lying in the troughs, also the clips. Wooden bridges are placed about every 18in., and the whole is filled in with bituminous compound, cast-iron covers being laid on the top. Disconnecting joint-boxes are placed every 450 yards, and are filled with Messrs. W. T. Glover and Co.'s patent diatrine, which is an excellent insulator. Fig. 3 will give some idea as to how the intermediate joints are made, also the magnitude of the contract already referred to. The working pressure on these cables is 6,500 volts, but they are subject to a breakdown pressure of 14,000 volts. Figs. 4 to 7 show other views of the work in progress.

The question as to whether cables should be laid solid or drawn into conduits is controlled greatly by the conditions as to the style of cable to be used, the nature of the soil, available space, etc. Lead-covered cables, for example, will naturally suffer much from electrolysis and earth currents in a draw-in system where moisture has accumulated in the conduits, especially if the bonding has not been closely attended to; it would therefore appear that the best remedy would be to lay such cables solid, but even although this is done and the bonding perfect in every way, there is always a chance of the bituminous compound getting cracked and exposing the lead at that point. Conductors break down owing to faults in manufacture also injury received whilst laying, yet it can safely be said there is no form of destruction so detrimental to the system as the action of electrolysis. Every precaution, then, should be taken to ensure a thorough metallic connection between the lead sheathing of all cables through the joint-boxes and manholes.

In the writer's opinion, the best method to ensure metallic continuity of the lead sheathing throughout any system, especially one where cast-iron troughs are used, is to securely bond the lead sheathing to the joint-boxes. The best system would probably be armoured cable laid solid in iron troughing, with a minimum thickness of 1in. of compound all round, well bonded with earth-plates, which could be under control placed at intervals. Such a system would, of course, be expensive, but it would be a guarantee against damage of all kinds, mechanical or electrical, provided the cable was properly manufactured. With this we must conclude our notice of conductors, though there are several points which we cannot find space to describe. The foregoing, however, will probably give our readers some general ideas as to the various methods employed, with their respective merits.

THE BRISTOL TRAMWAYS ELECTRICAL INSTALLATION.*

BY J. CLIFTON ROBINSON, A.I.C.E., M.I.E.E.

One of the first companies in Great Britain to recognise the advantages of electric traction and to adopt it for its tramway system was the Bristol Tramways and Carriage Company, Limited. In anticipation of the Board of Trade regulations of 1894, plans were prepared, and in October, 1895, the first power station was completed at St. George's, and served to operate the experimental electric line from Old Market-street to St. George's and Kingswood. This line proved so successful that extensions were laid down the following year and the power station equipment there was increased, and as the result of the working of those sections the company decided to reconstruct the whole of its lines (till then worked by horse traction) as well as to make large extensions, and to operate the whole system electrically. The Act authorising this important operation was obtained in July, 1898, and with characteristic energy the company set itself to carry out the reconstruction. By

* Paper read before the Incorporated Association of Municipal and County Engineers.

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December, 1900, the whole system, covering 28½ route miles, had been brought into electric operation, the completion of this immense undertaking occupying only a little more than two years. That the system has proved of immense public advantage is shown by the rapid growth of the passenger traffic. In the year 1900, when only parts of the system were as yet electrically worked, 27 millions of passengers were carried, while over the completed system in 1901 the number reached 37 millions, an increase of 10 millions, being an average of 1⅓ millions perannum per mile of line. It will perhaps be better in describing the system to give the various sections of the installation separately.

Power Station Building.

Choice of Site.—From a scientific and practical point of view, the interest of this extensive system of tramways centres in the new power station at "Counterslip," St. Philip's Bridge. It occupies a splendid position in relation to the work, being situated as nearly as possible at the centre of the system, the furthest point being distant four miles from the power-house. Built alongside the floating harbour, facilities are thus secured for a plentiful supply of water, for the reception of fuel and materials, and for the removal of ashes. The site had but one objection—its want of lateral extension. But it was so satisfactory in every other respect that it was adopted by the Board without hesitation, and the task of fitting the confined space to the requirements of the system was left to the engineer. This task has been met in a way that is absolutely unique in tramway engineering equipment—unique alike in design, adaptability, and com pleteness.

Architectural Description.—The leading feature is that the boilers and furnaces and the corresponding parts of that section of the equipment are on the floor above the engine-room. The reason for this unusual arrangement is that the most had to be made of a site of very limited extent, while it was, of course, desirable that the engines and dynamos should be on the ground floor. It was inevitable under these circumstances that all the other machinery should be taken to the upper storey, and that the building should be both lofty and strong enough to provide all the necessary accommodation The site had first to be dealt with. It abuts on the river, and, as in the case of the Corporation electrical station, on the other side of St. Philip's Bridge, it had to be closely piled before putting in the foundations. To do this a stout cofferdam was built around the river front, and the water between it and the site pumped out. The ground was then excavated to a considerable depth, and about 1,200 piles driven in. The concrete foundations have lattice steel girders embedded in them, and upon this solid basis is erected the steel framework for the building, which measures 140ft. in length and 52ft. in width outside the walls, the over-all height being 111ft. from the basement to the roof bridge. The walls are of red brick, closely set with cement, and Bath stone dressings have been freely used, so that the outward aspect presents a fine architectural effect, being graceful, dignified, and massive, sufficiently ornate to satisfy taste, while at the same time it is solid and businesslike, as the building for such a purpose should be. The interior of the power station is lined throughout with white glazed brick relieved with lines of blue. The basement is 8ft. high, the engine room is 37ft. high, the boiler-room is 20ft. 8in. high, and an additional floor above the boiler-room, 15ft. high, contains the tanks, bunkers, economiser, flue, etc.

Chimney Stack.—The chimney stack consists of two parts, a brick pedestal below and thesteel shell forming the shaft itself, this arrangement being necessitated by the extreme height of the boilers and flue. The pedestal is utilised to contain a spiral stairway giving access to the boiler-room floor. The chimney proper is 200ft. high from the base-plate on the top of the pedestal, or 265ft. in all above the ground level. The shell is made of steel plates in three thicknesses, being ⅝in. at the bottom, $\frac{5}{16}$in. in the centre portion, and ¼in. at the upper end. It is 10ft. 9in. in diameter at the top, and is there finished off with an ornamental cap. A ladder runs to the top from the base of the shell. The interior of the chimney is lined with firebrick, specially moulded, the thickness of the lining varying from 9in. at the bottom to 4½in. at the top. The shell is riveted to the cast-iron base-plate, which again is held in position by eight 2¼in. holding-down bolts, built in and running the whole depth of the brickpedestal.

Coal-handling Plant.—Coal is received from barges by a grab bucket and delivered into a storage tank. About 60 tons per hour are raised and tipped into a hopper, its weight being automatically recorded on its passage to the storage tank, which has a capacity of 486 tons. The fuel is delivered into the bunkers above the boilers by means of a bucket chain conveyor, with a total capacity of 267 tons, and the supply for the boilers is drawn off for the stokers through weighing hoppers. The bucket conveyor, which is 540ft. long, is electrically driven at a speed of 26ft. per minute, and will convey 34 tons per hour.

Boiler-Room.—The boiler-room contains eight horizontal water-tube boilers arranged in four batteries, each with a capacity of evaporating 8,250lb. of water per hour, at a steam pressure of 160lb., and each containing a heating surface of 3,140 square feet.

Mechanical Stokers.—Each furnace is fed by an electrically-driven mechanical stoker of the "coking" type. The driving shaft runs in a trench in front of the ashpit, and has at each end a worm gear driven by a motor. Either worm may be thrown out of gear. The ashes are removed by the return line of the conveyor, and are received into a tank outside the building, from which they can be drawn off into barges

Condensing Plants.—The condensing plant consists of two surface condensers of the "Admiralty" type, each containing 3,200 square feet of cooling surface, and each having a motor-driven 8in. centrifugal circulating pump. The air-pumps are of the vertical twin type, one set for each condenser. The exhaust steam passes through an oil separator before entering the condenser.

Hot-Well.—The hot-well consists of a cylinder 96in. long and 48in. in diameter located in the basement, and the water from this is forced into the water-tanks on the economiser floor by two electrically-driven three-cylinder pumps, passing through filters for extracting any remaining traces of oil. The make-up valve is situated in the hot-well.

Water-Tanks.—The water-tanks have a capacity of 12,000 gallons, and from them the feed pumps (which are of the vertical compound duplex type) supply the boilers.

Water Softener.—A "Tyack" water softener, capable of dealing with 3,000 gallons per hour, is located in the yard against the chimney base. Experience at the St. George's power station had proved this method of treating Bristol water to be satisfactory. The service from the town mains is arranged in duplicate, as a safeguard in the event of water being cut off fromeither.

Steam-Piping.—The steam-piping is designed to suit the particular arrangement of the station, there being one 10in. header in the boiler-room and another adjacent to the main engines; and provision is made by the insertion of separators to prevent water passing to the cylinders of the engines. From the lower steam header risers are taken to the stop valves of the engines, and a ring main is taken round the basement of the station for supplying steam to the auxiliary plant. The steam-pipes are lap-welded steel tubes screwed with heavy cast-iron flanges, the ends of the tubes being peened over. The exhaust from each pipe is carried into a main exhaust pipe 20in. diameter, in the basement, from which it passes to either condenser or by an automatic valve to the atmosphere by a pipe carried outside the building.

Engine-Room.—The engine-room on the ground floor is 116ft long by 48ft. wide and 37ft. high. It contains four 500-kw. direct-coupled sets, two 50-kw. direct-coupled lighting sets, the condensers, the air-pumps, five negative boosters, and the switchboard. It also has a 25-ton electrically-driven overhead crane traversing the whole length of the room. The main engines are of the vertical cross-compound Corliss type (built by the E. P. Allis Company, Milwaukee, U.S.A.), with cylinders 22in. and 44in. diameter and 42in. stroke, running at 90 revolutions per minute There are two galleries round each engine,

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the upper being connected from engine to engine. The fly-wheels, which are 16ft. in diameter and each weigh 40 tons, are built up in 10 semi-steel sections, each section being secured by three bolts between discs pressed out to the shaft. After it is built up in this way the joints in the rim are held together by links on both sides shrunk into recesses. The steam consumption of these engines is guaranteed to be not more than 12·7lb. per indicated horse-power, with a mechanical efficiency of not less than 91 per cent.

Generators.—The generators (constructed by the General Electric Company, U.S.A.) are of the 10-pole type, compound-wound, and will develop 1,250 amperes at 500 to 550 volts as may be required, or 1,500 amperes for short intervals. They stand over pits between the high-pressure and low-pressure engine columns, and the armatures are pressed and keyed on to the main shaft.

Gear.—The gear is of the automatic type with double-ported valves for the steam, and single-ported valves for the exhaust; and there are two eccentrics to the valve gear of each cylinder, one for operating the steam valves and the other for the exhaust valves. Two governors are attached to each engine, one of which operates both the high and low pressure cylinder valve gears, whilst the second or safety governor automatically closes a stop valve placed near the main throttle valve, to act in case the speed should exceed 95 revolutions per minute. The crankshaft is provided with journals of 18in. diameter. Between the cylinders there is a reheater receiver with coils supplied by steam at boiler pressure.

Lighting Sets.

The two lighting sets consist of two-crank tandem compound high-speed self-lubricating (Belliss) engines, running at 400 revolutions per minute, and each having direct-coupled a 50-kw. 500-volt compound-wound four-pole lighting generator. A centrifugal governor fixed at the end of the crankshaft and acting direct on the throttle valve controls the speed within 3 per cent. There are also in the engine-room three 30-kw., one 20-kw., and one 35-kw. negative boosters for drawing the return current from the track rails. These boosters or motor-generators are placed under the switchbord gallery, and each consists of two four-pole continuous-current direct-coupled machines mounted on a single bed-plate having three bearings. The generator is constructed as a series-wound machine, but its field is connected in circuit with the positive feeders supplying current for the locality so boostered. Separate return cables run from the distant points to be boostered, the extreme ends of which are connected to the track rails by plastic bonds, and the home ends to the negative side of the generator armature, the positive side of which is connected to the negative 'bus bar. The generator is separately excited, and the current in the armature corresponds with the current in the field, and when 600 amperes (which is the maximum capacity) are passing through both field and armature, the machine gives 50 volts at the terminals of the generator. The rails are also connected at the power station by bare cables, equivalent in section to four square inches, to the negative 'bus bar.

Switchboard.

The main switchboard consists of white marble panels 8ft. in height and 2in. thick, bolted to angle-iron frames on a raised gallery. It consists of four generator panels; 21 feeder panels, some of which are on the auxiliary board, as described later; two lighting generator panels, one panel containing the main station voltmeters and the Board of Trade test instruments, and one lighting and power circuit for the power station circuits; also five booster panels, all being furnished with connections and switches of the most approved type and design. The arrangements are such that the lighting and power panel may be supplied either from the lighting sets or from the tramway generators.

Auxiliary Switchboard.

There is also an auxiliary switchboard on a gallery above the main switchboard, containing the feeder panels supplying the parts of the system originally driven from the St. George's power station, and also panels controlling the feeders to the various depôts and car-sheds throughout the city, for both lighting and power.

TRAMWAYS AND LIGHT RAILWAYS EXHIBITION AT THE AGRICULTURAL HALL.

(Concluded from page 85.)

The manufactures shown by Messrs. Hurst, Nelson, and Co., Limited, of Motherwell, included one of their maximum traction trucks (Fig 29). This truck is of all-British design and manufacture, and contains some special features. The driving wheels are 30in. diameter, and the trailers 20in. diameter on tread. The spring bolster is placed at 1ft. 6in. and the pivotal centre at 12in. from the centre of the driving wheels. The wheel base is 4ft., and the brake is of an entirely new form, being arranged so that the blocks can be adjusted by the driver whilst on route. A complete car was also shown of the firm's improved double-deck type, arranged to seat 57 passengers. This car has extended canopies, access to the roof being provided by wide staircases of the reversed type, while improved outside dry seats are fitted. The car was mounted on a standard "Hurst-Nelson" four-wheeled cantilever truck. One of the special features of this truck is that it is made of pressed steel plates, with a top stay of flat steel. The body-bearing springs are of the laminated elliptical type carried in pressed steel shoes. Spiral truck-bearing springs of the compound type are

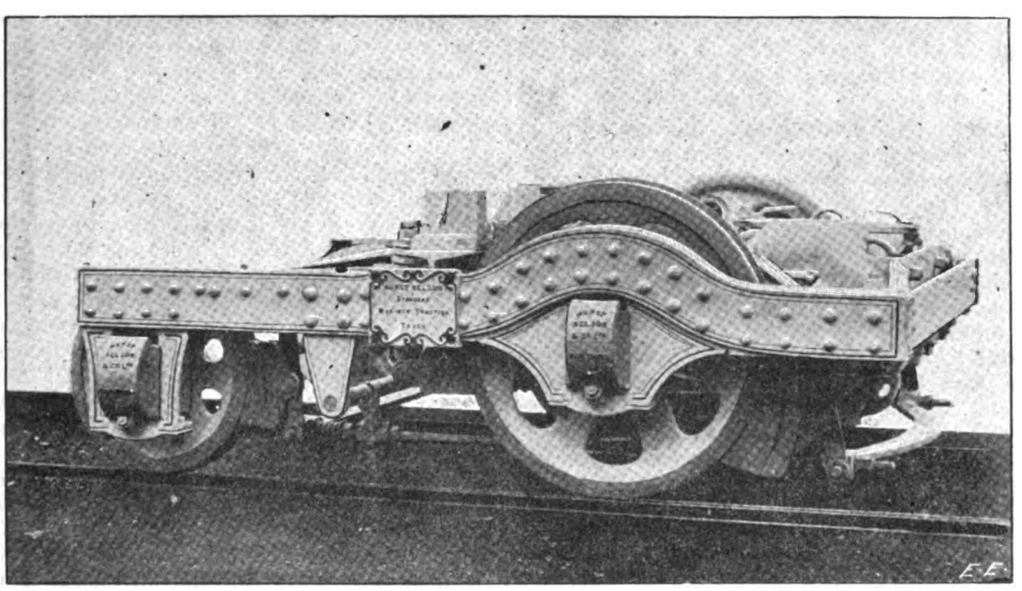

Fig. 29.—Hurst-Nelson Maximum Traction Truck.

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placed ever the axle boxes. Another special feature of this truck is the angle-steel diagonals for keeping it true and square. The motors are carried upon the usual spring suspension bars, and are geared direct to the axles. The axle boxes are of the roller-bearing type, specially adapted for use with collared journals. The wheels are 30in. diameter on tread, and the wheel base is 6ft. Lightness combined with strength are claimed for the design. It may be added that the workmanship of the "Hurst-Nelson" exhibits was uniformly excellent.

THE STURTEVANT ENGINEERING COMPANY, LIMITED, 147, Queen Victoria-street, London, had a varied and interesting exhibit of their well-known motor-starting and speed-regulating rheostats, etc. Included in the exhibit were four of the firm's C.H. self-starting rheostats, ranging from 3 h.p. to 10 h.p., by the use of which motors can be started and stopped automatically from a distance. Some automatic pressure regulators, suitable for use in connection with the self-starting rheostats when these are to be installed in connection with pumps maintaining a pressure of air, water, or gas in a receiver, were also shown. We also noticed a Sturtevant C.H. motor-starting and field-regulating rheostat of 10 b.h.p. 220 volts, designed to enable the motor to be started up properly, and the speed to be increased considerably above normal, and at the same time to prevent the possibility of the motor being started with a weak field. In connection with rheostats for special purposes, it may be mentioned that the firm are supplying a multiple solenoid pump-starting rheostat, which is automatically controlled by means of a float-switch, thereby enabling a practically constant level of water to be maintained in the tank to which the pump is delivering. Various types of the firm's blowing and exhausting fans, both electrically and steam driven, added to the attractiveness of this exhibit. On the same stand, but distinct from the Sturtevant exhibit, the Crosby Steam Gauge and Valve Company, of 147, Queen Victoria-street, London, were showing a collection of indicators and other of their steam specialities. Special mention may be made of a set of five indicators, coupled together electrically, showing how diagrams can be taken on five indicators simultaneously by operating one indicator only. The new reducing gear recently introduced by the Crosby Company was also shown. This reducing gear is attached directly on to the indicator cock below the indicator, provision being made for adapting the apparatus to strokes from 10in. up to 72in. by means of a nest of aluminium pulleys, which are attached in a convenient form to the main spindle of the reducing gear. The spring which provides for the return stroke of the drum is of the spiral type. It is claimed that in practice this apparatus has been found to be absolutely reliable and easy to fix and adjust. Something new in pressure gauges was also shown. The Crosby improved pressure gauge is fitted with two Bourdon tubes, an arrangement which allows of stouter tubes and fittings being used. The Bourdon tubes are attached to the gauge by means of screwed joints, no solder or brazing material being used. The base casting to which the tubes are screwed is carried up to the centre of the gauge, and supports the quadrant and levers. This gauge has been found to be very suitable for high-pressure steam, and especially in positions where the gauge is subjected to a great deal of vibration, as even under the most trying conditions vibration of the needle is practically non-existent. Chapman fullway gate valves were also well represented, samples being shown of valves for pressures from 60lb. to 250lb. Two fine valves, 8in. diameter, fitted with by-pass, were included in the exhibit.

Messrs. KELVIN AND JAMES WHITE, LIMITED, exhibited the latest types of Lord Kelvin's patent electrical instruments. Included in the exhibit were ammeters, voltmeters, and wattmeters both of the indicating, recording, and portable types, besides numerous testing sets for the measurement of insulation resistance and conductivity. An examination of these instruments disclosed the fact that various improvements have lately been introduced into their design, so as to render them suitable for modern requirements. The construction of the firm's recording instruments is particularly noticeable, on account of the increased facilities provided for reducing labour in connection with the changing of the charts. When the clock is moved to change the chart, the winding of the clock for the next record is done automatically, the clock being, moreover, so arranged as to make it impossible to overwind. A receptacle is also provided in each instrument for storing the used charts. Electrostatic voltmeters were shown provided with 6in. and 10in. scales—certainly a great improvement Samples of the firm's moving-coil or siphon recorder ammeters and voltmeters for use on traction and lighting boards were also shown, these being of three different types and six different sizes. Altogether 50 different types of instruments were shown, each instrument being suited for some particular requirement. Messrs. Kelvin and White are also making a speciality of switchgear, and a number of photographs of switchboards supplied by the firm to all parts of the world added considerably to the interest of their exhibit. Needless almost to say, the samples of the firm's circuit breakers and switchgear, which completed their exhibit, were of the same high-class finish as their instruments.

Messrs. EVERETT, EDGCUMBE, AND CO., 151 and 152, Great Saffron-hill, Holborn-circus, London, E.C., displayed some of their specialities, among which was a recording ammeter specially designed for use on tramcars. This recorder is carried on buffers, which protect the working parts from the excessive vibration to which they are subjected in working. The instrument is thoroughly damped, and a special arrangement is provided by means of which the chart speed can be varied at will from about $\frac{1}{2}$in. per minute to 4in. per minute. Another instrument exhibited by the firm was a new rotary synchroniser. This synchroniser, which was shown in operation, consists essentially of a two-phase rotary field motor, the stator of which is fed from the 'bus bars and the rotor from the machine to be paralleled, the split phase being produced by means of a choking coil. If the incoming machine is running too fast, the hand will revolve to the left, and if too slow, to the right. The correct speed, or rather frequency, is shown by the hand remaining at rest, and the precise moment for switching in is shown by the hand standing vertically and opposite a mark on the dial. Thus absolute accuracy is possible, and, moreover, in order to enable the engine driver to see from a distance what is going on, a green or a red lamp is shown through holes in the dial, according to whether the alternator is running too fast or too slow. An ordinary synchronising lamp surmounts the whole instrument, which is very compact, having a dial some 8in. or 10in. in diameter. The instrument performs three distinct functions: (1) it shows whether the incoming machine is running too fast or too slow; (2) by how much it is out of step; (3) the exact moment for switching in without any chance of error. It is claimed that with the aid of this synchroniser a novice can parallel even the largest machines with absolute safety. The firm were also showing an instrument which they have just introduced as an adjunct to their well-known lamp tester, in the form of a small direct-reading photometer set. The complete outfit, with the exception of the standard lamp, is only about the size of an ordinary cigar case, and it is claimed that extremely accurate results can be obtained even in an ordinary room with the blinds down. The photometer itself consists of a carefully-designed "Leeson disc," which is moved along a graduated scale ingeniously slung between the standard lamp and the lamp to be tested. In order to avoid the somewhat tedious calculations always necessary in photometric measurements, a direct-reading scale has been devised, and is included in the set by means of which not only the candle-power, but also the efficiency in watts per candle-power can be obtained at once. A novel type of cell-testing voltmeter was also shown. The case of this voltmeter measures only 5in. by 4$\frac{1}{2}$in. by 2$\frac{1}{2}$in., and yet it gives a scale of $\frac{1}{8}$in. for every twentieth-volt division. The scale reads from 1·5 to 3 volts, and by means of a small commutator at the top of the instrument it will always read in the right direction, no matter to which terminals of the cell it may be connected. An indicator on the commutator also shows which is the positive terminal of the cell, so that it can be used also as a pole

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indicator. Numerous other instruments, etc., were included in this interesting exhibit.

HOW THE ELECTRIC TRAMWAY SCHEME IN JOHANNESBURG FELL THROUGH.

From its first inception as a city until about two years before the war Johannesburg had been content to depend on its service of horse tramcars as a means of transit from one part of the city to the other. Time is not of the first importance in Africa, and whether a man arrived at his destination in 15 or 50 minutes did not matter so very much after all. So Johannesburg drifted along. Then some new arrivals appeared on the scene. These were men imbued with all the American and European ideas. In their eyes this waste of time appeared as little less than sinful, and they set to work to remedy matters. They decided to establish an electric tramway service. A committee journeyed to Pretoria, and interviewed President Kruger and the members of the First Raad. They were successful in their mission. The President regarded the idea favourably, and what the President regarded with favourable eyes, in the expressive language of the West, "went." That is to say, it did so as a rule. But in the present case the exception which proves the rule was to occur. A couple of the members of the Raad did not fall in with the ideas of the President and the majority. They were wise men, and they said little; but that night, when the business of the day was over, they passed in writing letters to the various field cornets in the country districts. Several of these letters were made public later on. They were simple epistles. They merely stated that the Government was contemplating entering into an agreement with some foreign capitalists to allow them (the capitalists) to establish electric tramways. The immediate effect of this would be that the horse tramways would be discontinued The after effect would be that all horse traction would be superseded by electric. And what are you going to do for a market for your forage then? With this question the letter concluded. The field cornets did not waste time in trying to answer this question. They simply sent round to their neighbours calling mass meetings together. I have heard how many meetings were held during the next few days, but my memory fails me as to the exact number. It was, however, something considerable. The result was the same everywhere. The people rose *en masse*. Each district put itself into communication with its nearest neighbours. On an arranged day 4,000 men marched on to Pretoria. They camped outside the capital, and a small detachment of some 200 rode up Church-street to interview the President. They found Mr. Kruger in his accustomed seat on the stoep, and without any unnecessary circumlocution explained the object of their visit. The President tried to temporise, but the people would not have it. "There must be no electric tramways," they said. "Must!" thundered the old man. "Must," repeated the crowd. The President looked hard at the people, and the look he saw in their faces gave him pause. "Well, I will see what I can do," he said, and the people went away satisfied, for they knew that they had gained their point.

TUBE BILLS IN PARLIAMENT.

SIR LEWIS McIVER'S COMMITTEE.

The Bills providing for the construction of underground tubular railways in the Metropolis which have survived the enquiries of the Select Committees of the House of Lords over which Lord Windsor and Lord Ribblesdale presided, came before two committees of the House of Commons on Thursday last week. The first committee has for its chairman Sir Lewis McIver, the other members being Mr. G. Montagu, Mr. Emmott, and Mr. G. Whiteley, and to this committee were referred three of the Bills—viz., the Brompton and Piccadilly-circus (New Lines); the Piccadilly, City, and North-East London; and the London United Electric Railways. The first Bill considered by the committee was the Brompton and Piccadilly-circus, for which Sir Ralph Littler, K.C., was leading counsel. The Duke of Devonshire, the Duke of Wellington (the treasurer of St. George's Hospital), and the Council of the city of Westminster petitioned against any alterations being made in the Bill as it left Lord Windsor's Committee. The other petitioners included the promoters of the London United and the Piccadilly and City Railways and the London County Council.

Mr. Balfour Browne, K.C., for the other two Bills in the group, explained at the outset that the only place where the Brompton and Piccadilly-circus line was likely to affect the lines mentioned in the other two Bills which had combined would be from Piccadilly-circus to about Leicester-square, where they would both run through the same street. There was lots of room for both, and he only wanted to see that the Piccadilly-circus Railway line was not put in such a position as to block his line. Therefore he did not then propose to use the *locus standi* they had obtained against the Brompton and Piccadilly-circus Bill.

Sir R. Littler said they had been put to enormous expense in preparing to meet the opposition of the combined railways, and, having regard to the unreasonable and vexatious course they had adopted, he should, when the proper time came, ask the committee to mulct them in some part of this expense. Describing the objects of the Bill, he said that the line was authorised in 1897, and in 1899 Parliament extended the time for the purchase of the land and for the construction. That extension expired, in the case of the land, in August of this year, and for works in August of 1904. The line could be completed within that time by a process of working day and night. He hoped, however, that the committee would not throw that additional expense upon them, but would grant the additional extension of time they were seeking under this Bill. The company were also asking for power to construct, at a cost of £400,000, a short line from their Piccadilly-circus termination on to Holborn, where it would join up with the authorised Great Northern and Strand Railway, thus giving a through route from the south-west to the north-east. It had been suggested in the recent debate in the House of Commons that there was no money behind their proposals, and that the lines would not be constructed. As a matter of fact, Mr. Perks, chairman of the District Railway Company, with his English friends, and Mr. Yerkes, with his American friends, had formed a company with a capital of £5,000,000 for the completion of various lines. Of that capital £1,600,000 was actually paid up, £400,000 would be due in a week or two, and the remainder was at command whenever it was required. Messrs. Speyer and Co., a financial house of large commercial experience and power in the City, had bound themselves to provide this capital as it was required on the terms of 5 per cent. in shares of the company at par and 1 per cent. in cash. As to the suggestion that the Brompton line was merely a "block" line, he would point out that the whole of the contracts had been let to responsible contractors, two shafts had been sunk at Brompton, the station was being constructed, and work was proceeding east and west along the line where the railway was to be made; and by Monday he hoped to be in a position to tell the committee that they had served the whole of the notices to treat for all the land they required under their old Bill. The generating station at Chelsea, which would cost £1,000,000, was in course of erection. With regard to fares, at present they retained the old-fashioned schedule of so much per mile.

The **Chairman** said it would be convenient to have a statement showing the capital and estimates for the Brompton and Piccadilly-circus, the Great Northern and Strand, the Baker-street and Waterloo Railways, and the proposed new line to Holborn, so that they might see how it was proposed to spend the money over these various undertakings. **Sir R. Littler** promised that such a statement should be prepared, and the committee adjourned.

FRIDAY, JULY 25.

The committee resumed consideration of the Brompton and Piccadilly-circus Bill.

Sir James Szlumper, engineer to the railway, said the new piece of line on to Holborn would be about three-quarters of a mile long. When the Brompton and Piccadilly-circus Railway was thus linked up with the Great Northern and Strand Railway there would be through communication from Finsbury Park to Earl's Court. At Earl's Court a connection was formed with all the western suburbs of London which were in communication with the District Railway, including Richmond, Fulham, Putney, Wimbledon, Hounslow, and so on. The estimate for the Holborn line, including land, was £511,199. There was also an item of £49,900 for subways. He repudiated the suggestion that the Brompton Railway was merely a "block" line. His instructions were to go on with the works as fast as he could, and, as a matter of fact, he had sunk two permanent shafts at Knightsbridge to a depth of 65ft. each. He was now driving the tunnel along the road for the purposes of the railway. He had to sink 12 more shafts for six stations, for the sites of which all the notices to treat had been served.

In reply to counsel for the London County Council, the witness declined to assent to the Council having power over the hoardings the company might think it proper to erect during the sinking of their shafts and the construction of their stations. Whatever control was given should be in the hands of the municipality concerned, and not of the County Council. The witness further said the new line was entirely in the London clay and not in gravel. His estimate of construction was £40 per yard forward for the railway and £150 per yard forward for the stations.

The **Chairman** said he would like to have the average cost per yard worked out and a comparison of that cost made with the tube railways that had been already constructed.

Sir R. Littler, K.C., promised that that should be done.

Sir Hugh Owen, late permanent secretary to the Local Government Board, and now Chairman of Commissioners under the Local Government Act of 1899, expressed the opinion that the new line would be of the greatest possible advantage to the residents in the northern part of London served by the Great Northern Railway who desired to reach the City and the west as far as Hammersmith.

Mr. Grinling, chief traffic manager of the Great Northern Railway Company, said his directors strongly supported the scheme.

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Mr. Alexander Ross, engineer to the Great Northern Railway and the Great Northern and Strand Railway, also spoke of the convenience of the new line.

Mr. Perks, M.P., chairman of the District Railway Company, denied that he was supporting this scheme as a "block" line so as to prevent any other tube railway from being made in this direction. That was an absolute falsehood from beginning to end. He expected the railway would bring a very large business to the District Railway from the north and the west of London, and so long as his policy was followed his company would support the undertaking in every way. The real causes for the delay in the construction of the Brompton and Piccadilly line were, first, the absence at the beginning of any physical connection with the District Railway; secondly, the fact that the District Railway Company had got no money at all to spare; and, thirdly, that people would not invest in these tube railways until they had seen the financial results of the Central London Railway.

The committee adjourned.

MONDAY, JULY 28.

Mr. Perks, M.P., continued his evidence in support of the Brompton and Piccadilly-circus (New Lines) Bill. In reply to Sir R. Littler he said it had been suggested that there was a controlling power over the District Railway by Mr. Yerkes and his section of their allies. As a matter of fact, the Underground Electric Traction Company, of which Mr. Yerkes was the chairman, owned less than 10 per cent. of the District Railway Company's nominal capital of over £9,000,000. Out of that 10 per cent. less than two-fifths were held in America. Of the £5,000,000 capital of the Traction Company, he thought he was correct in saying that less than £2,000,000 were held in America. In answer to further questions, Mr. Perks said that originally the power-house at Chelsea was estimated to cost about £800,000. As a matter of fact it would cost £1,250,000, due mostly to the enlargement of the works so as to provide power not only for the District, but for the Brompton and Piccadilly-circus, the Baker-street and Waterloo, and the Great Northern and Strand Railways. The District Company were under an agreement to pay a rental of 5 per cent. upon half the total outlay, and the other half of the capital would be provided by the other companies taking power. The capital powers of the Brompton and Piccadilly-circus Railway Company, including the £1,900,000 sought in the present Bill, were £3,233,000. The estimates amounted to £3,056,934, and this, after deducting £70,000 which could not be issued owing to the payment of interest out of capital to the extent of £220,000, left a margin of £106,000 to cover claims for vibration and other contingencies. He was afraid that under the vibration clause which had been put upon them by Lord Windsor's Committee a great many fancy claims would be manufactured. In these circumstances he did not think that £106,000 was too large a margin. Mr. Perks then dealt with figures in relation to the schemes under his control, and stated that the total capital of the four authorised lines was about £15,000,000; and of this the whole was obtainable, and £5,000,000 was obtained.

The **Chairman** asked if there was any precedent for Parliament sanctioning 6 per cent. on the capital of a company for under-writing?

Mr. Perks replied that Parliament had often sanctioned a great deal more, and instanced the case of the District Railway.

Mr. C. T. Yerkes, chairman of the Underground Electric Traction Company, stated that no promotion money had been paid in the acquisition of these companies. In one case they purchased the property at considerably less than one-half. The fares on all the railways would be as low as was consistent with making them pay. He had no doubt in his own mind that a 2d. fare was the best fare that could be charged both on the tube railways and on the District line. In America, on some of the lines, they were carrying passengers for about 12 miles for 2½d. In the tubes the trains would consist of two motor carriages and four trail cars, and on the District three motor carriages and four trail cars. The stations would be entirely fireproof, and the signalling would be automatic. The tunnels would be lighted throughout with an installation quite independent of that for the train. In consequence of improvements they had made in the laying of the permanent way and the character of the rails, he did not fear the vibration clause at all, if people were only honest about it. The average speed would be from 15 to 16 miles an hour. The Traction Company would operate all these allied companies, and would guarantee the shareholders 4 per cent. on the capital. Over and above the 4 per cent. they would also give to the shareholders one-half of whatever profit was made. He believed that in this way they would make it very much easier for the bankers to finance the companies. Besides, their guarantee made it more sure that the money would be raised. That agreement was a private one, and was not scheduled to the Bill.

That is not a binding agreement. Where will the profit on the £5,000,000 come in?—We expect to make a profit on operating the District Railway, on the shares we own in the District Company, and on operating these four different lines.

Mr. Emmott asked if it was intended to ask the public to take up any portion of these £15,000,000? The witness said that would be a matter entirely for Messrs. Speyer and Co. The Traction Company had nothing whatever to do with that.

The **Chairman** said the committee had instructions from the House of Commons to have regard not only to the interests of the public so far as the construction of these lines was concerned, but also as to the future fate of the railways, and, though they did not constitute themselves an investors' protection society, they would like to have some further information with regard to this agreement.

Mr. Yerkes said that as far as he was concerned, though he had not consulted their legal advisers, he would be willing to have the matter put in any shape the committee might wish so as to make the agreement binding on the Traction Company.

The committee adjourned.

WEDNESDAY, JULY 30.

On the committee resuming their deliberations, a short discussion took place with reference to procedure, as a result of which it was decided to postpone consideration of the other two Bills in the group—*i.e.*, the London United Electric Railways Bill and the Piccadilly, City, and North-East London Railways Bill—to the autumn session. Consideration of the Brompton and Piccadilly scheme was then continued.

Sir R. Littler announced that he had concluded the evidence he desired to call, and proceeded to address the committee on the clause dealing with the leasing of the undertaking to the Underground Electric Railways Company, in return for the guarantee of 4 per cent. given by the latter company to the shareholders in the Brompton and Piccadilly-circus Railway. In the Bill as it stood that leasing was optional, and he now introduced words to make it compulsory, as follows: "The company shall lease their undertaking to the Underground Electric Railways Company of London, Limited, and the last-mentioned company shall take on lease or work the same upon a rent or upon a guarantee of dividend of not less than 4 per cent. per annum on the amount of the debenture and share capital of the company; but such power of leasing shall not be exercisable until a certificate has been obtained from the Board of Trade that the company have paid up one-half of the capital authorised to be raised by the company's Acts of 1897 and 1899, and have expended for the purpose of such Acts a sum equal thereto, and the traction companies have paid up one-half of their share capital." The promoters had an actual contract for the construction of the Brompton and Piccadilly, the authorised portion, absolutely in hand; in the case of the Baker-street and Waterloo the works were rapidly approaching completion; and with regard to the others, the moment they obtained the Royal assent contracts as to them would become valid. The following letter from Messrs. Speyer Bros. crystallised the whole of the arrangements into one single document. It was addressed to Mr. Yerkes, as chairman of the Underground and District Railways Company: "With reference to our ability to provide the capital necessary for the building of the Brompton and Piccadilly-circus, the Great Northern and Strand, the Baker-street and Waterloo, and the Charing Cross, Euston, and Hampstead Railways, we beg to submit the following, which is in accordance with the arrangements we came to before the Bills were before the House of Lords. The Underground Electric Railways Company of London, Limited, which has entered into contracts to build the above-mentioned railways, was formed under our auspices with a capital of five millions, the whole of which has been subscribed at par by substantial persons well known to us. Thirty per cent. has been paid up in cash, and 10 per cent. is due on Aug. 18 next, the balance being available at any time required. Parliament is asked to give powers to issue altogether in respect of these four undertakings £3,844,000 of debentures and £11,536,000 of ordinary stock, or a total capital of £15,380,000. We have no hesitation in saying that with these two capitals at our command we and our associates undertake to raise all the money necessary to complete the lines under discussion." The learned counsel was therefore of opinion that everything had been done to make the position of the companies, humanly speaking, absolutely secure.

Mr. Roskill, on behalf of the Traction Company, put in resolutions agreeing to the new clause suggested by Sir R. Littler, and undertaking to promote a Bill next session for placing on the Baker-street and Waterloo and the Charing Cross, Euston, and Hampstead Railways the same obligation as that imposed on the Brompton and Piccadilly-circus Railway Company.

Mr. Edgar Speyer, senior partner in the firm of Messrs. Speyer Bros., said that he and his associates were ready to undertake to furnish the money necessary to build and equip these four tube railways. The £5,000,000 which was available at any time was really a reserve for contingencies. His firm and their associates contemplated taking up and "placing" the whole of the stock and debentures of all these undertakings. The £15,000,000 capital required would be obtained from the public on the guarantee of 4 per cent.

By Mr. Emmott: The whole of the £5,000,000, with the exception of, perhaps, £500,000 or £600,000, would be available for the purposes of their guarantee.

Sir R. Littler intimated that that concluded the case on the preamble of the Bill.

The **Chairman,** after the committee had consulted in private, said they desired that the following clause should be inserted in the Bill: "If, within 12 months from the passing of this Act the company shall have failed to substantially commence the construction of their railway, and such failure shall be due to any cause within the control of the company, the powers of the company under or as extended by this Act shall, at the expiration of that period, cease and determine, and the certificate of the Board of Trade as to whether or not the said railway has been substantially commenced, or any failure to commence the same has been due to a cause within the control of the company, shall be final and binding."

Sir R. Littler said they had not the slightest objection to such a clause.

The **Chairman**: Under those circumstances the committee find the preamble of the Bill proved.

The committee adjourned.

MR. SEALE-HAYNE'S COMMITTEE.

Mr. Seale-Hayne presided over the second committee, and the other members were Mr. Tennant, Sir J. Stirling-Maxwell, and Mr. J. Lowe. The Bills included in this group were the Great Northern and City, the North-West London, the Charing Cross, Euston, and Hampstead Nos. 1 and 3, and the Charing Cross, Euston, and Hampstead No. 2.

Proceeding with the Great Northern and City Railway first,

Mr. Moon, K.C., explained that the purpose of the Bill was to

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extend a tube railway from Finsbury-pavement to Lothbury. The railway authorised in 1892 was promoted to afford relief for the congestion of traffic at King's Cross from the northern suburban districts. It was one of the early tube proposals, and did not then command public confidence. In 1898 a strong and influential Board was formed with Sir C. Scotter as chairman, and then the capital was raised, and the construction of the line was now almost complete. In conjunction with the company, the Great Northern Company would construct the link between Finsbury Park and Drayton-park, and passengers by means of a lift would obtain access to the tube line which would convey them to the City. The new Board concluded that the proposed terminus of the shuttle line was not rightly placed, and the main object of the Bill was to obtain power to extend the line to a terminus at Lothbury near the Bank. Other objects were an extension of time for completion, the construction of an additional station at Highbury, and the acquisition of land for a generating station near Essex-road, but to these subsidiary objects there was no opposition. In the construction of the Great Northern and City line a diameter of 15ft. was allowed for the tunnel, so that there was ample room for ballast and the provision of a permanent way to check vibration, while the trains would be run by the multiple-motor system, motors being distributed over the whole length of the train. But, if vibration should be set up, landowners would be protected by a clause providing compensation for injury caused by the working of the line. The only opposition came from the Corporation of London, who, in a petition of 31 clauses, raised a variety of objections.

Sir C. Scotter, chairman of the company, said the whole of the capital had been raised, and the *bonâ fide* nature of the scheme was well understood. He expressed much surprise at the claim of the City Corporation for compensation for subsoil and street surface for station access. The Bill followed the precedent of the Central London Act. There was not the slightest intention to close the Finsbury-pavement Station.

Sir H. Oakley, director of the Great Northern Railway and chairman of the Central London Company, agreed that the proposed line would meet a long-felt necessity.

Mr. Bartley, M.P., and **Mr. Claude Hay, M.P.**, gave evidence strongly in favour of the extension proposed.

Mr. L. R. Vigers, land agent and surveyor, who prepared the estimates, said that he was valuer for the Central London Company, and that the payment of 1s. a foot run made to the Corporation was not in respect to the whole of Cheapside, but in respect to the ownership of the Bridge House Estate. It was not in accordance with precedent, and was contrary to the recommendation of the Parliamentary Committee that payment should be made for subsoil under streets, neither was it usual to pay compensation for the space used for exits.

Sir Douglas Fox, C.B., gave various engineering details, and expressed the readiness of the promoters to do anything reasonable at the new station to meet the views of the Corporation.

This closed the case for the promoters.

Mr. A. C. Morton, member of the Corporation, said the opinion of the Streets Committee was that the proposed extension was unnecessary; that, in fact, it would be a useless expenditure of money. If, however, the extension were sanctioned, the City would advance a claim for the use of the subsoil and for the surface area taken from the public.

Mr. Painter, another representative of the Corporation, and **Mr. Ross**, engineer, having given evidence in a similar direction,

The **Chairman** expressed a hope that by conference the parties might arrive at a settlement of their differences, and

The committee adjourned.

FRIDAY, JULY 25.

The committee resumed consideration of the Great Northern and City Railway Bill.

Sir R. Littler, K.C., for the Corporation of London, argued that as the streets in the City were the property of the Corporation, and as the promoters were going to interfere with the use of those streets at and near Lothbury for the purpose of their construction on the "cut and cover" principle, they should pay compensation for the inconvenience they caused to owners.

Mr. Acworth, for the promoters, said that as regards surface the promoters were at one with the opposition, and understood that where they took permanent occupation of a portion of the street they should be prepared to pay for it.

Sir R. Littler said that was not clear in the Bill, and not sufficient. When the promoters came to the surface, cutting it up and obstructing the traffic, they should pay compensation to the owners.

Mr. Vesey Knox, for the Corporation, wished to know whether there was any intention to pay.

The **Chairman** said it was evident that was not the intention.

Mr. Acworth said they would not if they could help it; but the Corporation, if they had a good claim, could enforce it.

The **Chairman** said, if it was clear that no right would be interfered with, he could not understand what they were fighting about.

After hearing further argument, the committee decided that the preamble of the Bill was proved.

In going through the clauses,

Sir R. Littler argued for the addition to Clause 4 of the words, "Nothing in this section shall authorise the company to take lands, if any, vested in the Corporation within 30ft. of the surface, without paying compensation under the Lands Clauses Act."

This, after consultation, the committee rejected, and the remaining clauses were adjusted.

The Charing Cross, Euston, and Hampstead Railway Bill was taken next.

Mr. Freeman, K.C., described the objects of the Bill as an extension of the authorised line to Golder's Hill from Hampstead, where it would make an end-on connection with the Hampstead and Edgware line; an extension of the Kentish Town branch to Highgate; and the substitution of a line down Villiers-street instead of Craven-street for giving connection with the District Railway. The promoters bound themselves absolutely not to put any shafts or openings on Hampstead Heath, and at a depth of 200ft. no injury could be caused to the heath. The London County Council and the Hampstead Council were quite satisfied on this point.

Evidence was then given on engineering points by **Mr. Galbraith, C.E.**, and **Sir A. Binnie**, and both gave it as their opinion that by the system proposed for constructing the tunnel, and by the depth of the tunnel in the London clay, no injury could be done to the heath.

Evidence was given against the Bill by **Mr. Holmes**, acting-secretary of the Metropolitan Gardens Association, on the ground of the risk of damage to vegetation from the draining of the subsoil, but the committee ultimately declared the preamble of the Bill proved.

The committee adjourned.

MONDAY, JULY 28.

The committee concluded their labours with the adjustment of the clauses of the two Charing Cross, Euston, and Hampstead Railway Bills.

Considerable discussion took place upon the opposition of the London County Council to the proposed site for the terminal station opposite the South-Eastern Company's station in the Strand. It was represented by **Mr. Talbot, K.C.**, who appeared for the Council, that the effect of the proposal in the Bill being sanctioned would be that the Strand would at that point be permanently 67ft. wide, while it was the desire of the Council and the Corporation of Westminster that the width should be 80ft.

Mr. A. Young, valuer for the London County Council, also gave evidence in support of the objection. While admitting that to refuse the proposed site would inconvenience the promoters, he remarked that that was merely a question of engineering, and the general public convenience was of primary importance.

Mr. Balfour Browne, K.C., as representing the Piccadilly and City Railway Company, said it was after coming to an arrangement with the promoters for a joint station that his company withdrew their opposition, but if the space were to be thrown into the street the joint station would be impossible or difficult to construct.

The **Chairman** said the opinion of the committee was that the 80ft. width of the Strand should be preserved.

Mr. Balfour Browne said this decision would not affect his company or the promoters so long as only the surface was taken for widening, leaving the underground for station purposes.

Clauses were subsequently arranged to carry out this proposal.

The other clauses were adjusted, and the Bill was ordered to be reported to the House.

The North-West London Bill did not come before the committee, opposition to it having been withdrawn.

UNOPPOSED BILLS.

The Baker-street and Waterloo Railway Bill and the North-West London Railway Bill were before Mr. Jeffreys on Monday as unopposed Bills. In each case the proposal was for an extension of time for three years. The first-mentioned line will connect the points mentioned in the title, and the North-West London line will run from the Marble Arch to Cricklewood under the Edgware-road, connecting with the Central London line. Formal proofs having been submitted, the Bills will be reported to the House of Commons for third reading.

Charing Cross and Hampstead Line.

Mr. Seale-Hayne's Committee, in reporting on Group II. of the Bills, states that they consolidated Charing Cross, Euston and Hampstead Railway (No. 1 and 3) Bill, and the Charing Cross, Euston, and Hampstead Railway (No. 2) Bill, into the Charing Cross, Euston, and Hampstead Railway Bill. The report continues: "That in accordance with the instruction of the House of July 18 the committee had enquired whether the railway proposed to be authorised by the Bill would seriously injure Hampstead Heath, under which it is to pass. Evidence had been adduced before the committee by the promoters, and also on behalf of persons apprehending injury to the heath, and the committee were fully satisfied that the railway would be constructed at such a depth and in such a manner that all risk of tapping the wells, draining the soil, or destroying the verdure would be obviated, and provision had been made in the Bill, as submitted to the committee, prohibiting the promoters from interfering with any part of the surface of the heath, and the committee were of opinion that the powers sought by the Bill in relation to the said railway should be allowed." The document also states: "That the report from the Board of Agriculture with reference to the proposed utilisation of portions of the subsoil between Whitehall Pond and Hampstead Heath had also been referred to committee, but, as already stated, it was proved to the committee that no injury would be caused to the surface of the said common or commonable lands. That by the Bill it is proposed to authorise the payment of interest out of capital during the construction of the railway, and it was proved to the committee that the power to pay interest would facilitate the raising of the capital authorised by the Bill, and the committee, having found that the restrictions contained in the Bill are in accordance with Standing Order 167, recommended that the payment of interest not exceeding 3 per cent., as proposed by the Bill, should be allowed."

Electric Lighting Regulations.—We understand that Mr. A. P. Trotter, the electrical adviser to the Board of Trade, has arranged to hold an informal conference in the autumn with reference to the electric lighting regulations, and that a number of gentlemen have been invited to attend as representatives of the electrical profession.

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CONTENTS.

Notes	145	British Electric Traction Company's Staff Dinner	164
The Arc Works, Chelmsford	150	Questions and Answers	164
Underground Cable Laying	152	West Ham Accounts	167
The Bristol Tramways Electrical Installation	155	Brighton Accounts	168
Tramways and Light Railways Exhibition at the Agricultural Hall	157	Legal Intelligence	168
How the Electric Tramway Scheme in Johannesburg Fell Through	159	Companies' Meetings and Reports	169
Tube Bills in Parliament	159	Appointments Vacant	171
The Birmingham Art Gallery Lighting	162	Contracts for Electrical Supplies	171
Wireless Telegraphy and Daily Papers	162	Lighting Notes	173
"Poisoned Arrows"	163	Traction Notes	175
Forthcoming Events	164	Provisional Patents, 1902	179
		Specifications Accepted	179
		Traffic Returns	180
		Companies' Stock and Share List	180

TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE BIRMINGHAM ART GALLERY LIGHTING.

In the lighting of a picture gallery it is of the utmost importance that the by-products which are given off by the source of light shall not injure the works of art contained in the gallery. As a rule, it is the sulphur compounds which have to be feared with the gas lighting, and these are apt to cause rapid changes in the lead oxides of the pigments. In order to ascertain how far the systems of arc lighting and incandescent gas lighting at the Birmingham art galleries were likely to harm the pictures, the committee consulted Prof. Percy Franklin, of the Birmingham University. His report, which we have before us, is well worthy of the attention of electrical engineers. In the beginning of the report he states that "the principal point to be ascertained, therefore, was whether the shafts passing straight through the roof of the gallery, and opening below with a large funnel-shaped aperture immediately over the incandescent gas burners, were adapted to immediately remove the products of combustion, and so prevent their circulation through the gallery." All the analyses were, therefore, made to find the carbonic acid present in the air in the gallery at various times of the day. The professor concludes that the above system of ventilation over the gas burners is satisfactory, and that in consequence the gas also ventilates the building. He finds that with the arc lamp illumination, the increase in the percentage of carbonic acid is distinctly more marked than is the slight increase in the percentage of carbonic acid due to the visitors in the gallery. All the figures of the test are given, and also others carried out by the professor in the chemical lecture theatre of his university. A few extracts from these figures will be of interest Air taken from the roof of the university buildings contained on three different days the following percentage volumes respectively of carbonic acid: ·053, ·041, and ·047. The chemical lecture theatre atmosphere after being used for several hours contained ·086 volume, and one hour and three quarters' use of eight incandescent gas burners and seven Bunsens raised the proportion up to ·184 volume, which shows what gas burners can do in the way of vitiating the atmosphere. In the picture gallery, on the other hand, the mean percentage volume on April 16 at about 10.20 a.m. was ·049, and the arc lighting, together with the visitors, only increased this percentage volume up to ·052 by 3 p.m. A somewhat larger increase in the same time was noted on April 23, when there was no artificial illuminant used at all. With the incandescent gas on April 17 the percentage volume of carbonic acid was ·054 at 10 a.m., which was reduced to ·048 at 3 p.m. There is no doubt that ventilators over the arc lamps would make them quite innocuous, but the general conclusion from our point of view is that the incandescent electric lamp is much the safer illuminant where valuable works of art are concerned. The figures from the university chemical lecture theatre clearly show how much damage would be done by the incandescent gas if the ventilators became blocked in any way.

WIRELESS TELEGRAPHY AND DAILY PAPERS.

"We have been informed," says the *Westminster Gazette* of July 26, and the information thus given has been copied broadcast by local dailies throughout the kingdom. Now, we have to ask, who is the informant, what is the value of the information, and what steps the responsible editor of the *Westminster Gazette* took to ascertain the information to be correct and trustworthy as well as unbiassed? So far as we can read, the outcome of the information is to prepare

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the general public for the promotion—or the absorption of promoter's subscription—of a company with a capital of £175,000. The *Westminster Gazette* further on speaks of "the amazing promises of the catalogue." Again we ask, what have promises in a catalogue to do with patronage by a daily paper? The investing public ought to demand the experienced, unbiassed opinion of technical experts as given by the technical Press, and not be led to entrust their money to companies which may or may not have something to work which is of great value. At the present moment the investing public runs with a fashion, if not a mania, to speculate in almost everything which promises high dividends. *Bonâ fide* industrial concerns get little patronage, except from among the people who know them intimately and are satisfied with a moderate return upon their capital. The technical Press is absolutely impotent for good in this direction so long as the daily papers lend their columns to the insertion of sensational accounts whose sole merit of accuracy depends on the "we have been informed." The greater part of the column which our contemporary devotes to the information received is more fitted for the columns of a penny dreadful devoted to conundrums, than to the pages of a paper which claims a position in the realms of accuracy and lucidity. Fancy a paper desiring to educate its readers printing such sentences as "it is declared on their behalf," without first ascertaining the accuracy of such declaration. The ordinary reader will not distinguish between the "we have been informed" and the "it is declared on their behalf" and the real belief of those responsible for the contents of the paper; but the whole thing in the course of two or three quotations and condensations will become the paper says "So-and-so," no matter how wonderful that "So-and-so" may be, or how skilfully the editorial pen has shirked real responsibility in the "we are informed."

"POISONED ARROWS."

I trust readers will kindly forgive one more note upon what may seem a personal question, but which in reality has far-reaching consequences. After some three weeks' cogitation the editor-agent has again put pen to paper and replied to my statement of July 4. I really do not know why I should give further attention to this small fry, but it is just as well to burst his bubble. Frogs, according to the fable, do not well to attempt becoming too big. Let me say here and at once that on this question newspaper controversy does not suit my book. I shall emphasise my previous statements and ask the editor-agent to argue his position before one of his Majesty's judges. His reply to mine of July 4 is extremely feeble; he gives himself irretrievably away, and admits to the full all I have said. The editor-agent is clever—too clever. Does he imagine that there is any necessity for me to advertise his name or his paper, or to answer his remarks in every paper with which I am connected? Does it make my remarks less to the point because they are made here, not there? However, I will tell him why I prefer this column It is because the major part of his quotations relate to this paper, and hence demand defence here, and not elsewhere. He makes seven quotations: (1) from a letter of his to me; (2) from a letter of mine supporting the action of the manager of the *Contract Journal*; (3) from a reply to that letter; (4) part of a letter from the *Electrical Engineer*; (5) part of reply to same; (6) part of further letter from *Electrical Engineer*; (7) part of reply to same. I admit responsibility for all letters and statements. Pray, Mr. Editor-Agent, do not stay your hand because my answer to you is not in a particular column of a particular paper.

My accusation is that you are not a *bonâ fide* advertising agent; that for an editor of a reputedly respectable paper to act as an advertising agent leads to everything bad, to nothing honest, to illicit commissions, to blackmailing, to collusive action detrimental to the people most concerned, to biassed and degrading journalism. Your admissions are astounding, and absolutely fatal to your contention and to your so-called agency. I hope you will support them in a court of law—as by doing that, and by that only, is the only way I can determine how far those who employed you understand their and your positions. You admit: (1) Your establishment of an agency dates only from February last. (2) That it is only a transmitting agency, "to distribute every advertisement received among the papers *named by the sender*" (the italics are yours). (3) For being permitted to do this you pay the authorities 2½ per cent. (4) Hoping to recoup yourself with a 10 per cent. commission from the papers. (5) Some papers do not give you any commission, yet you pay 2½ per cent. for doing the work. Good of you, isn't it? You only mention one, and that in a peculiar connection, but I fancy I can name others, and again others who will not recognise you at all, and again others who deal with you in exactly the same manner as any other man who comes to the counter. Your admission shows conclusively you are not recognised as an advertising agent. (6) That you are concerned with loans, analyses, registry for officers, provision of stores, dispatch of legal replies by post (really if you go on you will emulate the Army and Navy Stores or Whiteley in your extensive business projects). Surely you ought to take a course of lessons in the economics of business, and put your crude explanation differently, otherwise your readers will wonder about the correctness of that explanation! The one paper named paid you no commission, you paid 2½ per cent. out of your own pocket to be allowed to do this business. Cannot you read the moral? Your three columns of reply are full of these contemptible admissions, and it is difficult to conceive how any man outside a lunatic asylum fails to see their force, yet you seem unable to do so—nay, rather seem to glory in them. My point is this: neither the clerk who employs you, nor you, are doing the work intended to be done, and the result is, ignorantly or otherwise, a defrauding of those most concerned—the ratepayers. Who are you, or the clerk who employs you to do a little clerical work, that you should dictate where an advertisement is or is not to go? You are merely a transmitter, but in collusion with the clerk you determine an exclusion. The clerk who has received his instructions on the authority of the expert employed by his employers to do certain things, and fails to do them because you are not recognised as his go-between, is a man absolutely unfaithful to his trust and unworthy of his position. He is paid to do services which he relegates to others, and is ten thousand times more to blame than you, whose sole object is to mulct somebody of so much commission. The combined action savours of collusion to defraud, and if you do not think so, fight it out at law, and satisfy a good many interested in this matter. I will tell you I am partly a mouthpiece, although writing my earnest convictions, and all who agree with me will heartily welcome a chance to thrash this matter out to the bitter end. You say, "Every man must live." That doctrine I earnestly and emphatically deny. It is better for the world if some men be absent from it, and it would be still better if others quitted participation in its affairs. I have done with you in newspaper controversy. Your system, in my opinion, leads to fraud, to dishonesty, and everything condemnable, without a single saving feature.

C. H. W. Biggs.

P.S.—My attention has been specially directed to the peculiar manner in which my editor-agent friend has introduced his controversy with me. In both instances he has commenced his article with comments on a subject with which I have no connection nor knowledge. He infers some chicanery about an application for an official position. Personally, I do not believe or think anyone will attribute his remarks as concerning myself or our controversy, but careless readers have done so, which shows the necessity of not mixing matters—which is almost as dangerous as mixing drinks.—C. H. W. B.

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FORTHCOMING EVENTS.

WEDNESDAY, AUG. 6.

Sanitary Inspectors' Association.—Autumn meeting at Middlesbrough. The meeting closes on Aug. 8.

SATURDAY, AUG. 9.

Institution of Junior Engineers.—Summer meeting at Blackpool.

The following fixtures for meetings have also been made:

Sanitary Institute.—Sept. 9-13, congress, Manchester. Sept. 9-27, health exhibition.

Waterworks Engineers.—Winter meeting, December, London.

Iron and Steel Institute.—Sept. 2-6, Dusseldorf.

Institution of Civil Engineers.—Birmingham students' visit: Sept. 25, Crewe.

British Association.—Meeting at Belfast commences Sept. 10.

BRITISH ELECTRIC TRACTION COMPANY'S STAFF DINNER.

The annual staff dinner of the British Electric Traction Company and associated companies was given at the Criterion Restaurant, Piccadilly-circus, on Friday, July 25 The guests, to the number of about 250, assembled in the Grand Hall. It could not help but occur to one that if the staff of the parent and associated companies continue to increase at the present rate, it will be difficult a few years hence to find suitable accommodation for this annual event. Mr. Emile Garcke (managing director) occupied the chair. The evening's entertainment proved most enjoyable, an excellent programme of music and songs having been arranged to give life to the proceedings. For the most part, the after-dinner speeches were in themselves of an exceptionally entertaining nature.

The CHAIRMAN having proposed "The King," Mr. SYDNEY MORSE then proposed "The Houses of Parliament," which toast was responded to by Lord VAUX OF HARROWDEN, Sir ERNEST SPENCER, M.P., and Mr. L. A. ATHERLEY-JONES, K.C., M.P., the two latter speakers making witty contributions, as was expected of them.

Next in order came the toast of the evening—namely, "The British Electric Traction Company"—which was proposed by the Chairman, and responded to by Sir Charles Rivers Wilson, G.C.M.G., C.B. In proposing this toast, Mr. EMILE GARCKE said that many important schemes proposed by the company had received confirmation since Sir Charles Rivers Wilson had addressed their last meeting. A controlling interest in the Birmingham electric tramways had been obtained. He touched briefly upon the company's amalgamation with the Brush Electrical Engineering Company, and suggested in regard to the latter concern's departure in the matter of motorcar construction that the ultimate object they had in view was to work all automobiles by electricity. Continuing, he remarked that the shareholders and debenture holders in the parent and associated companies now numbered 16,000. They had confidence in what they were doing, and faith in the unlimited sphere and scope of electricity. There was still much to be done in the application of electricity. The ordinary mind was not equal to its potentialities. With regard to company promotion, this had been practically imposed upon them by Parliament and the Board of Trade. They were, however, something more than company promoters, and he felt personally that he had done some service to mankind. Arrangements had been entered into with more than 200 local authorities in the United Kingdom. About three millions sterling had been expended in carrying out schemes. The total traffic receipts of all their companies had reached 1½ millions sterling per annum, and they now had an annual passenger traffic equal to the total population of the country multiplied by eight. Their employés numbered not less than 10,000. These figures implied success, but nothing failed so easily as success. One failure would do them more harm than 99 successes; they must, therefore, strive to avoid failure by good organisation, efficiency, and economy in working.

Sir CHARLES RIVERS WILSON, in responding, dwelt upon the continued prosperity of the company's undertakings. He thought that Mr. Garcke's spirit and personality permeated the entire staff of the company.

The last toast on the programme—that of "Our Visitors"—was proposed by Mr. STEPHEN SELLON, and responded to by the Hon. ROBERT P. PORTER.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

503. Why should it make any difference which way a continuous current should be sent through a "Nernst" lamp filament? The instructions sent out with each lamp by the makers, state they *must* be connected up according to the correct polarity as marked on the terminals.—O. F. F.

504. Is there a satisfactory electrical method of softening hard-steel plates to enable same to be drilled and machined?—H. F. N.

ANSWERS.

Question No. 497.—In fixing a system of electric signals for pit and tank work, wires to be carried down rather wet shaft 500 yards deep, five sets of give and return signals and one telephone are required. The signals, one set are required give and return from pit bottom to banksman, the others from dips to surface give and return. What system of wiring would you adopt—multiple cable or single wires? Would you use iron pipes to run wires in, also would you use pipes for return, or one common wire? Give sketches of connections.

Best Answer to No. 497 (*awarded* 10*s.*).—*Re* the extra information respecting Question 497, it completely alters the thing altogether from the last question. I would advise "497" to employ a multiple cable armoured with 10 No. 20 S.W.G. wire inside, to be used as follows: two for shaft signals, three for each dip engine, two for telephone—total, 10. Suspend this cable on wooden cleats

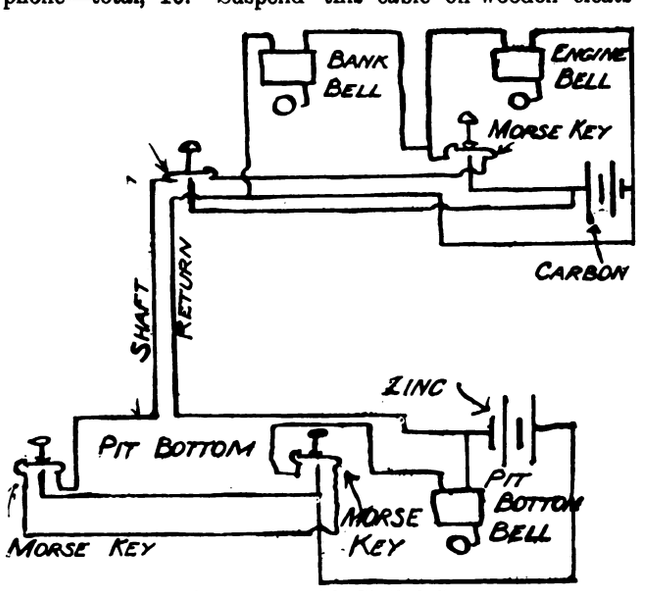

FIG. 1.—Arrangement for Pit Shaft Signals.

(as per sketch) every 20 yards, putting it in the driest and most protected place in the shaft. You must get two junction boxes one for top of pit, one for bottom—these to be water-tight. Place them in the most convenient place for leading cable into at top and bottom of pit. Use 6in. trembling bell of good make, watertight Morse keys, Leclanché cells, No. 12 galvanised iron wire for dip placed

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on porcelain insulators, and bound with No. 20 copper wire. In the dip I would advise you to use small brass connectors (as per sketch) to couple No. 12 iron wire together, as you will find they are very convenient to

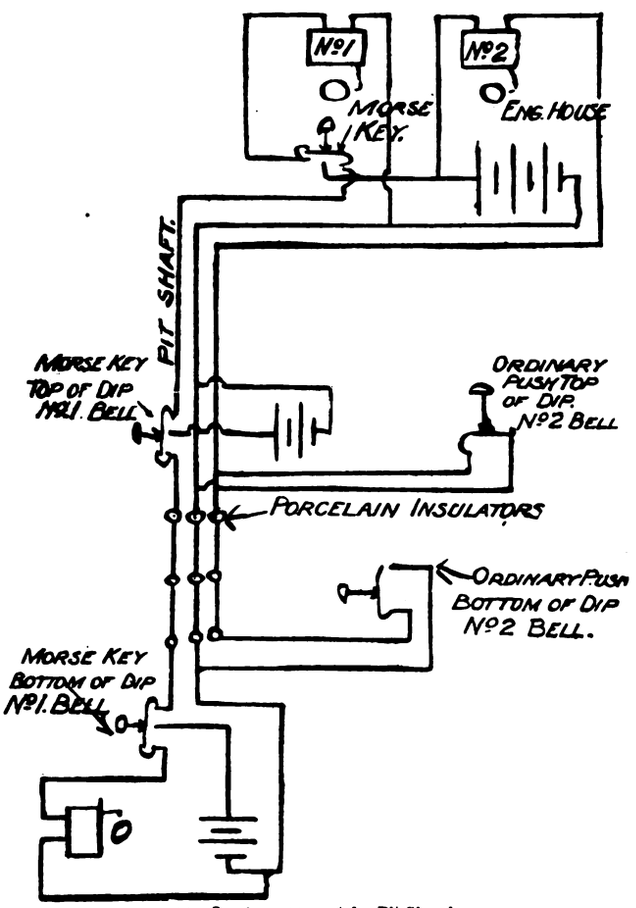


FIG. 2.—Arrangement for Pit Signals.

disconnect wires when dip requires timbering. Place them 40 yards apart. *Re* sketches of signals (Fig. 1), I think this arrangement will meet your requirements. You will see that when engineman or banksmen knock down to hook on at pit bottom it cuts out both engineman's and

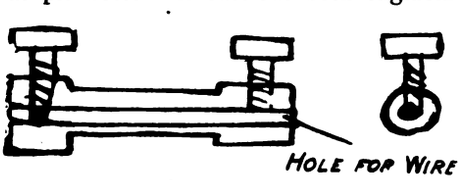


FIG. 3.—Brass Connector.

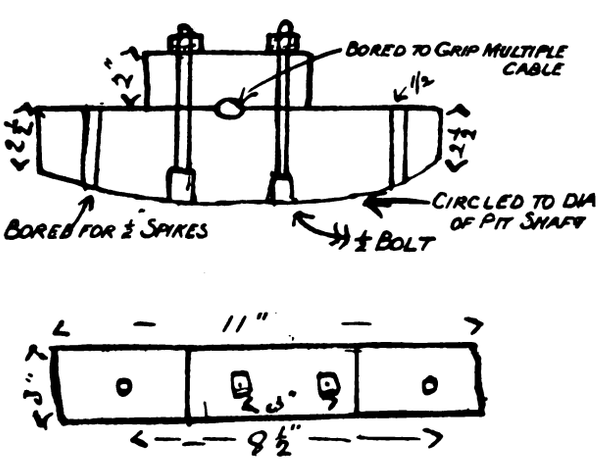
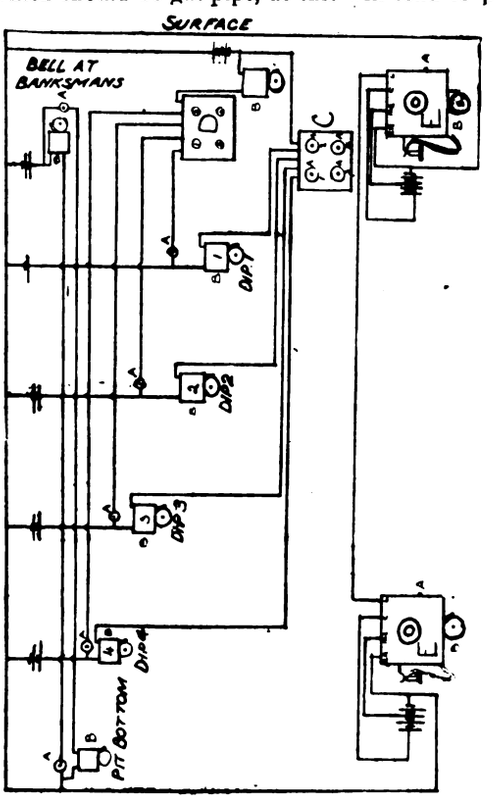


FIG. 4.—Details of Wooden Cleat for Multiple Signal Cables.

banksmen's bells, only ringing one at bottom. Also by the arrangement, if the banksmen's bell fails from any cause, it will not interfere with the engineman's bell working, as they are not coupled directly in series. Put about eight cells at top and bottom for these signals in dustproof box. At pit bottom I have shown two Morse keys, one on each side of pit. If this bottom is very wet, put the wire leading to pushes in pipes; it will pay you Also put sheet-iron covers over pushes to keep wet off. Under no consideration must you use earth for return; it is not reliable for pitwork.

I think the arrangement shown in Fig. 2 will also meet your requirements. You will see by sketch that three wires are used, and that there are two up signals and one return. You will see that engineman cuts his own bell out as usual; also you will see I have put a Morse key at top of dip, arranged to knock to engineman without ringing bell at bottom of dip. This is for No 1 bell. You will also see a single-way push at top of dip for No 2 bell, but this bell can be rung anywhere in dip by making contact with two bottom wires. If these dips are being driven down, it will mean shifting down of battery and bell I should advise you to put in an ordinary pull bell from where electric finish, until you have got down, say, 100 yards; then remove electric down. It will only mean a boy to be stationed where electric wires finish. Fig. 3 is a brass connector for joining wires in dip (advantage claimed). Unskilled workman can make good joint. Fig. 4 is a wooden cleat for suspending cable in shaft to be spiked to wood curb.—S. H. LEE.

Answer to No. 497 *(awarded* 7*s.* 6*d.*)—I should not advocate the use of multiple cable, because, as the shaft is wet, this would probably also get wet, and, if so, would short-circuit the wires more or less, which would affect the efficient working of the system, especially that of the telephone. This being so, single wires are preferable to multiple cable. As to the use of iron pipes to run wires in, these would be quite suitable if all the joints be made watertight with red lead or some such substance. Importance must be made of this point of the watertight joints, as if moisture gets in the pipes, it will stay there and rot all the insulation off the wires. Another point in favour of single wires is that there are less likely to be induction effects in the wires than in the multiple cable, but I should advise a good quality of insulated wire, say, something like ordinary electric light wire $^1/_{18}$ or $^1/_{20}$. Though considerably more costly, it would be better to run each wire in a separate pipe, which should be gas-pipe, as this will tend to prevent



induction effects, and there will be far less chance of short-circuits. I think one common return wire for the lot to be far preferable to using a pipe for return, as there will be considerably less chance of short-circuits. Another point in favour of running separate wires in separate tubes is that it will greatly facilitate testing operations any time

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anything goes wrong, as each circuit can be tested separately. If, however, separate wires be not run in separate pipes, put the wires for each circuit together in one tube, as this would help in any testing.

The diagram appended gives a sketch of the necessary connections, where A stands for a bell-push; B stands for a bell; C is a four-way switch block at surface; D is a four-way indicator at surface; E is a telephone. This is, I think, the most economical system it could be wired on with respect to material used, and should prove very efficient. It is necessary for the telephone circuit to have two batteries of its own, one at each station. With respect to the battery for the system of bells, it is not possible to have this all in one place at the surface, as the number of cells which would ring bell at and from dip No. 1 would not do so at dip No. 4. Hence I have put a main battery at the surface common to all the bells, and have put in series with this at each dip, or at the banksman in his bell, the number of cells it is necessary to make that particular bell ring properly. With this little explanation I think the diagram will be perfectly clear. I think the best job of all would be made if lead-covered insulated wire were used. In this case multiple cable could be used, but better single wires on account of induction. Could the whole wiring be done bare on small porcelain insulators, which should also make a good job of it?—E. R. ALEXANDER.

Answer to No. 497 (*awarded* 5*s.*).—Local requirements and conditions will, of course, determine the merits of any proposed system of wiring. For most arrangements, and especially damp places, a metallic circuit throughout is best practice. It is much more reliable to run two common battery wires throughout rather than use one single wire and the pipes, with their innumerable joints, as return. Unless the pipes suggested are made for the purpose, abrasion of the insulation might result in pulling the wires through. Considering the dampness of the shaft, "D. E. J." will do well to use the usual steel tubing now so commonly used for lighting work. It is easily fixed, and will maintain the insulation better than ordinary piping. Fig. 1

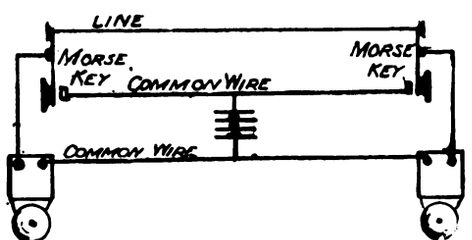


FIG. 1.

shows one common method of signalling either way, and would serve for signalling from pit bottom to banksman. The same arrangement would serve from dips to surface by simply tapping each point from the three wires, but as this involves code signallings, confusion might arise by one of the places mistaking the number of rings and accepting them for its own. Perhaps the best arrangement would be as shown in Fig. 2. Here each dip circuit terminates at

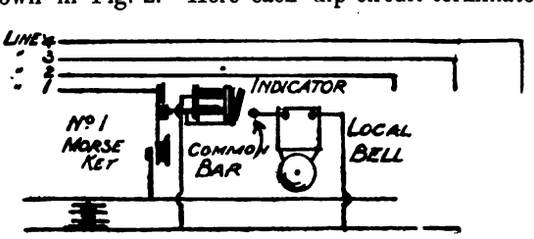
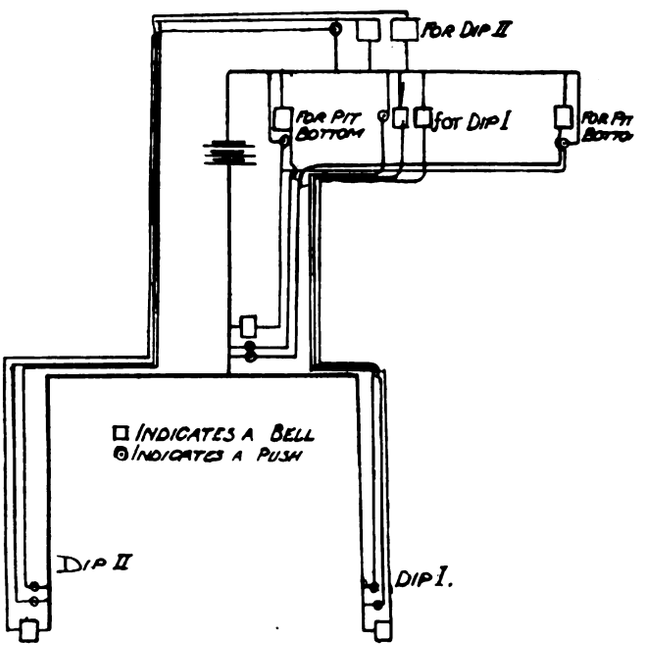


FIG. 2.

the surface on a Morse key spring, which rests normally against the upper contact, which is connected to one side of an indicator, the other side being joined to battery. The actuation of the armature releases the shutter, which falls against a common bar joined to a local bell. The shutter (which is attached to the line side of the indicator) in falling thus shunts the local bell on to the line and causes an audible signal to be made. Since the ringing of the bell depends upon the cleanliness of the contacts between the shutters and bar, this apparatus should be glass-cased and dustproof, with mechanical shutter replacement added. The telephone circuit should be metallic; the same battery can be used for signalling, but a separate battery at each end must be provided for the speaking.—T. R.

Answer to No. 497 (*awarded* 5*s.*).—The sketch indicates the run of the wiring. As far as I can see—10 wires only being used—no great advantage will accrue from using



multiple cable, except that for the same strength of insulation (as in the case of single wires) the wire will not take up as much room if in the form of multiple cable as if in the form of single wire. The telephone wiring is not shown. The wires and battery for the telephone should be kept separate from the signal system. It will be better far, if the shaft is at all wet, to make a good job of the installation from the first, as no end of trouble may be caused if "earths" put in an appearance afterwards. Therefore, I should recommend screwed tubing, with the sockets white and red leaded. All joints, too, should be very carefully insulated. It is at the joints that damp has the most effect. If necessary, seeing that the pit is so deep, relays could be placed in each circuit. If great battery power is needed to ring the bells through this distance, it would be better to instal relays and use small battery power, as a high-voltage battery would produce sparks, which, I presume, must be eliminated as far as possible. I should recommend "D. E. J." to see the *Electrical Engineer* "Questions and Answers" columns for the past week or two if he wishes to put down any special devices for interrupting sparking.—T. T.

Question No. 498.—With a series motor of about 50 h.p., run at 500 volts, 1,000 revolutions per minute, being used for winding at colliery, in case of signal being given to stop when running at full speed, is it safe or advisable to reverse and put the current against it while the motor is still running for the purpose of stopping it? If not, why not, and what is the danger?

Best Answer to No. 498 (*awarded* 10*s.*).—Such an action would be disastrous not only to the motor, but probably also to the generator supplying it. The usual method of reversing a series motor consists in crossing the connections to the armature, thus reversing the direction of the current in the armature whilst leaving that in the field unchanged. The immediate effect of this, if done whilst the motor is still running, is to cause the supply volts and the armature back volts to act in unison, instead of opposition, round the circuit. Consequently an enormous current is set up, which is only partially checked by the self-induction of the series winding. This large current would cause violent sparking at the motor commutator, and a flash over from the positive to the negative brushes would be sure to occur. It is the danger of this flashing over which makes it impossible to stop a large motor suddenly in the way described, for, should it occur, the arc may easily continue until the brush gear is burnt away and the commutator seriously damaged. This flash over at the motor at the

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same time forms a short-circuit across the supply generator, and may cause that in turn to flash over.

Though a sudden complete reversal of the current through the motor armature is not permissible, it is quite possible and safe to set up a sufficient backward torque to pull the motor up in a few seconds by simply disconnecting it from the mains, reversing the connections of the

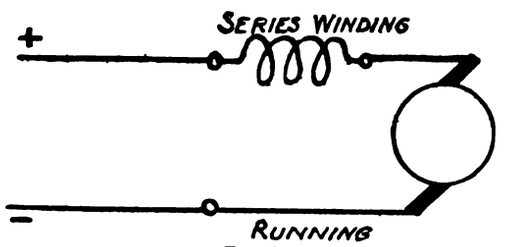

FIG. 1

armature to the series winding, and then short-circuiting the machine through a resistance (Figs. 1 and 2). This enables the machine to act as a series generator and produce a powerful braking action. If the amount of resistance is correctly chosen, the current need never exceed the normal full-load value, and there will be no sparking at the brushes. This method of braking is largely used in

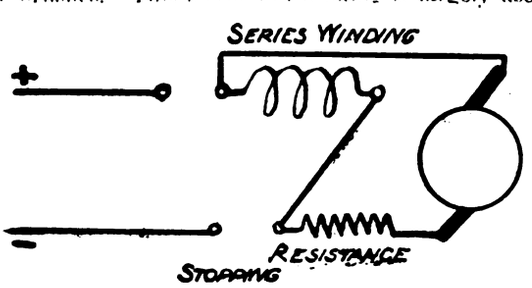

FIG. 2.

connection with traction and other motors requiring to be brought to a standstill quickly.—Q

Answer to No. 498 (*awarded* 7*s.* 6*d.*).—There are two reasons why it would be inadvisable to stop a series wound motor of the size stated by putting the current against it. From Lenz's law we know self-induction will prolong a dying current and retard an increasing current, and that if any circuit be suddenly opened there will be a sharp spark due to the effects of self-induction. Now, the E.M.F. of the self-induced current will depend upon the value of the current flowing, the number of spirals in the circuit, and whether the spirals enclose a magnetic material In the case in point we are dealing with a large current, probably some 85 amperes; a large number of spirals, which may amount to 1,500 or more; while at the same the spirals are wound round a highly magnetic soft-iron core. Under these circumstances the self-induction will be very great, and may result in the induced current having a difference of potential of several thousands of volts; hence there would be a bad flash when the current was broken, which would seriously injure the commutator, and also the insulation of the series turns would probably be pierced through by the excessive E.M.F. The starting switch would also be badly burnt, and the contacts would require to be replaced.

A further objection to this method of procedure is due to mechanical reasons. Full data as to the diameter and weight of the armature are not given, but for a 50-h.p. motor the weight must be considerable (say 12cwt.), and the diameter will not be less than 14in., hence the momentum of the moving armature will be very great, and if the current is suddenly reversed there will be a great jar, and a probability of the armature wires being torn out of their proper position.

Reversible series motors should be controlled by suitable starting switches, so arranged that it is impossible for the current to be suddenly reversed, while at the same time the motor should be filled with magnetic brakes which come into action as soon as the current is cut off. If good running is required, the switches should be so arranged that it requires a stipulated time, varying according to the size of the motor, for the switch lever to be moved from the on position in one direction to the on position in the opposite direction, while suitable arrangements should be inserted to absorb the induced current.

A short time ago the writer examined some reversible crane motors and controllers; there was no time device on the latter, the speed of the movement of the lever being at the option of the operator. It was evident that the method suggested by "G. H. O." had been more than once adopted, for although no burning out of the coils had taken place, the contacts of the controllers and the commutators of the motors were in a dreadful condition, being so badly burnt that it was impossible to work the plant longer until it was overhauled.—M.

Answer to No. 498 (*awarded* 5*s.*).—When a series motor as described is running on load, and it is necessary to bring it quickly to a dead stop, it is perfectly feasible to reverse the current through either armature or field magnets so as to tend to make it run the other way, only this must be done with care. The chief thing to observe is that the reverse current allowed to pass through the motor must be kept down to a small limit for several reasons. The sudden jar or pull due to the current might be so great as to twist the shaft and stain or even more seriously damage it; the keys and teeth of the gearing might come loose or snap off respectively, due to the same cause; the reverse current may become excessive and cause abnormal demands upon the source of supply, due to the following cause: when the motor is running normally, the back E.M.F. of the armature opposes the supply E.M.F., and only permits the requisite current to pass to supply the necessary torque, whereas when the current is reversed through the armature the back E.M.F. tends to assist the supply E.M.F. and to suck away current from the mains, consequently unless care be taken the motor might be seriously damaged by rush of current and supply cut-outs, etc., blown.

The writer finds in the course of his experience with series motors it is quite safe to reverse the current for a quick stop in a small degree; say, the controller put on the first contact for reverse current. As all the resistance is thus in circuit the current flowing is not abnormal, but is quite sufficient to make a decidedly quick stoppage of the motor without unduly straining the gearing. For any ordinary stoppages the writer finds that an ordinary electromagnetic brake (in which the current flowing through the motor also holds off two wood blocks from the face of a drum on the motor shaft, and releases them and puts on the brake as soon as current is switched off) is quite sufficient braking power, but in an emergency the reverse current forms a very effective means of obtaining a quick stop. Of course, such usage is rather hard lines on the motor, but the modern series motor built by firms of repute is quite able to stand the strain.—F. H.

WEST HAM ELECTRICITY ACCOUNTS.

From the accounts of the West Ham electric lighting department for the half-year ended March 31 it appears that the total expenditure on capital account amounts to £131,311. Abstracts of the accounts are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	6,224	18	11
Distribution of electricity	511	5	8
Public lamps	485	12	1
Special lamps (artisans' dwellings)	10	18	0
Rents, rates, and taxes	317	11	4
Establishment charges and management	933	14	10
Discounts, allowances, and bad debts	392	15	11
	8,876	16	9
Balance—gross profit for the half-year	5,311	0	8
	£14,187	17	5

Cr. Income.	£	s.	d.
Sale of current for public lighting	1,352	9	0
Private lighting and power	12,541	10	2
Special lighting—artisans' dwellings	38	1	11
Interest—hire-purchase and motors	41	3	11
Hire of motors	23	6	8
Miscellaneous charges—disconnecting meters, etc.	10	15	9
Wiring and fittings account	180	10	0
	£14,187	17	5

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BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Mortgages—Public Works Loan Board	94,774	17	0
Cash due to bankers	36,146	17	4
Sundry creditors	1,756	4	3
Excess of assets	9,805	0	11
	£142,482	19	6

Cr. Assets.	£	s.	d.
Capital outlay—amount expended	131,311	17	3
Sundry debtors for current supplied, etc.	8,297	18	4
Petty cash in hand	30	0	0
Plant and stores on hand	2,046	4	8
Motors (on hire)	796	19	3
	£142,482	19	6

BRIGHTON ELECTRICITY ACCOUNTS.

The accounts of the Brighton Corporation electricity department for the year ended March, 31, 1902, show a total expenditure on capital account of £404,858. Abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr. Generation of Electricity.				£	s.	d.
Coal or other fuel	£15,018	8	4			
Oil, waste, water, and stores	1,498	17	9			
Wages at generating station	5,561	12	10			
Repairs and maintenance	2,914	18	1			
				24,993	17	0
Distribution of Electricity.						
Wages and other remuneration	1,082	1	11			
Repairs, maintenance, etc., of mains	702	9	0			
Repairs, etc., of transformers, etc.	1,829	6	7			
Outlay for works executed	717	14	3			
Bedford-street store yard	300	16	9			
				4,632	8	6
Public Lamps.						
Street-lighting installations	2,851	18	9			
Attending and repairs	3,685	9	7			
				6,537	8	4
Rents, Rates, and Taxes.						
Income tax	110	18	0			
Rates	1,128	11	0			
				1,239	9	0
Management Expenses.						
Salaries—Engineer's department	3,014	14	8			
Accountant and collectors, etc.	375	0	0			
Stationery and printing	395	5	6			
Registrar of stock and stamp duty	335	3	4			
General establishment charges	338	12	7			
				4,458	16	1
Insurances and law expenses				161	4	11
Amount transferred to suspense account				250	0	0
Total expenditure				42,273	3	10
Amount carried to net revenue account				24,277	3	7
				£66,550	7	5

Cr.	£	s.	d.
Sale of current per meter	50,328	1	5
Public lamps	11,960	7	2
Service of tramways	1,799	6	10
Meter rents and sundries	2,462	12	0
	£66,550	7	5

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Redeemable stock	343,587	11	10
Debenture debt—balance	800	0	0
Premiums on stock, less discounts	14,760	10	4
Floating liabilities	26,324	5	8
Reserve fund	3,420	11	3
	388,892	19	1
Surplus account, less amounts written off	50,896	0	1
	£439,788	19	2

Cr. Assets.	£	s.	d.
Capital outlay—amount expended for works	400,361	18	8
Stores on hand	1,302	10	0
Floating assets	30,926	9	5
Investments	7,198	1	1
	£439,788	19	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			5,685,435
Quantity sold	Public lamps	809,350	
	Tramways	264,693	4,860,430
	Private consumers by meter	3,786,387	
Quantity used on works			360,066
Total quantity accounted for			5,220,496
Quantity not accounted for			464,939

Number of public lamps: 372 arcs, 1,259 incandescents.

LEGAL INTELLIGENCE.

A CASE FROM CANADA.

The case of the Corporation of Toronto *v.* the Bell Telephone Company of Canada, the Toronto Electric Light Company, and others, came before the Judicial Committee of the Privy Council on July 26, on the application of the Corporation of the city of Toronto for special leave to appeal from a decision of the Court of Appeal for the province of Ontario. The question raised was as to the principle on which the Corporation should assess the companies for taxes. The points involved in the case turned upon the true construction of Sections 7, 18, and 28 of the Revised Statutes of Ontario, c. 224, and Section 2 of the Statute of Ontario, 1 Edward VII., c. 29. The defendant companies appealed from the assessment of a Board composed of three county court judges, who reduced the assessment. From that decision the Corporation appealed to the Court of Appeal for the province of Ontario, who affirmed by a majority (one of the judges dissenting) the decision of the Board of county court judges. The amount of taxes involved in the four appeals together was 23,225dol.

The applications were dismissed, with costs.

ELECTRIC TRAMWAYS CONSTRUCTION COMPANY.

On Friday last Mr. Justice Buckley in the Chancery Division heard a motion on behalf of the defendant in the action of the Electric Tramways Construction and Maintenance Company, Limited, *v.* Rutterford asking that all proceedings might be stayed upon the terms of a certain agreement that had been entered into.

Mr. Buckmaster, K.C., for the defendant, said the action was brought against his client to obtain specific performance of the agreements relating to certain electrical undertakings. The case was before Mr. Justice Byrne on July 7, but terms were agreed between defendant and Mr. Harry Lawson and Mr. Osborne, who the defendant thought had power to act for the company. It was now denied that these gentlemen had any authority to bind the company. Mr. Harry Lawson was not a director and Mr. Osborne was merely secretary. The evidence was not such as would enable him to move the motion effectively, and he suggested that the motion should stand over till the trial, when he could cross-examine these gentlemen and ascertain whether the terms of the agreement were communicated to the company and were adopted. If he showed that that was the case the action would be stayed.

His Lordship ordered the motion to stand over till the trial.

ELECTRO-LAMP REGENERATING COMPANY.

Mr. Justice Buckley on Tuesday, sitting in the High Court, had before him the application of Messrs. Howard and Jones, creditors, for the winding-up of the above company. It was stated, however, that a scheme of reconstruction had been proposed, and nearly three-fourths of the shareholders, at a meeting on Friday last, approved it in principle. The scheme provided for further capital, and a sum was subscribed which was sufficient to cover the claims of creditors. Mr. Milne, the chairman, would give his personal undertaking to pay the creditors, and his Lordship ordered the petition to stand over for a week, to see if the undertaking were carried out.

MANCHESTER TRAMWAYS PURCHASE.

Mr. Justice Bigham, in the King's Bench on Monday, gave his reserved judgment in the case of the Manchester Carriage and Tramways Company *v.* the Corporation of Manchester, which arose, it will be remembered, out of the taking over by the local authorities of the company's undertaking. A case had been stated by the arbitrator, Sir Frederick Bramwell, who was appointed to assess the amount which the company were entitled to receive from the Corporation and various outside urban districts. The arbitrator found in favour of the company, and awarded them £496,068, but found alternatively that in the event of the contention of the authorities being correct they were only to pay £229,353. It was for the Court now to decide which of these sums was the right one.

Mr. Justice Bigham, in giving judgment, after discussing the legal bearing of the case, said the question at issue was whether the arbitrator in making his award, was bound to exclude from his consideration some part of the properties in question, by reason of the fact that, though the whole of such properties were used with the tramways now being acquired, they were also used for the purposes of the leased lines, which were not being acquired. In effect, the arbitrator found that all the depôts and plant were suitable to and used for every part of the system. That finding he could not disturb, nor would he disturb it if he could. He could understand that different circumstances might have justified a different finding; and he did not suppose, nor wish it to be thought, that the finding here was to be regarded as a precedent in other cases, where the considerations might be very different. The arbitrator, having arrived at this conclusion of fact, was of opinion that under the words of the statute he was bound to accede to the demand of the claimants. It seemed to him (the learned judge) that it would be a mistake in the circumstances of this case to say that because the property in question was suitable to and used for the purposes of the leased lines, it therefore could not be said to be suitable to and used for the purposes of the undertakings to be acquired under the award. The statute did not limit the property to be paid for to that which was exclusively used, or suitable only for the purposes in question; and it did not say that the property to be paid for should comprise

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"all." He was of opinion, therefore, that the first of Sir F. Bramwell's alternative awards was right, and that the claimants were entitled to be paid the sum found to be due on that footing—viz., £ 496,068. Judgment accordingly.

COMPANIES' MEETINGS AND REPORTS

CITY AND SOUTH LONDON RAILWAY.

The ordinary general meeting of the proprietors in this Company was held on Tuesday at the offices, Finsbury-pavement, Mr. C. G. Mott presiding.

In moving the adoption of the report (*vide* last issue), the **Chairman** said that he was glad to meet the shareholders under more satisfactory circumstances than they had ever met before. At last, in the past half-year, they had completed and solved the difficult problem of making the line a fairly profitable one to the shareholders. They proposed a dividend on the ordinary stock at the rate of 3 per cent. per annum. The net revenue for the half-year was £44,405, or at the rate of £88,810 per annum. This gave a return of 3·60 per cent. on the capital. A good deal of the capital, however, was raised at a discount, and, allowing £264,000 for that, the net cost of the line was £2,200,000, and £88,400 a year would be fully 4 per cent. on that account. The total increase in the receipts was £26,703, to earn which had cost them £7,860, leaving a net increase in the revenue of the past half-year of £18,848. The train miles run in the six months had been 618,470, showing an increase of 174,010, largely owing to the Islington extension, and the number of trains had also largely increased. The working expenses had been reduced from 52·36 per cent. a year ago to 44·74 per cent. The subways at the Bank and London Bridge had benefited them greatly in the interchange of traffic with the Central London and the Brighton Railways. The Bill for the extension to Euston, which was mainly in the public interest, was rejected by the Lords Committee, but it was proposed to reintroduce it next session.

Mr. C. G. Grenfell seconded the motion, which was carried unanimously.

METROPOLITAN DISTRICT RAILWAY.

A meeting of the preference stockholders of the above Company was held on Monday at the Cannon-street Hotel (Mr. R. W. Perks, M.P., in the chair) to consider a proposal made to the Board by the Underground Electric Railways of London.

Mr. Perks first alluded to the position of the 5 per cent. preference proprietors, whose stock, amounting at the present time to £1,500,000, was receiving no dividend. Having described the conditions under which this stock was issued in the year 1869 at a discount of £548,766, and to the vicissitudes through which the stock had passed, he pointed out that the interest on it rose from a ½ per cent. in 1873 to 5 per cent. in 1878, and said that it continued at the latter rate until 1882, when it again fell away, dropping to nil in 1899. From that year the rate of interest rose gradually until 1897, when 3⅛ per cent. was paid, but the dividend had now fallen again to nil. The Underground Electric Railways Company, with a subscribed capital of £5,000,000, would be willing, under certain conditions, to guarantee to the preference proprietors 1 per cent. for the first year, 2 per cent. for the second year, and thereafter 3 per cent. in perpetuity, the Underground Company taking any surplus interest that might be earned between the 3 per cent. and 5 per cent., and also having the right to vote in respect of the preference stocks so guaranteed. The offer, he said, was conditional upon three fourths of the shareholders assenting to the arrangement within the specified time.

After some slight discussion a committee, with power to add to their number, was appointed to confer with the directors and with the Underground Company on the proposition.

GLOBE TELEGRAPH AND TRUST.

The directors' report for the year ended June 18 states that the net revenue of the Company for the year, after deduction of expenses, amounts to £199,371, and makes with the balance of £1,102 brought forward a total of £200,473. From this amount there has been distributed the sum of £130,467 in interim dividends, leaving an available balance of £70,005. The directors now recommend the payment of a final dividend of 3s. per share on the preference shares and of 4s. 9d. per share on the ordinary shares, making, with previous distributions, a total dividend for the year of 6 per cent. on the preference and 5⅜ per cent. net (against 5¼ per cent. for the preceding year) on the ordinary shares, leaving a balance of £1,856 to be carried forward to the next account. The offices of the Company were removed on March 21 last from Winchester House, Old Broad-street, to Electra House, Moorgate, London, E.C. During the year the directors have issued, at a premium, 300 ordinary and 485 preference shares of the Company, being part of the issue authorised by special resolution of May 11, 1875; the proceeds have been, as usual, invested in telegraph securities. For the general convenience it is proposed that in future the annual meetings of shareholders be held in the month of May, when the directors' report and the accounts for the year ended April 30 will be presented. The next accounts will, therefore, cover a period of about nine months only.

The ordinary general meeting of the shareholders of this Company was held on Wednesday at River Plate House, Finlbury-circus, E.C., the Marquis of Tweeddale, K.T., presiding.

The **Chairman**, in moving the adoption of the report, stated he thought the position it disclosed was satisfactory. While their dividends had been not only maintained, but increased during the last two or three years, the market value of the shares had, on the other hand, suffered somewhat severely, due almost entirely to the threatened competition of wireless telegraphy. On that point he had nothing to add to the remarks which had already fallen from his colleague, Sir John Wolfe Barry, in public on more than one occasion—that while wireless telegraphy would probably prove a very considerable use for certain purposes and within certain limits, he did not think it would interfere with the system of submarine telegraphy, and certainly would not supersede it. The entire Board held this opinion, which, however, only time could prove. It was, moreover, a matter for comment that telegraph manufacturing companies were never more active than at present; cables were being manufactured for home and foreign governments, evidencing the fact that no apprehension was felt in these quarters as to the competition it was supposed would be met with from wireless telegraphy, the progress of which new system has been very slow.

Sir James Pender seconded the motion, which was carried *nem. con.*

DIRECT UNITED STATES CABLE.

The general meeting of the shareholders in this Company was held on Tuesday at Winchester House, Old Broad-street, under the presidency of Mr. E. M. Underdown, K.C.

The **Chairman**, in moving the adoption of the report, which appeared in our last issue, stated that the revenue for the six months ended the 30th ult., after deducting out-payments, amounted to £46,610, while the working and other expenses, including income tax, absorbed £21,516, leaving a balance of £25,094 as net profit, making, with £3,350 brought forward from the previous half-year, a total of £28,444. This has been appropriated as follows: interim dividend of 3s. a share to March 31, £9,106; proposed final dividend of 3s. a share to the 30th ult., together with a bonus of 1s. a share, £12,142; transferred to reserve fund, £5,000; leaving to be carried forward, £2,196. The revenue showed a decrease of £4,039, as compared with that of the corresponding period of last year, owing to the additional cables now in operation. With reference to the question of wireless telegraphy, the greatest authority on the subject—Lord Kelvin—was strongly of opinion that, however valuable wireless telegraphy might be for certain purposes, it could not affect the transmission of messages over great distances through cables.

Sir James Pender, Bart., seconded the motion, which was carried unanimously.

CROMPTON AND CO.

The annual general meeting of the shareholders in this Company was held at Salisbury House, London-wall, on Wednesday, Mr. John Trotter presiding.

In moving the adoption of the report and accounts (which appeared in last week's issue), the **Chairman** said the real reason for the falling off in the profits was easily explained, although the remedy was not quite so simple. Trading and administration expenses had risen, but not abnormally. The gross profits had decreased owing to competition prices. At one period during the year there was a falling off in the demand for electrical appliances. This caused many manufacturers to seek at all hazards to keep up their output in order to diminish the proportion of establishment expenses. The consequence was a fall in prices. Had this been all, the shareholders would not have had so much to grumble at, but during the year the Company had met with a kind of competition to which they had not been so much accustomed. There had been a great deal of speculation in new enterprises in the electrical world, and some people were willing to put things on the market at prices which could not be remunerative. Such a policy could only be temporary. The self-denial of the shareholders in the past had put the Company in a comfortable position to meet that class of competition. There had been a great demand for workmen expert in electrical matters, and the effect, so far as the Company was concerned, was a rise both in the salaries of officials and in the wages paid to workmen. This increase had nullified a good number of economies which the Board had been able to effect. One of the results of the severe competition was that the Company had to do a great deal more work to get orders; and, in the circumstances, it was satisfactory to find that the ratio of expenses to sales had not gone higher than it was last year. The directors had set their faces against taking anything in the shape of paper for work that had cost solid sovereigns, so that they found themselves, to a certain extent, cut off from that class of work, because it meant taking a large interest and subsequently "unloading." He considered that in the long run such a method could only be disastrous to those who adopted it. The slight diminution in the volume of business had, to a certain extent, passed away, and orders were coming in more freely. Years ago the Board set themselves the task of removing the whole of the manufacturing business to the new premises, which were equipped with the best possible machinery, and of putting the balance-sheet in order. These changes had now been effected.

Lieut.-Colonel R. E. B. Crompton, in seconding the motion, stated that prices again showed an upward tendency.

The motion was adopted unanimously.

DUBLIN UNITED TRAMWAYS.

The half-yearly meeting of the shareholders in this Company was held in Dublin on Tuesday, Mr. W. M. Murphy presiding.

The **Chairman**, in moving the adoption of the report, said the

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position and prospects of the concern were satisfactory. The feature in the report was the increase in the dividend on the ordinary shares from 4 per cent. to 5 per cent. per annum. There was an increase of £5,120 in the gross revenues, and the net result was that there was £45,220 available, against £39,820 this time last year. The Company carried 22½ million passengers in the half-year, being an increase of nearly a million, at an average per head of 1·21d. The local rates and wayleaves, amounting together to £15,609 in the half-year, were on a larger scale than in any city in the United Kingdom. The report was adopted. A motion advocating the establishment of an eight hours' day for the motormen and conductors was ruled out of order.

BARCELONA TRAMWAYS.

An extraordinary general meeting of the above Company is to be held on Wednesday, Aug. 6, at which a resolution will be submitted for the confirmation of an agreement made on the 23rd inst., between the Company of the one part and Luis Pujol and Juan Llopart, of Barcelona, of the other part, whereby an option is given to purchase the Company's undertaking. These gentlemen have paid to the Company for the right to purchase the sum of £4,000, which is forfeitable to the Company if they do not declare their option by Oct. 31 next. If they exercise their option to purchase, they are under obligation on that date to pay a substantial portion of the purchase money in cash and to give a guarantee of a first-class bank in London, to be approved by the directors, for the payment of the balance of the purchase money, the final instalment to be paid not later than Feb. 28 next. If the purchase is completed, the directors estimate that after completing the capital outlay already undertaken in Barcelona, paying the company's liabilities to the debenture and debenture stock holders and the preference shareholders, the purchase money and current profits will together enable a distribution to be made to the ordinary shareholders in the liquidation of between £11. 10s. and £12 per share. The directors, having regard to all the circumstances, recommend the shareholders to confirm the agreement.

CITY OF LONDON ELECTRIC LIGHTING.

The half-yearly interim report of the directors of the above Company is to hand. The following statements show the position of the Company at various periods: On Dec. 31, 1898 the number of customers being supplied was 7,414; 1899, 8,738; 1900, 9,855; 1901, 10,618; and June 30, 1902, 10,650. The equivalent number of 8-c.p. lamps connected was 355,825; 1899, 429,628; 1900, 511,113; 1901, 549,175; and June 30, 1902, 558,526. On June 30, 1902, in addition to the lamps connected, there were 15,362 awaiting connection on completion of the consumers' wiring, etc. The gross revenue from sale of electricity for public and private lighting, and meter rentals, excluding sundry receipts, for the first six months of 1898 was £78,552; 1899, £99,213; 1900, £100,550; 1901, £126,122; and for the first six months of 1902, £124,230. After payment of interest on the first and second debenture stocks and loans, the net revenue for the first six months of 1902 (including the amount of £14,063 brought forward from 1901), subject to adjustment, was £63,864 available for depreciation, reserve, any special charges, and dividends on the preference and ordinary shares, etc. From the above it will be seen that, after deducting the lamps disconnected at the request of consumers, principally owing to refusal to supply such consumers at unremunerative rates, the lamps connected to the Company's mains show a net increase of 9,351 during the six months, notwithstanding the present competition; that the reduction in the working expenses, to which the chairman called attention at the last ordinary general meeting, is being maintained, especially in the consumption and in the price of coal. As a consequence, the net revenue for the past six months shows a considerable increase, amounting to £49,801, which, added to £14,063, the amount brought forward from the previous year, gives a total of £63,864, an increase of £13,111 over the net revenue for the corresponding period last year. The dividend on the Company's preference shares for the six months ended June 30 last has been paid. The appeals to the House of Lords in respect of the contracts with the Corporation of London will probably not be heard until after the Long Vacation.

CENTRAL LONDON RAILWAY.

The report of the directors for the half-year ended June 30 last states that the sum of £107,099 has been received during the half-year on account of debenture stock, including the premium thereon, and the amount expended on capital account has been £21,537. The receipts from all sources on revenue account have amounted to £185,118, and the working expenses to £93,099, leaving a balance of £92,018. The number of passengers carried during the half-year was 22,879,334, as against 20,385,739 in the corresponding period of 1901, an increase of 2,493,595. and during the week in which it was intended to hold the Coronation the large number of 1,256,000 passengers was carried over the railway. These satisfactory results clearly indicate the capacity and utility of the undertaking. After providing for interest on debenture stock, the net revenue account shows a balance of £82,603, including the amount of £5,874 brought forward from last half-year. The directors recommend that out of this sum interim dividends be declared at the following rates of distribution: On the undivided ordinary stock at the rate of 4 per cent. per annum and on the preferred ordinary stock at the rate of 4 per cent. per annum. Under the Company's Acts the dividend on the deferred ordinary stock is not payable until the result of the working of the year ending Dec. 31 has been ascertained. A sum of £9,994, representing the deferred dividend, and being part of the general balance of £35,598, has therefore been carried to the "dividend suspense account (divided stock)," and will be dealt with at the end of the year, leaving a net balance of £25,603. The results for the half-year would have sufficed to pay an increased dividend, but in view of the pending liabilities for the expenses in connection with the "vibration" enquiry, and with the promotion of the Bill referred to below, as well as provision for reserve, the directors have thought it expedient to carry forward the above-stated sum. The Bill entitled the "Central London Railway (New Lines) Bill," which was submitted to the proprietors and approved at the last half-yearly meeting, for the construction of a railway from Shepherd's Bush, by way of Hammersmith, Piccadilly, and the Strand, to the City, forming, with the existing line, a circular route through the heart of London, was considered by a committee of the House of Lords, in the present session, but this proposal was rejected, although it was supported before the committee by the Corporation of London and the London County Council. The committee finally approved a combination of opposition schemes consisting of railways (1) from Hammersmith to Hyde Park-corner, (2) from Hyde Park-corner to Ludgate-circus, and (3) from Ludgate-circus to Palmer's Green. The Company's Bill, so far as it authorises the acquisition of property adjoining the Marble Arch Station, and an increase of capital powers, has passed both Houses of Parliament, and now awaits the Royal assent. The work of providing additional lifts at Shepherd's Bush, to accommodate the traffic at that station, is progressing satisfactorily, and it is hoped that two of the lifts will be available for service in September next. It will be remembered by the proprietors that a committee was appointed by the Board of Trade in the early part of last year to enquire into the cause of vibration on the Central London Railway, and that their report was issued in January last. It was stated by the experts who were appointed that the amount of vibration caused by the running of a motorcar train was very slight compared with that of a train hauled by one of the Company's electric locomotives. The directors, therefore, determined to act upon the recommmendations contained in the report, and to remove all cause of complaint by adopting the motorcar (multiple unit) system. The necessary motorcars have been ordered, and it is anticipated that by the end of this year most of them will have been delivered and put into service.

BRITISH ELECTRIC TRANSFORMER MANUFACTURING.

The report of the directors for the year ended June 30 last shows that, after paying all manufacturing costs and expenses of administration, and providing for repairs and depreciation, there remains a net profit of £7,194, which, with the amount brought forward from last year—namely, £1,961—makes a total available balance of £9,155. The Board proposes to deal with this as follows: in payment of a dividend at the rate of 10 per cent. per annum (one-half of which was paid as an interim dividend on Feb. 8 last), to reserve fund £2,500, and to carry forward £2,655. The new works at Hayes, Middlesex, were completed and manufacturing commenced in November last, and the removal of the plant and machinery from the old factory was satisfactorily effected by the end of the year.

WATERLOO AND CITY RAILWAY.

The report of the directors for the half-year ended June 30, 1902 states that the gross receipts of the line, less Government duty, amounted to £17,204 and the working expenses to £7,714, being at the rate of 44·84 per cent., as compared with 54·78 per cent. for the corresponding period of 1901. The balance available for dividend, after providing for interest on debenture stock, is £8,558, and a dividend at the rate of 3 per cent. per annum on the ordinary stock will absorb £8,100, leaving £458 to be carried forward to next half-year. The accumulated deficiency in net revenue, amounting to £11,907 at the end of last year, has been disposed of in an adjustment of accounts with the South-Western Company. The number of passengers carried during the past six months, exclusive of season-ticket holders was 2,239,394, showing an increase of 105,332 over the number carried in the corresponding period of 1901. The season-ticket holders on June 30 last numbered 1,197, as against 1,057 at the end of June, 1901. The working company have recently been enabled, by an altered system of signalling, to introduce a more frequent service of trains, which no doubt accounts to a large extent for the satisfactory increase in the traffic.

LIVERPOOL OVERHEAD RAILWAY.

The report of the directors for the half-year states that the gross revenue receipts amount to £37,988. 0s. 2d., and the working expenses to £29,287. 12s. 11d. The number of passengers carried during the last half-year is as follows: first-class, 656,756; second-class (including tramways), 2,966,690; workmen (special return tickets), 1,402,976—total, 5,026,422. There has been a further falling off in traffic during the past half-year, mainly due to the competition of the Corporation tramways. To render the line more attractive, the directors have decided to accelerate the service, which will reduce the time required to make the journey from end to end from 32 to 20 minutes. The new service will be inaugurated next month. The working of the Crosby, Waterloo, and Seaforth tramways continues to be satisfactory. The revenue account shows that receipts from passenger traffic, miscellaneous receipts, and interest amount to £37,988. 0s. 2d., which, after deducting working expenses, £29,287. 12s. 11d., and interest on mortgage debenture, £3,400, and adding balance brought forward Dec. 31, 1901, £3,692. 12s. 4d., and amount transferred from Dingle fire contingency account, £300, leaves available for dividend £9,292. 19s. 7d. Out of

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this balance the directors recommend the declaration of dividends as follows; 5 per cent. per annum on preference shares, £3,000; 1 per cent. per annum on ordinary shares, £2,500; leaving a balance of £3,792. 19s. 7d. to be carried forward to next half-year.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Maintenance of way, works, and stations	4,554	2	1
Locomotive power	7,706	14	0
Repairs and renewals of carriages	298	17	2
Traffic expenses	10,979	1	11
General charges	2,398	12	5
Law charges	59	15	10
Compensation	105	15	6
Rents, rates, and taxes	3,120	6	11
Government duty	64	7	1
	29,287	12	11
Balance carried to net revenue account	8,565	13	2
	£37,853	6	1

Cr. Receipts.	£	s.	d.
Passenger traffic	37,207	7	0
Parcels, etc.	49	12	10
Rents	588	16	3
Transfer fees	7	10	0
	£37,853	6	1

ANGLO-AMERICAN TELEGRAPH.

The report of the directors for the six months ended June 30 last, to be submitted at the meeting on Aug. 1, states that the total receipts from Jan. 1 to June 30, including the balance of £1,265 brought forward from the last account, amounted to £169,908. The traffic receipts show a decrease of £23,167, as compared with the half-year ended June 30, 1901. The total expenses of the half-year, including the repair of cables, etc., as shown by the revenue account, amounted to £58,930, being a decrease of £6,048, as compared with the corresponding period of 1901. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £98,977. One quarterly interim dividend of 12s. 6d. per cent. on the ordinary stock, and of £1. 5s. per cent. on the preferred stock, was paid on May 1 last, absorbing £43,750, and a second quarterly dividend of 15s. per cent. on the ordinary stock, and £1. 10s. per cent. on the preferred stock, amounting to £52,500, will be paid on Aug. 1, 1902. The balance of £2,727. 12s. 2d. will be carried forward to the next account. All the main cables and land lines of the Company are in good working order.

GREAT NORTHERN AND CITY RAILWAY.

The directors in their report for the past half-year state that the railway between Drayton-park and Finsbury-pavement is completed so far as the tunnelling is concerned. The laying of the permanent way and the erection of the stations at Drayton-park, Essex-road, Old-street, and Finsbury-pavement are making rapid progress. The generating station is in a very forward condition, and the British Thomson-Houston Company, under their contract for the electrical equipment, are providing an installation which, it is believed, will embody all the latest improvements. In accordance with the agreement with the Great Northern Railway Company, Messrs. S. Pearson and Son, Limited, under their contract with that company, are pushing forward the works of the extension from Drayton-park to Finsbury Park Station. An agreement has been entered into with the City and South London Railway Company for the joint user with that company of the station at Old-street. The Company's Bill, which was explained to and approved by the last meeting of shareholders, has passed the House of Lords and the second reading in the House of Commons, and will shortly come before a committee of the latter House.

CHELMSFORD ELECTRIC LIGHTING.

The directors in their report for the year ending Dec. 31 state that the net result of the year's working is a profit of £2,890. 8s. 11d., and after adding thereto the balance from 1900 and providing for debenture interest and other charges, there remains an available balance of £2,564. 19s. 8d. At Dec. 31, 1901, the number of lamps connected to the Company's mains was equivalent to 15,417 8-c.p. lamps, an increase of 1,138 lamps during the year. The supply of electricity has been well maintained, and there has been a satisfactory increase in the revenue from the sale of current. The working costs have at the same time been considerably reduced, the principal item of reduction being in coal. Twenty-five thousand one hundred and twenty-two additional shares have been applied for and allotted, and with the proceeds from the same the loan account has been paid off, and trade creditors' account has been reduced. Messrs. Crompton and Co., Limited, have removed from the old Arc Works adjoining the Company's generating station at Chelmsford, but the premises have been taken by a firm of motorcar manufacturers, who are driving their machinery by electric power supplied by this Company. The directors propose to set aside a sum of £800 towards the establishment of a renewals fund account, to pay a dividend at the rate of 4 per cent. per annum on the share capital, and to carry the balance, £365. 6s. 8d., forward

Dr. ABSTRACT OF REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	3,824	1	5
Distribution of electricity	450	4	0
Public lamps—attendance, etc.	170	11	7
Rents, rates, and taxes	79	18	3
Management expenses—salaries, etc.	256	5	1
Special charges—insurances	110	17	0
Total expenditure	4,891	17	4
Balance carried to net revenue	2 890	18	11
	£7,782	6	3

Cr.	£	s.	d.
Sale of current per meter	6,200	19	0
Public lighting	1,273	11	0
Rental of meters and other apparatus	264	13	6
Sundry work	33	2	9
Rents and sundry receipts	10	0	0
	£7,782	6	3

APPOINTMENTS VACANT.

Electrical Engineer, Tonbridge Urban District Council, £150 per annum. Aug. 2. Particulars may be obtained from Mr. A. H. Neve, clerk, Tonbridge Castle, Tonbridge.

Various Appointments are vacant under the Woolwich Borough Council Electricity Department, Aug. 14. See advertisement.

Switchboard Attendants, Peterborough Corporation, 24s. 6d. per week, Aug. 9. Carlisle Corporation, 25s., Aug. 18. See advertisements.

Assistant Engineer, Oldham Corporation, £100 per annum, Aug. 11. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Warrington.—The Corporation invite tenders for tramway cables. Tenders by Aug. 6. See advertisement.

Calarasi-Stirbey (Roumania).—The Municipality require tenders for public electric lighting. Tenders by Sept. 3.

Trujillo (Spain).—The Municipality require tenders for public electric lighting for 20 years. Tenders by Aug. 10.

Manchester.—The Tramway Committee invite tenders for the supply of quick-break switches. Tenders by Aug. 2. See advertisement.

Plymouth.—The Corporation invite tenders for overhead line construction, etc., in connection with the tramways. Tenders by Aug. 23. See advertisement.

Rochdale.—The Corporation invite tenders for the supply and delivery at the car depot, Rochdale, Lancs., of three tramcars, complete with trucks, motors, and equipment. Tenders by Aug. 4. See advertisement.

Ware.—The Urban District Council invite tenders for lighting certain streets in the town of Ware for the period of two years from Aug. 8, 1902. Full particulars may be obtained on application to the Clerk. Tenders by 3 p.m. on Aug. 7.

Nisch (Servia).—The Municipality invite tenders for electric lighting of the town estimated at 202,132·47 dinars, and for plant estimated at 366,841·75 dinars. Tenders by Aug. 13. Particulars may be obtained on application to above.

Coventry.—Tenders are invited for the supply of electric motors, to be let out on hire by the Corporation. Motors to be single or two phase at 50 periods, and single-phase at 87 periods; voltage, 200 in all cases. Tenders by Aug. 5. See advertisement.

Brandon.—The Brandon and Byshottles Urban District Council invite tenders for 15 additional electric lights and fittings, complete at Sleetburn. Particulars may be obtained from Mr. J. McKenzie surveyor, Langley Moor, near Durham. Tenders by Aug. 2.

Newport.—The Corporation invite tenders for tramways reconstruction and wood paving, rails and fishplates, and tiebars, bolts, nuts, etc. Specifications, etc., may be obtained at the offices of the Borough Engineer, Town Hall, Newport. Tenders by Aug. 7.

Elmton-with-Creswell.—The Parish Council invite tenders for the supply and erection of plant for the distribution of electricity for lighting the villages. Particulars may be had from Mr. W. G. Moorby, clerk to the Council, Creswell, near Mansfield. Tenders by Aug. 2.

Malvern.—The Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work); engines, alternators, exciters, and switchboard; high and low tension concentric cables; and transformers. Tenders by Aug. 23. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1. The Government also propose to lay a cable between Punta-Arenas and Puerto-Montt.

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Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories Tenders by Sept. 15. See advertisement.

Rugby.—The Urban District Council invite tenders for the supply and erection of one 150-kw. and one 60-kw. high-speed steam alternators, three-phase, switchboard, underground mains, arc lamps, public incandescent lamps, etc., and meters. Tenders by Aug. 20. See advertisement.

Ilford.—The Urban District Council invite tenders for a combined track watering and sweeping car on maximum traction truck with complete electrical equipment. Specification, etc., may be obtained at the offices of Mr. John W. Benton, clerk to the Council, Town Hall, Ilford. Tenders by 12 noon on Aug. 19.

Bexley (Kent).—The Electric Lighting and Traction Committee invite tenders for tramway and lighting cables, including trenches, and for switchboards, accumulators, motor-boosters, rotary converter, and motor. Specifications, etc., can be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster. Tenders by Aug. 9.

Cork.—The Committee of Management of the Cork District Lunatic Asylum invite tenders for the supply and erection of steam plant, dynamos, storage battery, switchboards, instruments, wires and fittings, etc., for the electric lighting of the Youghal Asylum. Specifications, etc., can be obtained from Mr. Henry A. Cutler, A.M.I.C.E., Municipal Buildings, Cork. Tenders by 10 a.m. on Aug. 12.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

Madrid.—The Public Works Department invite tenders for the extension of electric tramways in the east of Madrid, and also for a new line and working of the same for not more than 60 years. A preliminary deposit of 3,368 pesetas and a final deposit of 16,844 pesetas is required, also the repayment of 3,189 pesetas and interest to the Sociedad del Tranvia del Este for preparation of the scheme. Particulars may be obtained from the above. Tenders by Aug 26.

King William's Town (South Africa).—The King Electric Lighting and Cold Storage Company invite tenders for supply of plant, boilers, wrought-iron smokestack, high speed enclosed engines, single-phase alternator, direct-driven exciters, surface condenser, main switchboard, transformers, copper mains, etc. Specifications, etc., can be obtained from the London agents, Messrs. A. E. Booth and Co., 16, New Union-street, Moorfields, London, E.C. Tenders by Aug. 7.

London, S.W.—The London County Council invite tenders for the supply and delivery of seven tubular fuel economisers, of not less than 320 tubes each, complete with scraper gear, and seven motors with their starting gear for driving the same; for erection of above-named plant in the Council's electricity generating station at Greenwich; and for supply and delivery at the station of dampers and frames for flues and chimney openings to be erected and fixed by the Council. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Aug. 15.

Leicester.—The Tramways Committee invite tenders for electric tramway works and materials, under the following sections, each comprising a separate contract. For supply and delivery of steel girder tramway rails and fishplates; supply and delivery of bolts, nuts, and tiebars; supply and delivery of points, crossings, and special track work; supply and delivery of stoneware pipes and conduits; supply and laying of feeder cables, telephone and test wires, and supply and delivery of roadway frames and covers; supply and erection of overhead electrical equipment, and the supply of copper bonds; supply and erection at the power station of steam-raising plant; supply and erection at the power station of engines, generators, battery, boosters, switchboard, overhead travelling crane, etc.; supply and delivery of electric tramcars. Specification, etc., may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., engineer, Town Hall, Leicester. Tenders by Sept. 3.

Selangor (Malay States).—The Crown Agents for the Colonies invite tenders for certain plant and materials in connection with the electricity supply scheme for the town of Koala Lumpur, in the protected native state of Selangor, Federated Malay States: (Contract A, Section 1) supply, delivery, and erection of a generating station, consisting of two 600-h.p. high-pressure turbines, with pipes, two 400-kw. three-phase alternators, switchboard, and sundries. (Section 2) The supply, delivery, and erection of a sub-station plant, consisting of three 150-kw. motor-generators, two balancers, switchboards, and sundries. (Contract B, Section 3) The supply and delivery f.o.b. at a European port of steel poles, cross-arms, insulators, copper wire, &c., for the high-pressure transmission line. (Contract C, Section 4) The supply and delivery f.o.b. at a European port of arc lamps, iron posts, controlling apparatus, incandescent lamps and fittings. Tenders may be sent in for any or all of above three contracts. Specifications, drawings, general conditions, and forms of tender may be obtained from the Crown Agents for the Colonies, Downing-street, London, S.W., on and after 7th inst., on payment of £2 for Contract A, £1 for Contract B, and £1 for Contract C. Sealed tenders, endorsed "Selangor Electric Lighting Contract," and addressed to the Crown Agents for the Colonies, are to be delivered at Downing-street, London, S.W., by 12 noon on Aug. 21. All information regarding above contracts is to be obtained from **Messrs Preece and Cardew, 8, Queen Anne's-gate, S.W.**

RESULTS OF TENDERS.

Newcastle.—The Corporation have accepted the tender of M. A. Potts and Co., Manchester, for 2,000 tons of tramrails.

Cheltenham.—The Board of Guardians have accepted the tender of Messrs. Marshall for inter-telephonic communication in the workhouse at £87. 10s.

City of London School for Boys.—The tender of Lund Bros. has been accepted for the installation of the electric light at the school, at £631. 8s.

Maidenhead.—The Town Council have accepted the tender of J. Bakewell and Co., of London, for the electric lighting of the technical school, at £55. 12s.

Bradford.—The tender of Mr. G. A. Steinthal, 41, Piccadilly, Bradford, has been accepted for an installation for electric lighting at the new central fire station, Nelson-street.

Hammersmith.—The Borough Council have accepted the tender of the English Electric Carbon Company for arc lamp carbons as may be required up to March 31 next, at £137. 14s. 3d.

Western Australia.—The Perth Gas Company have placed an order with Willans and Robinson, Rugby, for an 850-h.p. compound engine intended for the electric lighting of Perth.

Prescot.—The British Insulated Wire Company have placed an order for engines for direct coupling to alternators of Johnson and Phillips' make with Willans and Robinson, Rugby.

Devonport.—The Corporation have accepted the tender of William Griffiths and Co., Limited, London, for the construction of the permanent way of the municipal tramways, at £38,157.

South America.—Willans and Robinson, Rugby, have received an order for engines for direct coupling to dynamos of the General Electric Company's make for the electric lighting of Uruguay.

Manchester.—The Corporation Electricity Department have accepted the tender of Rowland Carr and Co., London, for the supply and delivery of the whole of the bitumen required by them for electrical purposes for the year ending June 30, 1903.

Storage Batteries.—Contracts for the supply of storage batteries have been placed with the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, E.C., by the Corporation of Newport and by the Windsor Electrical Installation Company, Limited.

Falkirk.—The Town Council have accepted the following tenders: Babcock and Wilcox, steam pipes, pumps, etc., £1,349; International Electrical Engineering Company, balancing transformer, etc., £485 Electrical Power Storage Syndicate, storage batteries, £1,024; Johnson and Phillips, switchboard, £798; Crompton and Co., arc lamps, £349; Callender's Cable and Construction Company, cable work, £2,704; Carrick and Ritchie, travelling crane, £195; Falkirk Iron Company, arc and incandescent lamp posts, £8 per post.

Chester.—The City Council have accepted the following tenders: R. W. Blackwell and Co., Limited, London, for construction and reconstruction and electrical equipment of tramways, alteration, adaptation, and equipment of shed, tramway cars, and general equipment—viz., permanent-way construction (length of route about 4,678 yards) and car-shed, bonds, overhead equipment, and cars, at £40,182. 19s.; Callender's Cable and Construction Company, cables, £2,799; Crompton and Co., reversible booster, £357; Tudor Accumulator Company, battery of accumulators and maintaining same for 10 years, £1,268 and £77.

Accrington.—The Electricity Committee have received the following tenders for one steel Lancashire boiler, and steam and other piping:

Boiler.

Yates and Thom, Canal Foundry, Blackburn (accepted)...	£741	0	0
E. Danks, Oldbury	763	16	0
Tinkers, Daisy Field Boiler Works, Hyde	850	0	0
Beeley and Son, Hyde	870	0	0
Foster and Sons, Preston	741	0	0
Heaton and Son, Holt Town, Manchester	780	0	0
Taylor and Son, Marsden	750	0	0
Tinker, Shenton, and Co., Hyde	756	0	0
Musgrave, Bolton	857	0	0

Piping.

Yates and Thom (accepted)	214	0	0

London County Council.—The Council have received the following tenders for the supply and erection of (*a*) a 25-ton electric crane for use at the temporary generating station, Loughborough Junction, and (*b*) three 10-ton hand cranes for three of the sub-stations to be established by the Council in connection with the reconstruction of the Tooting to Westminster, etc., tramways:

J. Hitchen and Son, Halifax	£1,387
J. Hitchen and Son (alternative) (accepted)	1,447
J. Larmuth and Co., Salford	1,745
C. and A. Musker, Limited, Liverpool	1,787
Carrick and Ritchie, Edinburgh	1,928
Morris and Bastert, Loughborough	1,962
Higginbottom and Manuock, Limited, Manchester	1,966
A. Chaplin and Co., Glasgow	1,980
J. Booth and Bros., Limited, Rodley	1,995
T. Broadbent and Sons, Limited, Huddersfield...	2,000
Rushworth Bros., Colne	2,085
J. M. Henderson and Co., Aberdeen	2,144
Craven Bros., Limited, Manchester	2,370

The accepted firm propose to sublet to Messrs. C. C. Dunkerley and Co., Limited, Manchester, the manufacture of certain parts of the crane girders, and to the British Thomson-Houston Company, Rugby, the manufacture of the electrical equipment of the crane for Loughborough Junction.

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Bexleyheath (Kent).—The Urban District Council have accepted the following tenders: A. Faulks, Sparrow Hills, Loughborough, building electric generating station, comprising buildings, boiler settings, flues, and brick chimney; Hadfields Steel Foundry Company, Hecla Works, Sheffield, points and crossings; J. Fraser and Son, Millwall, E., boilers, etc.

London County Council.—The tender of Dick, Kerr, and Co. has been accepted for the supply, at £47,686, of 80 double-deck, single-truck, electrically-equipped cars required for use on the Streatham section of the London County Council tramways. Messrs. Dick, Kerr, and Co. are to be allowed to sublet—(*a*) to the J. G. Brill Company, Philadelphia, U.S.A., the manufacture of the car trucks; (*b*) to the Electric Railway and Tramway Carriage Company, the manufacture of the car bodies; (*c*) to J. G. White and Co., the manufacture of car ploughs; and (*d*) to the English Electric Manufacturing Company, the manufacture of the electrical equipment and motors for the cars specified in the contract. The following is the list of unsuccessful tenders:

G. F. Milnes and Co., Wellington, Salop	£47,855
British Thomson-Houston Company, Rugby	48,288
British Electric Car Company, London	49,307
Siemens and Halske, Berlin	49,800
British Westinghouse Electric and Manufacturing Company, London	50,128
Brush Electrical Engineering Company, London	52,788

Full particulars of these tenders will be found in our issue of April 25, the difference being that in the previous tenders the quotations given were for 100 cars, whereas the present are for 80 cars only. The tender of the Electric Construction Company has been accepted for the supply of a motor-generator in connection with the emergency electric light installation at the Horniman Museum at £62. 10s.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Mansfield.—Good progress is being made with the electric light works at this place.

Rotherham.—A report is in course of preparation with regard to the lighting generally of the workhouse.

Gravesend.—All the Corporation buildings from High street to Queen-street are to be lit with electricity.

Norwich.—The electric lighting installation at the city asylum is to be improved at an estimated cost of £200.

Llanedy.—The Council have been authorised to borrow £530 towards the cost of electric lighting at Hendy.

Calverley.—The District Council have decided to oppose the scheme of the Yorkshire Electric Power Company.

Macclesfield.—The District Council have resolved to apply for a provisional order for the electric lighting of the district.

Ilford.—The Local Government Board have sanctioned a loan by the District Council of £31,718 for electric lighting works.

Barrow.—The Electric Lighting Committee have been authorised to apply for power to borrow £20,000 for electric light extensions.

Broughty Ferry.—The Electric Lighting Committee are making arrangements for the erection of 12 arc lamp standards in the town.

Clacton.—The Board of Trade have consented to defer consideration of the question of revoking the electric lighting order until January next.

Gillingham.—Nine tenders have been received by the Council for the supply of plant, etc., for the electricity station. A report is being prepared on them.

West Bromwich.—Sanction has been obtained to the borrowing of £10,000 for the extension of the electricity works for the supply of electricity for the trams.

Aldeburgh.—On the question of extending the telephone trunk system to Aldeburgh, a conference is to be held shortly between the three authorities concerned.

Newhaven.—In reply to an enquiry the Urban District Council have decided that they cannot consent to offer facilities for the supply of electricity in their district.

Westminster Electric Supply Corporation.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 11 per cent. per annum.

Eastry.—The Rural District Council have decided to formally object to the orders applied for by the Kent Electric Power Syndicate so far as they affect this district.

Fraserburgh.—Notice of intention to apply for powers to supply electric power in the district has been given by the Electric Supply Corporation Company, Limited, London.

Penzance.—A draft agreement has been drawn up between the Town Council and the Cornwall Electric Power Syndicate for the supply of electricity in bulk to the Council.

West Kirby.—The electrical mains are to be extended in Lingdale-road, West Kirby, to meet the demand from new property there, also to provide for the lighting of property in Sea-view.

Poole.—The Bournemouth and Poole Electricity Supply Company have made an offer to the Town Council to light certain streets with incandescent and arc lamps, which has been accepted.

Share Market.—Electric supply shares have kept steady all the week, and there has been no appreciable rise or drop in value. On Tuesday, however, there was a fair investment demand.

Electric Lighting Acts.—The Electric Lighting Acts Amendment (Scotland) Bill passed through the committee in the House of Lords on the 24th ult., and was reported without amendment.

Worthing.—Mr. Meade-King has held an enquiry into the application of the Town Council for power to borrow £8,459, principally for additional plant in connection with their electricity undertaking.

Exeter.—As soon as the consent of the Local Government Board to the electric generating station is received, the City Council have decided to make application for authority to issue £250,000 stock.

Barry.—The South Wales Electrical Distribution Company are seeking permission to acquire certain land here for the erection of a generating station, but up to the present they have not been successful.

Holyhead.—The Anglesey County Council have decided to support the petition of the Holyhead Urban District Council to the Postmaster-General in the matter of telephonic communication for that town.

Taunton.—Plans and estimates have received the approval of the Town Council for laying feeder mains in connection with the existing electric light main in the Haines Hill and Wilton district, and for constructing a sub-station for that district.

Falkirk.—The charge for electricity has been fixed at 6d. per unit for lighting and 3d. per unit for motive power with certain discounts. The North British Railway Company have asked the Council to quote a price for electric light up to a quantity of from 20,000 to 30,000 units.

Stoke-on-Trent.—The electrical engineer has submitted a scheme, prepared by him, advising on the electric supply within the borough, and the Town Council have decided to make application to the Local Government Board for sanction to borrow £30,640, being the estimated cost of the scheme.

Metropolitan Electric Supply Co.—The directors of the Metropolitan Electric Supply Company, Limited, have declared an interim dividend for the half-year ended June 30 last of 7 per cent. per annum, being an increase of 1 per cent. upon the interim dividend paid for the same time last year.

Pwllheli.—A form of agreement has been drawn up between the Council and an electric lighting company as to the transfer of the powers of the company under a provisional order to the Council. The company, however, have disapproved of the document, objections being raised to almost every clause in it.

Cardiff.—The employés of the Cardiff Corporation electric lighting department had their annual outing on Saturday at Llantwit, to which place they were accompanied by Mr. Arthur Ellis, borough electrical engineer and manager. Dinner was served at the Cross Keys Hotel, after which sports were held in the valley.

Typewriting Telegraph Co.—We are informed that the new telegraph machine of the Typewriting Telegraph Company can now be rented from the postal authorities for the sum of £8 per set per annum, including maintenance. This instrument can be worked on any existing telephone with great advantages to the users of the line.

Pumps.—Messrs. W. H. Willcox and Co. inform us that at the Tunbridge Wells show last week they obtained first prize with silver medal for their collection of Willcox semi-rotary patent double and quadruple acting pumps, "Record" convertible pumps, patent wire-bound suction and delivery hose, Penberthy patent injectors, and their X-L ejectors, etc.

Hoisting Machinery.—A new illustrated catalogue is now being issued by the London Hoist and Machinery Company, of Finsbury, E.C., whose speciality is light and quick-hoisting machinery. The catalogue gives full particulars of the numerous types of this class of machine manufactured by the firm, together with illustrations of their different applications.

Electric Supply in London.—The London County Council are circularising the municipal authorities in London with a view to obtaining their views on the question of the reintroduction of the London County Council (Electric Supply) Bill in the next session of Parliament. The measure was rejected this year by a Select Committee of the House of Commons.

County of London and Brush Provincial Electric Lighting Co.—The directors of the County of London and Brush Provincial Electric Lighting Company, Limited, have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ended June 30, 1902, and an interim dividend on the ordinary shares for the same period at the rate of 4 per cent. per annum.

The Canadian Arch.—We understand from the Electrical Company, of Charing Cross-road, that they have again secured the order for the illumination of the Canadian Arch in Whitehall at the Coronation As on the previous occasions the arch has been illuminated, Nernst lamps will be used, but nearly double as many are to be brought into service this time. It is intended to make this display as effective and brilliant as any in London.

Bermondsey.—The Borough Council have approved the following charges for electric current for power purposes: 2½d. per unit up to 10,000 units per annum; 1¾d. per unit between 10,000 and 50,000 units per annum; 1½d. per unit between 50,000 and 100,000 units per annum; quantities over 100,000 units per annum at special rates. A flat rate of 3½d. per unit is to be charged for the electric light supplied to the Council's offices, etc.

Dungannon.—With reference to the proposed electric lighting scheme, the Board of Trade have directed that the wires in the principal streets shall be laid underground, but that in the side streets the wires can be placed overhead. This latter permission is, however, subject to alteration after five years' time if the increase of the town or other exigency requires a change to be made. A site for the proposed works has been selected.

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Schuckert Electrical Co.—A Reuter's telegram from Nuremberg states that the balance-sheet of the Electrical Company, formerly the Schuckert Company, shows a deficiency of 15,500,000 marks, owing to depreciation of material, writing off, and the formation of guarantee funds for depreciation to the amount of 9,000,000 marks. The general meeting to be held on the 19th inst. will have under consideration a proposal to cover the loss by drawing on the reserve fund.

Epsom.—The electrical engineer reports that the machinery at the station is in good working order, and that the supply of current has been maintained without interruption. The total number of public lamps fixed to date is 208, and the extension of the cable in Hook-road is now being proceeded with. Application has been received from Lord Rosebery for a supply of electric light equivalent to 450 lamps of 8 c.p. at the Durdans. This makes a total of 3,011 8-c.p. lamps to date.

National Physical Laboratory.—The new National Physical Laboratory, Bushy House, Teddington, is being fitted up with the most improved machinery and scientific apparatus under Prof. Glazebrook's guidance. One of the latest acquisitions is a patent water-tube boiler of Merryweather's "Valiant" type, but constructed for the exceptional steam pressure of 400lb. per square inch, which will be used for testing motors, indicators, gauges, and new inventions in steam machinery.

Peat Fuel.—We note that a company called the Irish Peat Development Company has been formed, with a capital of £20,000, for the purpose of carrying on the business of dealers in peat and manufacturers of peat fuel, peat moss, peat litter, etc. It will be recalled that there has recently been considerable discussion as to the suitability of peat fuel as a substitute for coal in electric light and power stations. In this connection the above company may find a very profitable field of operation in the near future.

Grimsby.—The borough electrical engineer's monthly report shows a slight reduction in the units sold, but a great increase—viz., 29,117 units—over the same month last year. Seventy-four permanent lamps were connected during June, wiring being almost entirely suspended owing to the amount of temporary work being carried out for Coronation illuminations. The equivalent of 1,744 8 c.p. lamps were connected to the mains for Coronation illuminations, and the number would have reached over 2,000 if the Coronation had not been postponed.

Obituary.—We regret to announce the death of Mr. Arthur Dennis, who died suddenly on Sunday evening, after a few days' illness, of peritonitis, at his residence at New Barnet. Mr. Dennis was senior partner in the firm of W. F. Dennis and Co., who for many years past have been, and are still, the sole agents in this country for the firm of Felten und Guilleaume Carlswerk Actien-Gesellschaft, Mulheim-on-Rhine, also the Antwerp Telephone and Electrical Works, and the Pather Iron and Steel Company. Wishaw. We understand that the business of the firm will be carried on as heretofore.

Maidenhead.—The electrical engineer reports that the contract work has progressed very satisfactorily since the committee's last meeting. Twenty-four of the arc lamp columns have been erected, and a further quantity of cable is now ready for testing and will be delivered shortly. Since the last report applications have continued to come in, and the number of lamp connections applied for now stands at 632. Several new installations have also been commenced, of which official notice has not yet been received. Arrangements have been made for 24 services in connection with Contract 9.

London Gazette.—A first and final dividend of 2s. 0½d. per pound has been declared in the estate of G. J. Lloyd (trading as G. J. Lloyd and Co.), electrical and mechanical engineer, lately carrying on business at Castle Mill-street, Bristol, but whose present address is unknown; payable from Aug. 8 at Brighton-chambers, St. Stephen's-avenue, Bristol.—A first and final dividend of 10s. per pound has been declared in the estate of H. D. McIntyre (trading as the Glanamman Colliery Company), 15, Wester-road, Putney, Surrey; payable from Aug. 2 at the office of A. B. Davies, 58, Wind-street, Swansea.

Common Council.—The Court of Common Council at their last meeting received a letter from the London County Council desiring to know the view of the Corporation as to the reintroduction into Parliament next session of the London County Council (Electric Supply) Bill, which was rejected by a Select Committee of the House of Commons this session. This Bill sought for powers to enable the London County Council to acquire the several electric lighting concerns supplying the County Council and City areas. The letter was referred to the Streets Committee for consideration and report.

Hammersmith.—The Finance Committee recommend that proceedings be taken against a consumer for the recovery of £6. 12s. 9d. for electricity supplied. A report of the Electricity Committee presented to the Borough Council at their meeting on Wednesday, states that since the last Council meeting 18 additional consumers have been connected, representing a maximum of 638 8 c.p. lamps, and nine consumers have been disconnected, and that the present number of consumers now taking current from the mains is 1,050. A sub-station is to be built on a portion of the premises at present occupied by St. Paul's High School at Brook Green

York.—Mr. C. H. Wordingham has reported to the Council that it is imperative that further extensions of the electric light undertaking should be undertaken at once. The results of the second year's working of the undertaking show a total revenue of £6,110, as against a total revenue last year of £3.802. The total cost of generation and management has been £3,518, as against £2.276, being an increase of £1,241, and the gross profit is £2.591, as against £1,526. Interest and sinking fund this year absorb £2.242, leaving a net profit of £349, as against £98 last year. The salary of the electrical engineer, Mr. Midgley, has been increased by £100.

Tunbridge Wells.—There seems to be as much disappointment and ill-feeling in certain quarters here at the fact that the Corporation have made a profit of £130 on their first year's working of the telephone undertaking, as there was opposition to the recent application of the Corporation to raise an additional loan for extending the system to the outlying districts. The local ratepayers' league have sent a communication to the Press alleging that the above-mentioned profit is "commercially fictitious," and giving several reasons why this is so. Before accepting their statements, however, we prefer to wait until the accounts of the undertaking are available for public scrutiny.

Catalogues and Books Received.—From the Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C., we have received three new price lists. The first of these (No. 10) deals with accumulator apparatus, the second (No. 13) with lightning arresters and sundry safety devices, and the third (No. 15) with measuring instruments. We hope to refer again to the contents of these lists in a future issue.—"Electric Wiring" is the title of a little book by W. C. Clinton, B.Sc.Lond., a copy of which we have received from the publisher, Mr. John Murray, Albemarle-street, London. The price of this book, which seems to contain information calculated to be of great value to would-be wiremen and students, is 1s. 6d.

West Riding.—The Bill seeking confirmation of the West Riding Tramways and Electricity Supply Company's provisional order came before the Chairman of Ways and Means of the House of Commons on Wednesday as an unopposed measure. The areas affected by the order are Pontefract, Normanton, Featherstone, Whitwood, Knottingley, Allerton Bywater, Kippax, and Great and Little Preston. The Bill confirms another small order granted to the Tadcaster Electricity Company, Limited, in respect to the townships of Tadcaster East, Tadcaster West, and other places in the rural district of Tadcaster. Formal evidence having been given, the Bill passed, and will in due course be reported to the House for third reading.

Greenwich Tunnel.—The Greenwich Tunnel, which gives direct communication for pedestrian traffic between Island-gardens, Poplar, on the north side of the Thames, and Billingsgate-street and Church-street, Greenwich, on the south side, will be allowed to be used by the public within specified hours and limits on and after Bank Holiday, Aug. 4. The entrance to the tunnel is by means of two shafts, 32ft. 8in. in diameter, in which are to be fixed two electric lifts, which, with the other electrical fittings at the tunnel, will, it is estimated, cost £7,334. An offer from the Poplar Borough Council to supply electricity for the purposes of the tunnel at 1·8d. per unit, upon a minimum quantity of 100,000 units, has been accepted.

New Issue.—Callender's Cable and Cable Construction Company, Limited, announce the issue at 105 per cent. of £110,000 4½ per cent. debenture stock, ranking *pari passu* with the £90,000 debenture stock already issued, and redeemable at £110 per cent. in either of the following events: (1) the voluntary winding up of the company; (2) on six calendar months' notice from the company, to be given at any time after June 30, 1916. The company has a subscribed share capital of £375,000, in 60,000 ordinary shares of £5 each, of which 35,000 are issued and fully paid and 40,000 5 per cent. cumulative preference shares of £5 each issued and fully paid. The proceeds of the present issue will be applied in the extension of the business, repayment of temporary loans, and for the general purposes of the company.

Hull.—Complaints are made that a serious nuisance is being caused here by the excessive discharge of dense black smoke from the chimney at the electric lighting station, Sculcoates-lane. Steps are to be taken to abate the nuisance. The telephone question was under discussion at a special meeting of the Telephone Committee last week, when it was stated that the Postmaster-General had agreed to grant the Corporation a license. It was decided in these circumstances to instruct Mr. Bennett, the consulting engineer, to prepare the necessary specifications, and advertise for tenders to carry out the work of establishing a municipal telephone system. A further resolution was passed with a view to allowing the underground wires of the Telephone Company to remain until the expiration of their license in 1911 on certain terms.

Blackpool.—Mr. C. Furness, borough electrical engineer, in a report on the proposed scheme for condensing at the electricity works, remarks that the present method of exhausting steam to atmosphere is very wasteful and expensive, both as regards the amount of steam raised from the coal consumed, and in the fact that only 80 per cent. of the output the plant was designed for is actually obtained in practical working. He says there are some 610 kw. of plant practically dead under the system, and in addition there are on the works five idle condensers, which represent about £9,000. Three of these condensers are already in position, and the other two sets are laying in the works yard. Mr. Furness estimates that by condensing, the undertaking would save £3,500 a year on the present rate of production. The total cost of the new plant required he estimates at £5,100.

Bath.—At the last meeting of the Town Council the Electric Lighting Joint Sub-Committee presented a report dealing with the contract with Messrs. Dick, Kerr, and Co. for the supply of plant at the electric light works, and also with the question of discounts to be allowed to large consumers. The committee had resolved to rescind all previous resolutions of the authority fixing the charge for current to consumers for lighting (except for the public arc lamps), adopting in their stead a new scale of charges to come into force from Sept. 30 next. By this scale the charge is 4d. per unit for quantities exceeding 6,000 units in the June and September quarters, and for quantities exceeding 12,000 units in the March and December quarters; 4½d. a unit for quantities exceeding 4,000 and 8,000 units respectively; and 5d. a unit for quantities of 4,000 units or less and 8,000 units or less according to the quarters. The minimum charge for current for a year is £1. 5s.

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Woolwich.—It was reported at the last meeting of the Borough Council that the Bill to confirm the Woolwich electric lighting order and other orders came before a Select Committee of the House of Lords recently. The committee passed the Bill, subject to the insertion of this clause—*i.e.*: "The undertakers shall once in every year after the first year's working of the undertaking, cause to be laid before them a statement and balance-sheet of the accounts of the undertaking, and shall thereupon fix annually the charges to be made for the supply of energy in the then ensuing year at such rates (not exceeding the maximum rates specified in the order), that as far as is reasonably practicable the revenue for the year shall not be less than the expenditure for that year." The Bill has since passed the full committee of the House of Lords, and will be introduced into the Commons, and it is hoped will receive the Royal assent before Parliament rises.

Electric Lighting in Scotland.—It may be noted that seven local authorities and six companies in Scotland have powers to supply electricity on which action has yet to be taken. The local authorities include Arbroath, Clydebank, Dumbarton, Dumfries, Gourock, Inverness, and Nairn, while the towns included by the companies are Carnoustie, Dunblane, Dollar, Jedburgh, Melrose, and St. Andrews. In operation or in course of construction there are municipal schemes in 21 towns and company undertakings in seven. The latter include Brechin, Coatbridge, and Airdrie, and Montrose already at work, and Berwick, Dalkeith, Musselburgh, and Ross in process of erection; while the Corporation stations in operation are at Alloa, Aberdeen, Ayr, Dundee, Edinburgh, Glasgow, Govan, Greenock, Kirkcaldy, Leith, Motherwell, Paisley, Partick, Perth, Rothesay, and Stirling; and in process of completion, Broughty Ferry, Falkirk, Hamilton, Kilmarnock, and Oban.

Stock Exchange.—The Stock Exchange Committee has appointed Thursday, Aug. 7, special settling day for the British Westinghouse Electric and Manufacturing Company's £500,000 4 per cent. mortgage debenture stock. The committee has also ordered the undermentioned securities to be quoted in the official list: British Insulated Wire Company's further issue of 10,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 70,001 to 80,000; British Westinghouse Electric and Manufacturing Company's £500,000 4 per cent. mortgage debenture stock; Callender's Cable and Construction Company's further issue of 5,000 ordinary shares of £5 each, fully paid, Nos. 40,001 to 45,000; Edmundsons' Electricity Corporation's further issue of 10,000 ordinary shares of £5 each, fully paid, Nos. 40,001 to 50,000, and 4,500 ordinary shares of £5 each, fully paid, Nos. 35,501 to 40,000; Notting Hill Electric Lighting Company's £50,000 4 per cent. first mortgage debentures of £100 each, Nos. 1 to 500 (registered).

Buxton.—The electrical engineer has presented a report to the Council in reference to the electric lighting undertaking, giving a comparison of the June quarters for 1901 and 1902. In the last June quarter the committee have sold 8,221 more units, and increased the revenue by £137. 3s. as compared with the corresponding quarter last year, after taking off the discount of 10 per cent. for prompt payment—viz., £45. 0s. 2d. The increase in percentage of units sold, however, is greater than the percentage of increase of revenue. This is due to a large number of units being paid on the 4d. scale, which will start at 6d. this quarter. The extensions to the works are now practically completed, all that is left to do being to paint the steam-pipe covering, and the flooring to be finished off by the new machinery. The extensions to the mains are also progressing favourably, but they are now waiting for jointing material from Messrs. Callender. During the last quarter they have connected 434 8-c.p. lamps, making a total of 12,405 connected to the mains, which includes one ¼-h.p. and one ·5-h.p. motor. Application has also been received from the Peak Hydro for 10-h.p. motor, and from one or two more large houses.

London County Council.—At their usual weekly meeting on Tuesday the London County Council, on the recommendation of the Finance Committee, agreed to lend the Poplar Borough Council £28,170 for electric light and meters; the Woolwich Borough Council, £96,170 for electric light and meters; the Woolwich Borough Council, £23,960 for electric light installation and meters; the St. Pancras Borough Council, £20,000 for electric light purposes; and the Hampstead Borough Council, £5,100 for electric light meters. Notices of intention to lay electric light mains were received from the following companies: the Charing Cross and Strand Electricity Supply Corporation along Howard-street, portions of Surrey-street and the Strand, Suffolk-place, Leicester-square, Suffolk-street, Panton-street, Oxenden-street, and St. James's-street; from the City of London Electric Lighting Company, along a portion of Gravel-lane; from the County of London and Brush Company, along Dane-road, Denmark-road, Upland-road, River-street (including a transformer box), Magdalen-road, Ellerton-road, Mount Ephraim-lane, and Colinette-road, and of intention to build a transformer box at Great Arthur-street and another in Ellerton-road; from the London Electric Supply Corporation, across the Haymarket to the Carlton Hotel; and from the St. Pancras Borough Council of intention to lay mains along Guildford-street.

Coventry.—The annual report of the electric light department for the 12 months ended March 31 last states that the capital expended during that period has been £2,628. 9s. 11d., bringing the total expenditure to date up to £78,441. 19s. 8d. The amount raised on loan is £69,874. 12s. 2d., and £798. 4s. 11d. has been received on various accounts. The balance of £7,607. 11s. 4d. has not yet been raised. The total capital sanctioned is £93,074. 12s. 2d. The amount of capital repaid is £788. 17s. 6d., and the sinking fund amounts to £5,178. 2s. 4d. During the year the number of consumers has increased from 331 to 375, and the lamps connected from 23,637 (8-c.p.) to 27,226. Further connections are being made. The number of units sold has increased from 341,810 to 404,968, and the revenue from sale of current and meter rental from £6,053. 17s. 3½d. to £6,612. 7s. 6d. The increase in units sold to private consumers has been from 268,982 to 340,316, and the revenue from this source is £5,857. 17s., against £5,128. 18s. 6d. The working expenses show a reduction from £4,514. 19s. 1d. to £4,260. 18s. 11d. The profit on working is, therefore, £2,351. 8s. 6¾d., against £1,538. 18s. 2½d. last year. The capital charges amount to £4,159. 8s. 2d. The net charge on the rates is, therefore, £1,807. 19s. 7½d., against £2,250. 15s. 11¾d. last year. The whole of this sum, except £218. 5s. 3½d., has been raised by means of rates already made.

Islington.—At the last meeting of the Borough Council a councillor asked why the electric current for public and private lighting is charged for at widely varying rates, ranging from 7d. to 2d. per unit. It was stated, in reply, that the public lighting is supplied at a fixed rate of 3½d. per unit. The private supply during the hours of darkness is charged at 7d. per unit for an average of one hour's consumption per day during the quarter, all the remainder being charged at 4d. per unit as an encouragement to the long-hour consumer, who is the best customer to the undertaking. The charge of 2d. per unit is for current consumed during the hours of daylight, and the reduction in price during this period is made with the object of encouraging a demand when the plant would be otherwise lying idle. It was further stated by Mr. Gay, the electrical engineer, that no profit is being made by the department on street-lighting, as will be seen from the following figures. If the sum of £2,016 for wages, repairs, and carbons for street lamps be excluded from the general works cost, the total will amount to 2·5d. instead of 2·7d. per unit. This sum of £2,016 must therefore be added to the costs for street-lighting only, and amounts to ·5d. per unit. To this add the capital charges and interest upon £29,000 made up by the cost of lamps and columns and special mains. If 3 per cent. interest and 3 per cent. sinking fund be provided, the result will amount to 3½d. per unit, exclusive of any charge for plant and machinery or buildings. The Lighting Committee have recommended the Council to extend the low-tension electric lighting mains in Southgate-road at an estimated cost of £300, in Tollington-park at an estimated cost of £430, and in Hornsey-road at an estimated cost of £161.

Sydney (N.S.W.).—We understand that Messrs. Dick, Kerr, and Co., Limited, have secured the contract for the supply of the whole of machinery for the electric lighting station of Corporation of Sydney, New South Wales. Alternating three-phase current is to be generated at the central station, and transmitted at a pressure of 5,000 volts by means of underground cables to sub-stations, at two of which it is converted into continuous current to supply the three-wire network of distribution mains. At four other sub-stations static transformers are to be installed, reducing the E.M.F. to 240 volts between each of the outer conductors and the central point of the three-phase star-connected system of conductors. The distributing mains will in this case be four-core, the lamps being connected in approximately equal numbers between each of the three outer conductors and the conductor which is connected to the central point of the star; this point is also to be connected to earth at each of the sub-stations. Messrs. Preece and Cardew are the consulting engineers, and devised the scheme after a personal investigation by Major Cardew into the whole of the local conditions. The plant comprises five boilers of the water-tube type (Babcock and Wilcox), each capable of evaporating 10,000lb. of water per hour. There are, in addition, mechanical stokers, economisers, superheaters, feed pumps, feed-water storage tank, condensers, and various air and circulating pumps. There are three steam alternators, each consisting of a steam-engine coupled direct to a three-phase alternator and exciter. Two of the steam alternators are each of 600 kw. capacity, the third machine having an output of 300 kw. The machines will be each capable of giving considerable overload for some time. The engines are of the Ferranti type The generators will be manufactured at Preston, and will be of the standard design adopted by the contractors in their machines for the London County Council, Fulham, and other contracts. The Sydney contract also covers the whole of the pipework, travelling crane, and storage battery. The sub-station plant is also included, and comprises five sets of motor-generators, each set being capable of giving an output of 150 kw. continuous current. Three of the sets consist of an induction motor driving two 75-kw. continuous-current generators, the other two sets consisting of an induction motor driving a 150-kw. continuous-current dynamo. A number of static transformers are also being supplied by the firm. The main switchboard will be of the Ferranti type. It may be observed that the contract provides for the erection of the plant, the total amount of the contract being between £50,000 and £60,000. It is interesting to record that the same firm are now supplying large plants all over the world, their contracts comprising the erection of generating plant at Cape Town, the construction and equipment of electric tramways in Calcutta and Hong Kong, and now the complete equipment of the Sydney Corporation lighting works.

TRACTION.

Hull.—It has been decided to have a car fitted with new patent dry seats.

Ashby-de-la-Zouch.—The Urban District Council have agreed to the proposal to widen Bath-street in view of the proposed light railway.

Ayr.—The total drawings from the tramways for the week ending Saturday last was £448 odd, an amount which has been only once previously exceeded.

Brighton.—The Tramway Committee have offered to take energy for the tramways service from the Lighting Committee at the inclusive flat rate of 1·4d. per unit.

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Rawmarsh.—The Urban District Council held a meeting in committee last week to deal with the tramways and electric light question. The result of their deliberations has not yet been made public.

Bersham.—The Rural District Council have agreed to the application of the National Electrical Traction Company, Limited, to prolong the time limited for the completion of the Wrexham tramways.

Lancaster.—Negotiations are still going on between the Corporation and the tramways company with reference to the purchase of their undertaking. It is hoped that a settlement will be arrived at soon.

Ilford.—The construction of the electric tramways here is being rapidly pushed on, and the District Council are in communication with the East Ham authorities with reference to a working agreement.

Personal.—The London County Council are recommended to approve of the appointment of Mr. Edwyn Lonsdale Pope in the tramway department as distribution engineer at a salary of £351 per year.

Pontypridd.—The Select Committee of the House of Commons presided over by Mr. Ashton has this week passed the Bill promoted by the Urban District Council to confirm their tramways provisional order.

Waterloo and City Railway Co.—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended June 30 last, carrying forward a balance of £458

Worthing.—It is the intention of the Town Council to apply to the Light Railway Commissioners next November for an order authorising the construction of light railway in the borough and out to Shoreham.

Acton.—The District Council are taking steps to compel the tramway company to provide a margin of 9ft. 6in. between the tramrails and the footpaths through High-street in accordance with the terms of their agreement.

Cape Electric Tramways.—Holders of share warrants to bearer can obtain payment of dividend due to them on coupon No. 12 at the offices of the company, 55 and 56, Bishopsgate-street Within, E.C., after 5th inst.

Gillingham.—A discussion took place at the last meeting of the Council with reference to the running of the electric cars on Sundays, and it was decided to forward several letters received on the subject to the light railway company.

Lowestoft.—We understand that the Corporation, who are about to construct a system of electric tramways, have accepted a tender for the supply of Belgian rails. The offer was £1,400 lower than that of English steel manufacturers.

Wrexham.—The Board of Trade have decided to grant the application of the National Electric Traction Company, Limited, that the time fixed for the tramways extension shall be extended from Aug. 1, 1902, for a period of six months.

Prestwich.—The draft agreement between the Salford Corporation as to the provision of an electric tram service for the district was under discussion at the last meeting of the District Council, and was ultimately adjourned for the discussion.

Welshpool.—The Welshpool and Llanfair Light Railway Company have given notice of an intended application to the Board of Trade for a prolongation of the period limited by their order for the completion of the railway to March, 1903.

Devonport.—The tender of Messrs. William Griffiths and Co., of London, having been accepted for the construction of the permanent way of the Corporation tramways, the contractors will commence the construction of the St. Budeaux section on Aug. 12.

Swansea.—The announcement was made at a meeting of the Electrical Committee on Friday that the Kingsland Electric Traction Company are prepared to lay down an experimental tramway line on one of the proposed new extensions on their surface-contact system.

Sunderland.—The Tramways Orders Confirmation (No. 1) Bill has been laid on the table of the House of Commons for consideration. By this Bill a provisional order granted by the Board of Trade to the Sunderland Corporation will be confirmed. The Bill has been ordered to be set down for third reading.

Buenos Ayres.—A syndicate has been formed to take up the concession for an electric tramway between the federal capital and Adrogué. The line would pass through Barracas al Sud, Banfield, Lanus, Lomas, Temperley, and Adrogué, and, if successful, might in time be extended to Chascomus.

Wandsworth.—The London County Council have written the Borough Council to the effect that that they would give a formal undertaking to proceed continuously with the construction of the tramway on Putney Bridge, but they could not assent to the proposed time limit enforceable by a penalty.

Ipswich.—All the plans are now completed for the power station, refuse destructor, and tramcar shed on the Seven-Acre Field, as well as the details for relaying the present tramway tracks for electric traction and extensions. Messrs. Kennedy and Jenkin are the consulting engineers for the scheme.

Chester.—The preparations for the putting down of an electric tramway system in the town are going ahead. Tenders have now been placed for additions to the electricity plant, for the construction of the permanent way, and for cables; and a sub-committee has been appointed to select the type of cars, poles, etc.

Birstall.—The representative of the District Council in the negotiations for the acquisition of the Birstall portion of the undertaking of the Dewsbury, Batley, and Birstall Tramway Company (on behalf of the British Electric Traction Company) has fixed the price £6,430, including a portion of the rolling-stock.

Mexico.—Preparations are being made to operate a portion of the Mexican Railway between Esperanza and Vera Cruz by electricity. The electrification of this section of about 120 miles is of considerable interest, containing, as it does, the heaviest grades in Mexico. Power will be derived from the waters of the Metlac River.

District Railway.—The accounts of the Metropolitan District Railway Company will, after paying all prior charges admit of a payment for the six months ended June 30, 1902, of a dividend of 3 per cent. per annum on the 4 per cent. guaranteed stock, carrying forward £1,433, as against £523 for the similar period in 1901.

Halifax.—The Tramways Committee of the Town Council by a majority of two votes have decided against extending the tramway system to Brighouse, Hipperholme, and Greetland. Already the present system extends to Stump Cross, within a mile of Hipperholme, and the estimated cost of extending it to the latter place is £6,862.

Blackpool.—The tramway returns from April 1 to date show a decrease on the promenade route of nearly £1,900 as compared with the corresponding period last year. The New-road and Marton routes, however, have returned a satisfactory income, the total revenue for the whole system from April 1 to July 19 last amounting to £12,590.

Aston.—At the next meeting of the District Council, the Tramway and Electric Light Committee will present a report recommending that the overhead system of electric traction be adopted on the tramways. With regard to the acquisition of the Aston trams, Sir Frederick Bramwell has fixed Oct. 16, 17, and 18 as the dates of his arbitration in connection with the matter.

Auckland (N.Z.).—The electric tramways in this town are making rapid progress towards completion. Both the permanent way and overhead equipment are being pushed on with all dispatch. The first shipment of cars has arrived, and the steel framework for the power station, and all other material required, is due to be delivered. The company expect to be able to fix a date for the opening of all the city lines soon.

Private Bills.—In the House of Lords the Garston District Tramways and Electric Supply (Transfer) Bill, the London County Council (Subways and Tramways) Bill, and the London County Council (Tramways and Improvements) Bill have been read a third time and passed. In the House of Commons, the North and South Shields Electric Railway Bill, the Rossendale Valley Tramways Bill, the Wrexham District Tramways Bill, the Hastings Tramways Bill, and the Rhondda Urban District Council Tramways Bill have been read a third time. The Lords' amendments to the London, Tilbury, and Southend Railway Bill were agreed to by the House of Commons on the 29th ult.

Employes' Grievances.—A public meeting of tramway employés under the Cardiff Corporation was held on Tuesday at the Gladstone Hall to receive the report of the deputation previously appointed to wait upon the manager (Mr. Ellis) *re* the existing conditions of labour. The following resolution was passed: "That this meeting, having heard the report of the deputation who waited on Mr. Ellis, reluctantly complies with his suggestion not to press their grievances, on the distinct understanding that Mr. Ellis will make an urgent effort to remedy the grievances as quickly as possible, and, further, that the management be heartily thanked for kindness in promising to remedy the wage question in a certain direction."

Electric Traction to Brighton.—Speaking at the half-yearly meeting of the London, Brighton, and South Coast Railway Company on Wednesday, Lord Cottesloe, referring to the parliamentary expenses incurred in opposing the proposed electric railway to Brighton, and other hostile schemes, said that the activity of promoters would probably compel the company to act on the defensive for some time to come. The possibility of checking such schemes by improvements and extensions of the company's system, and particularly the advisability of establishing electric traction on some of their lines, was seriously engaging the attention of the Board; and the proprietors might be assured that no stone would be left unturned in seeking means for preserving the traffic to and from those districts which the railway served.

Manchester.—The annual report of the Corporation tramways for the year ended March 31, 1902, issued this week, states that the total car mileage run during the year was 1,831,126, the number of passengers carried was 23,590,288, and the receipts totalled £91,619. 8s. 4d., the average receipts per car mile being 12d. The average receipts per car mile by electric traction were 12·20d., and by horse traction 9·79d. The gross profit amounted to £33,196. 16s. 10d., but with addition of bank and other interest, etc., the sum available was £50,034. 13s. 2d. This has been applied as follows: interest on mortgage debt, £17,086. 6s. 1d.; sinking fund, £678. 12s. 3d.; instalment of loans, £1,669. 14s. 10d.; contribution in relief of the rates, £20,000; and reserve, renewals, and depreciation account, £10,600. The total electric traction operating expenses per car mile were 8·10d., made up as follows: electrical energy, 1·45d.; traffic expenses, 4·24d.; management expenses, 1·80d.; and repairs and maintenance, 0·61d. During the year many important matters have occupied the attention of the committee, and these from time to time have been reported to the Council. One of the most important points which has arisen for consideration has been the question of running powers and interchange of traffic. The Manchester tramway system with its 150 miles of track is now connected with a much larger system of tramways aggregating probably some 500 miles of track; consequently there is no doubt, the committee state, that in the future they will be called upon to deal with many difficult problems as to interchange of traffic in connection with this larger system of tramways. At Tuesday's committee meeting the town clerk was instructed to give notice and take such steps as counsel might advise for the purpose of appealing against the judgment of Mr. Justice Bigham in the case of the Manchester Carriage and Tramways Company *v.* the Manchester Corporation.

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Middlesex.—The County Council have decided to oppose the London United Tramways (Light Railways Extensions Hounslow to Slough) Order No. 3, with a view to the insertion of clauses for the protection of Middlesex roads and bridges and the interests of the County Council.

Huddersfield.—On Tuesday one of the electric cars, instead of taking a sharp curve from East-parade into Queen-street South, left the metals and crashed through a wall into a children's recreation ground. The front of the car was smashed, and the driver, who stuck to his post, was injured, but not seriously. The conductor and passengers escaped unhurt.

Barrow.—At a meeting of the Town Council this week it was stated that since the engines and cars of the British Electric Tramway Company had been burnt the town had been without any tram service, and it was asked if anything further had been done in the agreement with the company for the laying down of an electric system. It was decided to consider the matter in committee.

Bournemouth.—Last week the official inspection of the tramway from Pokesdown to Lansdowne was carried out by Mr. Pringle and Mr. Trotter, of the Board of Trade. The inspectors afterwards gave leave for the cars to run. The Corporation have now decided to lodge an appeal in the House of Lords against the decision of the Court of Appeal determining their powers to construct certain tramways in Bournemouth.

Newcastle.—At a special meeting of the Tramways Committee on Saturday a tender was accepted for tramrails, and it was also decided to have a special kind of fishplate. The city engineer was instructed to continue to complete the present tramline from Raby-street down to Fisher's Hill. After this is completed, it will be considered whether the Corporation will themselves make the line from Shields-road to Welbeck-road.

Margate.—Last week a driver of an electric car was summoned for driving a car at a greater speed than four miles an hour—the Board of Trade regulation speed. A police constable said he timed the car from the top of Paradise-hill to Fort Green, and it covered a distance of 153 yards in 46 seconds, a rate of nearly seven miles an hour. The Bench convicted, and imposed a fine of 20s. and 11s. costs. Notice of appeal was given.

Newport.—The Electricity and Tramways Committee have decided to recommend the Town Council to proceed with the electric tramway up Stow-hill after the Parliamentary Committee had carried out the negotiations successfully in connection with the widening of the streets and lowering the levels. To mount Stow-hill will be one of the finest feats of traction engineering in the kingdom. The gradient in some places is as great as 1 in 14.

Barnsley.—The British Electric Traction Company have given notice of their intention to apply to the Board of Trade to extend the time limited for the completion of the works authorised by the Barnsley and District Light Railway Order, 1900. We understand that the whole of the additional plant at the generating station for supplying current to the tramways has now been installed, and the Corporation are only waiting for the cars to run.

West Sussex.—The County Council have appointed a committee with authority to enter into negotiations with the Corporations of Hove and Worthing, the British Electric Traction Company, and other authorities interested in the proposed light railway or tramway schemes between Hove and Worthing, and submit for the consideration of the County Council such proposals in relation to such scheme or schemes as they considered it desirable the Council should adopt.

Southend.—On Friday the application of the Corporation was enquired into by the Light Railway Commissioners for powers to extend the borough light railway from Southchurch Church to Croxson's corner, Southchurch, and from the bottom of Brewery-road, along the sea-front, to the Cambridge Hotel, Shoeburyness. The Borough Engineer explained that they proposed to borrow £60,000 for the extensions. The new lines would not compete with the London, Tilbury, and Southend Railway.

Tanat Valley Light Railway.—It was stated at the ordinary meeting of the shareholders of the Tanat Valley Light Railway Company at Oswestry last week that the progress of the works had been very satisfactory, and the directors trusted soon to be able to fulfil the conditions which would enable them to apply to the Treasury for the payment of one-half of the free grant promised. They anticipated that if the same satisfactory progress was made, the line would be completed in the early months of next year.

Bath.—The Light Railway Commissioners heard an application last week for an order to authorise the North Somerset Light Railway to be constructed between Bath and Clutton, tapping the Somersetshire coalfield. The Commissioners, without hearing the whole of the promoters' case, said the application as to parts of the railway failed under Section 9, Sub-Section 3, it having been shown by the promoters' own witnesses that the line would compete with an existing railway. The proceedings therefore abruptly terminated.

West London.—The electric tramway service between Hammersmith, Kew Bridge, and Hounslow was blocked for some time onwards from 10 o'clock on Friday night as the result of a couple of accidents at Gunnersbury Station. The first was caused by a pantechnicon getting across the metals and colliding with an electric car. Both vehicles were considerably damaged, but neither driver was hurt. The second accident occurred at almost the same spot 20 minutes later, a four-wheeled cab and a private carriage coming into collision.

Presentation.—On the occasion of the departure of Mr. O. A. Pilcher, the chief assistant electrical engineer of the county borough of Blackburn, to take up his new position of engineer and manager to the Ilkeston tramways, he was presented by the staff of the electricity and tramways departments with a travelling bag, dressing case, etc. Mr. Giles, the chief engineer, in making the presentation, spoke very highly of Mr. Pilcher, and said he was exceedingly sorry to lose him. Mr. Pilcher suitably thanked the donors for the presents and for the good feeling shown him.

London United Tramways.—The preamble of the London United Tramways Bill has now been passed by a Select Committee of the House of Lords. It had previously been approved by a House of Commons Committee. The measure provides for the construction of electric tramways in the neighbourhood of Richmond, Hammersmith, Wimbledon, and Barnes to the extent of about 15 miles. The total population to be served in the districts of the existing and authorised tramways is 412,000. The street widenings scheduled in the Bill are estimated to cost £293,770, and the tramways £192,464, giving a total expenditure of £492,234 involved in the scheme.

Exeter.—At their meeting last week the City Council decided to promote a Bill in Parliament for the construction of municipal electric tramways in the city, and further decided that the overhead trolley system be adopted except for High-street and Fore-street, which are left undecided. It will be remembered that a deputation from the Corporation was recently appointed to visit several towns in England and on the Continent having tramway systems in operation, and as a result of their tour the overhead trolley system has been selected "because of its economy and greater simplicity." The proposed mileage of the new tramways is about nine miles, the construction of which is estimated to cost £92,000.

Rochdale.—In regard to the negotiations with the tramway company for the purchase of their undertaking by the Corporation, it may be stated that the company's powers over nearly the whole of the lines in the borough of Rochdale will expire next month. The only exceptions are the short length in Cheetham-street, that from the Town Hall-square up Manchester-road to the Castle Inn, the Heywood section beyond the old boundary at Sudden, and the Royton section from the Dog and Partridge at Buersil to Summit. Over these detached pieces of their system the company's rights extend to July of next year, though it is practically certain that the whole of the undertaking will be transferred to the local authorities at the same time.

Tynemouth.—At a meeting of the employés of the Tynemouth and District Tramways Company, Limited, last week it was decided to give notice to the company for the men to cease work on Aug. 1 unless their applications for increases of wages were granted. The men made application some time ago, and soon afterwards the directors posted a notice in which they stated that in regard to the motormen they could not see their way clear to accede to their request. With regard to the conductors they were prepared to advance by ½d. per hour the wages of those who had served under the company for 12 months and had good records. It is stated that under these conditions only one man is entitled to the advance offered. The men have the support of the Amalgamated Association of Tramway and Vehicle Workers.

Stoke-on-Trent.—Major Druitt has made a report as to the light railway from Stoke to Newcastle through Hartshill. The Potteries Electric Traction Company propose to construct a double line throughout the entire route, but the Corporation object to this as inconvenient and dangerous to the public, and Major Druitt has held an enquiry on behalf of the Board of Trade with respect to the matters in difference. As a result he has given his decision in favour of the company. Although he thinks it right to give every consideration to the views of the Corporation, he considers they would be well advised to consent to the whole of the railway being laid as a double line, as experience has shown generally that such lines cause little inconvenience to the other vehicular traffic in the road, and the gain to the general public who use the tramways is very great. The report was considered at the last meeting of the Town Council, and a resolution passed adhering to their objections as submitted to Major Druitt, being still of opinion that a double line along Section 1 would prove a source of danger.

Leeds.—The Bill to confirm a provisional order of the Board of Trade authorising the construction of additional tramways in Leeds came before a Select Committee of the House of Commons on Tuesday. Counsel for the promoters explained that in the course of further extensions of the tramway system some of the lines were to pass over a bridge belonging to the London and North-Western Railway Company. The contention of the railway company was that, if necessary, the tramway authority should bear the cost of strengthening the bridge, and should get no compensation for the stoppage of traffic for that purpose. Counsel urged that the road was in existence before the railway company came there. It was for the company's benefit that the bridge was constructed, and they were compelled to maintain the bridge and the roadway over the bridge for all time. They were bound to make the bridge of sufficient strength to carry all the traffic that could lawfully be put upon other portions of the road. The company's was an untenable position, which the committee ought not to sanction. For the London and North-Western Railway Company it was argued that more than ordinary traffic was to be sent over the bridge in consequence of the tramway extension, and the protection sought was necessary and reasonable. After a little further discussion the Chairman said that the committee thought the railway company were already sufficiently protected by the Bill, without any additional clause being inserted.

Bury.—On the 23rd inst. Mr. Alderman Sykes laid the foundation stone of the new tramcar depôt at Bury. The building will be situate at Whitehead Bridge in Rochdale-road. The office block will be a single-storey building fronting Rochdale-road, and will contain clerks' and manager's offices, men's room, clothes-drying room, storerooms, conveniences, and lavatory accommodation. A public convenience will be provided at the corner of Rochdale-road and George-street. The main building faces Rochdale-road, but is separated from the office block by an enclosed yard. It has also frontages to Foundry-street and George-street. The building will comprise a car shed, 140ft. by 156ft.; repairing shop, 57ft. by 45ft.; painting shop, 58ft. by 45ft. The shed will have one bay alongside Foundry-street

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and four bays at right angles. Each of the four bays will contain three tracks for the storage of cars, and will have sunk pits each 70ft. long to enable proper examinations and repairs to be made under the cars. There will be two tracks in the repairing shop and painting shop, also provided with pits. The elevations are of a simple character, the external walls being faced with pressed red bricks from Black Hill, near Entwistle, relieved with stone dressings, and the walls inside the shed being faced with common bricks. The roofs are of iron, supported on iron columns and girders. The main roof is divided up into six bays, and patent glazing has been provided on each side of the ridges for the full length. In addition to this, there are large windows in the outside walls, so that the shed and shops will be amply lighted. The building is being erected by Mr. James Byrom, of Woolfold, Bury, from the designs and under the superintendence of Mr. Arthur W. Bradley, A.M.I.C.E., borough engineer.

Cardiff.—It was stated at the last meeting of the Tramways Committee that during the month of June several alterations and improvements have been made in the tramway service. The single-deck cars adopted by the committee are not giving satisfaction. They were purchased to meet the special requirements of the Cathays Ward, where the lowness of the Taff Vale Railway bridge at the town end of Salisbury-road prevents the use of double-deckers. A number of the inhabitants and tradespeople of the ward are considering the advisability of holding an indignation meeting to pass resolutions urging the Corporation to alter the tramcars. A further complaint is that the inside compartments are ventilated badly. The Corporation has already passed an order for the construction of a specimen "composite car." It will be fitted with bogie trucks, will have seating accommodation for 16 people in the enclosed portion, and for 12 in the smoking compartments (to be one at each end of the car). The borough engineer reports that Mr. Glenn, the engineer of the tramways company, and himself had estimated at £12,327 the value of the work of the reconstruction of lines carried out by the company in Newport-road and St. Andrew's-crescent before the lines were taken over by the Corporation. To this there is to be added £500 commission to Mr Glenn, bringing the total up to £12,833, which works out to £7,568 per mile, as against £6,100 per mile for the reconstruction work carried out by the Corporation. It was mentioned at the last meeting of the Electricity Committee that Mr. Ellis, the borough electrical engineer and manager, has received an offer of an appointment at Lisbon worth £1,500 a year, plus bonus on profits. Mr. Ellis, however, is not in a position to accept the offer, as he is under an agreement to remain with the Corporation for five years. Returns show that the generation costs for the month of May worked out at 1·72d. per unit for the 43,794 units generated, the high cost being accounted for by the fact that the load on the plant was small whilst expenses were high. There was considerable improvement in June, the cost per unit being ·98d. for the 91,054 units generated. The electrical engineer hopes the costs will be still further reduced during July down to ·5d. per unit. The total receipts from the tramway undertaking for the three months ending June 30 from all sources amounted to £15,960. 9s. 2½d. The Portmanmoor-road section of the system is now ready for traffic.

Local Veto.—In his evidence on Wednesday before the Select Committee of the House of Commons which is considering the question whether any changes in the Standing Orders of the House are desirable, Mr. Albert Gray, counsel to the Chairman of Committees in the House of Lords, criticised rather strongly the working of the Standing Order which requires that the consent of the local authority shall be obtained before a Tramway Bill shall be proceeded with. This consent had become a marketable commodity of no small value to local authorities. In some cases they exacted as the price of their consent a considerable annual rent for the wayleave of the roads, though the Tramways Act, 1870, did not contemplate anything of the kind. This condition had been struck out of Bills by the Lord Chairman, but local authorities had devised an expedient which Parliament had sanctioned in some cases. They consented to put off the date of purchase for a few years in consideration of the payment by the company of a rent for the use of the roads in the meantime. He thought such a condition was wrong, because a local authority should not have the power to bind its successors. There were also exactions in the way of maintaining and improving roads. In more than one case he had seen the conditions imposed that members of a district council should have free tramway rides, and charges of blackmailing by local authorities had been freely made by companies applying for powers. When a local authority gave its consent, it did so with a mental reservation, and very often appeared afterwards as a petitioner against the Bill. He suggested that proof of consent should be given on or before Jan. 18, the first day on which the examiners sat. He thought that an effective appeal from the veto of the local authorities should be secured to the Standing Orders Committee or to some other committee constituted for the purpose. The Standing Order should provide for the hearing of claims for dispensation, and it should be a sufficient claim for dispensation that the local authority had refused its consent except upon conditions to which the promoting company could not agree. In answer to further questions, Mr. Gray expressed the opinion that if public legislation were brought up to date in two departments, the department of public health and the department of tramways, private business would be expedited. Numbers of Improvement Bills were introduced which were almost entirely composed of amendments of the Public Health Act. Then the whole subject of tramways was in confusion, largely owing to the Light Railways Act. Public legislation would also be required in regard to electric power. Mr. Beal, solicitor, on behalf of the Railway Companies' Association, and Mr. Sidney Morse, also gave evidence. Both these gentlemen expressed the opinion that it would be impossible to deposit Bills earlier than Dec. 17. Mr. Morse thought that the important stage in a private Bill was the committee stage, and that a second reading debate in the House should only be allowed on the decision of some tribunal which might make observations on the case for the benefit of the House. He also thought that committees should get to work earlier in the session, and suggested that it was scarcely fair to promoters that they should sit for such a short time each day as they did now that the new rules were in operation. The committee adjourned.

London County Council.—As will be seen by our "Results of Tender" column, the tender of Messrs. Dick, Kerr, and Co. has been accepted for 80 cars for the Streatham lines of the London County Council tramway system. Reporting upon this tender at the meeting of the Council this week, the Highway Committee point out that Messrs. Dick-Kerr are supplying the electrical cars required for the Tooting tramways, one of the principal reasons which led Dr. Kennedy to recommend the adoption of the cars supplied by this firm being the superiority, for the Council's purposes, of their electrical equipment and motors. The manager is also of opinion that motor and electrical equipment submitted by Messrs. Dick, Kerr, and Co. is preferable to that specified in the lower tenders. He also points out that the cars now on order will be fitted with ploughs manufactured by Messrs. J. G. White and Co., and he considers it essential that the further supply of cars should have the same plough. Messrs. Witting Bros., Limited, in their lowest tender, it will be seen, specify a different make of plough, and although they also send in a tender in which the White plough is specified, this is only £94 lower in amount than that of Messrs. Dick, Kerr, and Co., and provides, as has been stated, for a form of motor which, the committee are advised, is not so satisfactory as that of the last-named firm. For these reasons they decided that the tender of Messrs. Dick, Kerr, and Co. for the supply of the cars should be accepted. The time within which they undertake to deliver the cars is 24 weeks, well within the time when they will be required for use. In the Tramway and Improvement Bill this year the Council are seeking powers for the acquisition of certain land and premises, adjoining the Greenwich tramways depôt, for the erection of a generating station, and they recommend that the estimate of £31,000 for the acquisition of this property and property adjoining the Clapham depôt (which it is proposed to enlarge for the accommodation of electrical cars) be appproved. In connection with the Greenwich generating station the Highways Committee recommend that the erection of the chimney be carried out without the intervention of a contractor. The estimated cost of this work is £18,750. They further recommend that the foundation shall be laid by the Works Committee in the event of that committee agreeing to accept the work at the architect's estimates. The acquisition of a site for a sub-station near the Elephant and Castle is suggested by the Highways Committee at a cost of £12,500, and they further recommend that the work of erecting the sub-stations at (*a*) Clapham, (*b*) Brixton, and (*c*) near the Elephant and Castle be carried out without the intervention of a contractor; that the drawings, specifications, bills of quantities, and estimate of £22,500 be referred to the Works Committee for the purpose of the work being carried out on the basis of the priced bills of quantities under which that committee are now carrying out the erection of the fire brigade station at Clapham, and that any prices not included in those bills be mutually agreed between the Highways Committee and the Works Committee. A report of the Highways Committee will be brought up at the next meeting of the Council recommending the approval of an estimate of £11,500 for the purchase of certain land at New Cross-gate for the erection thereon of car-shed workshop, and sub-station, etc.

London County Council Tramway Extensions.—The proposals of the Highways Committee to expend a sum of £1,784,580 on new tramways in London was reported on by the Finance Committee at the usual weekly meeting of the London County Council last Tuesday. In their report the Finance Committee point out that of this total expenditure £37,480 and £127,164 would be provided by the sale of surplus lands and by the contributions of local authorities respectively. The total net outlay is thus reduced to £1,619,936. With four exceptions, there appears in the opinion of the committee every probability that the proposed tramways would be self-supporting from the first. These exceptions are the proposed lines from Harlesden to Hammersmith-broadway, from Garratt-lane to Wimbledon, from Bushey-green to Bromley-hill, and from Woolwich *via* Wickham lane to the county boundary. Taking the schemes as a whole, however, the committee think they may be accepted, for it may be said that with the exception of the proposed line from Hammersmith-broadway to Harlesden there will be no serious deficit. The consents of the road authorities are, however, still wanted in some cases before the schemes can be introduced into Parliament. In addition to the proportion of the cost of the street improvements which is to be charged to the tramways account, the interest and sinking fund charges on which will be provided out of the tramway receipts, and the further proportion which is to be contributed by local authorities, there is a net sum estimated at £284,669 to be borne as a charge for street improvements. This will involve a charge on the rates for interest and repayment of about £14,000 a year. It is to be observed, however, that the last proposal in the list, involving a net outlay of £146,500 for the widening of Southampton-row between Vernon-place and Bloomsbury-place, has already been approved by the Council, and the cost has been voted. It is only included now in order that compulsory powers may be obtained. The committee point out that the proposals already approved or now before the Council in regard to the conversion to electric traction of the tramways on the south side of the river, including extensions and smaller undertakings about to be purchased, and the necessary generating station, involve an aggregate expenditure of about £5,500,000. The present tramways debt amounts to £1,750,000. In addition to this, there will be the expenditure on the proposed generating station at Pimlico and for the conversion of the northern system and extension on that side of the river. While the committee are satisfied, on estimates, that the large capital outlay involved in

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the development of tramways in London will be ultimately remunerative, they think it well to prepare the Council for the possibility that while these large works are in process of execution the tramways undertaking may occasion a charge on the rate. A great deal will depend, of course, upon the manner in which the various operations are carried out and the period during which expenditure remains unproductive. They believe that the Highways Committee are alive to this points, and are shaping their proposals accordingly. After some four hours' discussion, and having considered the above report, the Council adopted the whole of the recommendations of the Highways Committee with regard to obtaining statutory powers for the construction of the new tramways proposed. Full details of the scheme appeared in our last issue.

PROVISIONAL PATENTS, 1902.

JULY 21.

16142. Apparatus for indicating that an electric current has reached a predetermined amount, and for the consequent closing of a switch or switches. Joseph Edmondson, Walter Alexander Purdon, John William Dawson, and Edmondson and Purdon, Limited, Penny Bank-chambers, Halifax.

16143. A new method for suspending electric light pendants. Alfred White, 36, Percy-terrace, Sunderland.

16154. Electric cable and trolley wire hangers. Ivor Viktor Zealander and William Wilson, 33, Taylors-road, Stretford, Manchester.

16160. Improvements in electric lampholders. Thomas Chalmers, 18, Cawdor-road, Fallowfield, Manchester.

16165. Improvements in electrical fire-extinguishing apparatus. Willis Nelson Stewart, 62, Hackford-road, Brixton, London.

16178. Improved means for applying and removing electric incandescent lamps. John William Kirk, 32, Countess-road, Kentish Town, London.

16191. Improvements in electric train signals. William James Hare and James Peter Hare, 33, Cannon-street, London. (Complete specification.)

16205. Improvements in dynamo-electric machines. Alexander Heyland, 47, Lincoln's-inn-fields, London.

16232. Improvements in regulating devices for electric arc lamps. Aron Nicolaus Thorin, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 22.

16264. Improvements in electrical switches and cut-outs. Charles Mark Dorman, Reginald Arthur Smith, and Herbert George Baggs, Ordsal Electrical Works, Salford. (Complete specification.)

16270. A new or improved electric facia sign. Abraham Goldsmith, 237, Whitechapel-road, London.

16293. Improvements in or relating to electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.) (Complete specification.)

16294. Improvements in and relating to electromagnetic switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.) (Complete specification.)

16319. An improved device for adjusting the length of and taking up the slack in electric lamp cords and the like. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (The Crescent Novelty Company, United States.) (Complete specification.)

16325. Improvements in dynamos. John Davidson, 6, Lord-street, Liverpool.

16332. Improvements in collectors for electric railways and tramways on the overhead conductor system. James George Willcox Aldridge, 40, Chancery-lane, London.

16341. Improvements in and relating to the provention of formation of deleterious vapours by electric discharges in air. Hermann Viertel and Gebrüder Siemens und Co, 27, Chancery-lane, London.

JULY 23.

16354. Improvements in electric accumulators. Henry Danzer, 70, Market-street, Manchester.

16358. Improvements in electrolytic processes and in apparatus therefor. Leo Gurwitsch, 70, Market-street, Manchester.

16391. Improvements in and relating to electric incandescent lamps and to circuits and conductors therefor for decorative and other purposes. Gustave Weissmann, 139, Queen Victoria-street, London.

16394. Improvements in or relating to adjustable electric resistances, and to the method of using the same. George Leonard Addenbrooke and Lionel Robinson and Co., 37, Essex-street, Strand, London. (Complete specification.)

16402. Improvements relating to wireless telegraph systems. Harry Shoemaker, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 24.

16419. Improvements in shuttles used in weaving for electrically changing the shuttle before the weft has become completely exhausted. Arthur Johnston Davidson, Ballywoollen House, Crossgar, co. Down.

16449. Improvements in and connected with means of electrically communicating between distant stations. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

16485. Improved carbon brush-holder for dynamos. Eugene Gaud, 40, Chancery-lane, London.

16488. A quick-break and a quick-make snap-off improved tumbler switch. Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London.

16489. Improvements in and in the application of electric motors for automobile vehicles. Herbert Sefton-Jones, of the firm of W. P. Thompson and Co., 322, High Holborn, London. (Eugenio Cantono, Italy.)

16492. Improvements in electrical cut-outs and regulators. Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

16493. An automatic electric chain-welding machine. John Ebenezer Bousfield, of the firm of G. F. Redfern and Co., 4, South-street, Finsbury, London. ("Union" Aktiengesellschaft, Switzerland.) (Complete specification.)

JULY 25.

16521. Electric lift controller. Percy Dewhirst, 24, Birley-street, Blackpool.

16529. Improvements in apparatus for reducing attenuation of electrical waves. Michael I. Pupin, 22, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 14, 1901, being date of application in United States.) (Complete specification.)

16550. Improvements in controlling alternating currents for signalling. Silvanus Phillips Thompson, Morland, Chislett-road, West Hampstead, London.

16556. Improvements in electric furnaces and in the production of chemicals in such furnaces. Griffith Brewer, 33, Chancery-lane, London. (Edward Randolph Taylor, United States.) (Complete specification.)

16564. Improvements in electrically-controlled air-brakes. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske-Aktien Gesellschaft, Germany.)

16575. Improved construction of apparatus for measuring electrical resistance. John Westmoreland Record, Henry Brooker, and Walter Herbert Goss, 173, Fleet-street, London.

JULY 26.

16597. Wireless telegraphy, telephony, or improvements in same. John Tatchell Studley, Wellington Club, Grosvenor-place, London.

16610. Improvements in electrical switches of the "tumbler' tyye. Richard Hadley and Francis Joseph Taylor, 11, Burlington-chambers, New-street, Birmingham.

16612. Improvements in switchboards for street fire-alarms. William Albert Shaw, 4, Corporation-street, Manchester.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 14.

1901.

10700. Electric tram and railways on a sectional conductor system. Hacking, Hancock, and Leighton.

14931. Electric meters. McWhirter.

17278. Carts or wagons used for transporting electric cable drums or reels, and for supporting same whilst cable is being paid out. Robinson.

18079. Electric heating systems for cars. Newell and Herr.

18010. Electrically-operated cranes and other electrically-operated machines or vehicles. John Brown and Co., Limited, Tressider and Jones.

18652. Means applicable for use in breaking electric arcs. Von Zweigbergk.

18691. Electric switches. Smith.

18797. Trolley-line switches and the methods of operating the same. Dawe.

19377. Means of fixing carbons for dynamos and motors. Hartnell.

20462. Electromagnetic clutches. Earle.

25318. Electricity meters. Evans. (Allgemeine Electricitäts-Gesellschaft.)

26700. Electric lighting of railway trains and apparatus therefor. Henry.

1902.

7751. Trolley retractors. Johnson. (Date applied for under International Convention, Oct. 12, 1901.)

11073. Means for controlling electric circuits. British Thomson-Houston Company, Limited. (Wood.)

11165. Switch box apparatus used for testing, standardising, or calibrating electrostatic instruments, and measuring electric currents thereby. Addenbrooke.

11427. Endless electric conveyor for conveying tin plates from the bath of molten metal to a suitable or desirable place. Baxter, Clark, and Hillman.

11889. Electric devices for igniting mines. Norres.

12099. Staying telegraph and telephone poles and the like. Egnér and Celion.

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12110. Means and apparatus for effecting telephonic intercommunication. Young.

12309. Electric heating device. De Mare.

12582. System of electric lighting. Wise. (Moore Electrical Company.)

14329. Storage batteries. Marks. (Smith Storage Battery Company.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	July 26	4,833	4,637	+ 196	143,958	132,165
Blackburn Corporation	,, 25	885	707	+ 178	14,747	12,009
Blackpool Corporation	,, 24	1,585	1,467	+ 118	14,177	15,017
Blackpool-Fleetwood Tramways	,, 28	1,209	1,038	+ 171	3,559	4,231
Bolton Corporation	,, 20	1,615	1,606	+ 9	45,174	41,224
Bradford Corporation	,, 27	3,135	990	+ 2,145	79,959	26,148
Bristol Tramways Company	,, 25	4,720	4,675	+ 45	—	—
Carlisle Tramways Company	,, 26	216	208	+ 8	5,065	4,700
Central London Railway	,, 26	6,218	5,956	+ 262	26,591	24,398
City and South London Railway	,, 27	2,715	1,906	+ 809	10,891	7,550
Cork E. T. and L. Company	,, 24	985	560	+ 425	14,782	13,380
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 26	256	269	- 13	6,106	5,932
Dublin & Lucan Electric Railway	,, 27	122	133	- 11	495	578
Dublin U. T., electric cars	,, 25	3,987	3,953	+ 34	—	—
Dublin S. District, Electric	,, 26	1,138	1,108	+ 30	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 26	9,252	11,439	- 2,187	—	—
Halifax Corporation	,, 16	2,715	2,844	- 129	18,943	—
Huddersfield Corporation	,, 26	1,058	1,013	+ 45	—	—
Hull Corporation, E. S.	,, 26	1,693	1,689	+ 4	29,437	28,475
Liverpool Corporation	,, 19	10,748	10,302	+ 446	275,241	252,076
Liverpool Overhead Railway	,, 27	1,561	1,608	- 47	6,373	6,906
Newcastle-on-Tyne Corporation	,, 12	2,688	—	—	—	—
Portsmouth Corporation	,, 26	1,796	875	+ 921	—	—
Sheffield Corporation	,, 27	4,051	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Sunderland Corporation	,, 20	1,356	1,351	+ 5	18,756	17,043

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £74 decrease.

Barcelona Ensanche y Gracia, £88 decrease. Barcelona £498 increase.

Brisbane, £437 increase (month of June, £10,187; increase, £1,813).

Buenos Ayres and Belgrano Electric (month of June, receipts £12,229; increase £478), £64 increase.

Calcutta, £246 increase.

Cape Town (month of June), receipts, £14,148; expenditure, £6,689.

Isle of Thanet Electric, £26 decrease

Mexico Electric (month of June), receipts, £20,285; expenditure, £12,275.

Perth Electric, £664 decrease.

Port Elizabeth (month of June), receipts, £3,849; expenditure, £1,891.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	..	½-½
—— Ordinary, 1-125,000	1	..	⅛-¼
British Insulated Wire, Ord., 1-70,000	5	..	7¼-7¾
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¼-5¾
—— 5 per cent. Mortgage Debentures	100	..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	5⅝-6⅛
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	1¼-1⅜
—— Non. Cum., 6 per cent. Pref.	2	..	1½-2
—— 4½ per cent. 1st Debenture Stock	100	..	102-105
—— 4½ per cent. 2nd Debenture Stock	100	..	94-99
Callender's Cable, Debentures	100	..	109-113
—— Ordinary	5	..	15¼-16½
—— 5 per cent. Pref.	5	..	5¼-6
Crompton and Co.	3	..	2¾-3¼
—— 5 per cent. Debentures	100	..	101-106 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	⅛-⅜
—— "A" Shares, 01-017,139	5	..	1½-2¼
—— 5 per cent. Debentures	100	..	78-83
—— 4 per cent. Deb. Stock, Red.	100	..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-2
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	98-101
W. T. Henley's Telegraph Works, Ordinary	5	..	16-17
—— 4½ per cent. Preference	5	..	5¼-5¾
—— 4½ per cent. Debentures	100	..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10	..	20¼-21¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	36-39
—— 5 per cent. Bonds	100	..	102-105
Electric Railways.—			
Central London, Ordinary	100	..	105-108
—— 4 per cent. Pref.	100	..	106-109
—— ,, ,, deferred	100	..	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	115-118
City and South London, Consolidated Ordinary	100	..	72-74
—— 4 per cent. Debenture Stock	100	..	115-118
—— 5 per cent. Pref. Stock '91	100	..	128-133
—— ,, ,, ,, '96	100	..	129-132
—— ,, ,, ,, '01	100	..	123-127
Liverpool Overhead, 5 per cent. Pref.	—	..	13-13¼
—— Ordinary, 1-50,000	—	..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	102-104
Waterloo and City, Ordinary	100	..	98-99

Name.	Amount paid.		Last price.
Electric Lighting and Supply.—	£		£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	½-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	103-106
Bournemouth and Poole, Ordinary	10	..	11¼-12¼
—— 4½ per cent. Cum. Pref.	10	..	9¼-10¼
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	..	9¼-9⅝
—— 7 per cent. Preference	5	..	9¼-9⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	8-9
—— Nos. 20,001-30,000	5	..	8¼-9¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14¼
—— ,, ,, £10 Ord.	6	..	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	105-107
Charing Cross and Strand	5	..	9-10
—— Nos. 50,001-70,000	5	..	8-9
—— 4½ per cent. Cum. Pref.	5	..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	105-107
Chelsea Electricity Supply	5	..	5¼-5¾
—— 4½ per cent. Debentures	100	..	109-112
City of London, Ordinary	10	..	8¼-9¼
—— 6 per cent. Cumulative Pref.	10	..	11¼-12¼
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	101-104
County of London and Brush Provincial, Ordinary	10	..	8-9
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	6-6¼
—— 6 per cent. Cum. Pref.	5	..	6-6¼
—— 4½ per cent. First Mort. Deb.	100	..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	..	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100	..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10-11
—— 4 per cent. Debenture Stock, Red.	100	..	101-104
Kensington and Knightsbridge and Notting Hill	100	..	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼
London Electric, Ordinary	3	..	1¼-1⅜
—— 6 per cent. Pref.	5	..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	94-99
Metropolitan, Ordinary	10	..	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	9-9¼
—— Preference	4	..	6¼-6¾
Notting Hill Electric Lighting	10	..	13¼-14¼
Oriental, 1879	1	..	1¼-1⅜
—— £5 Shares	5	..	7-7¼
—— £4½ Shares, New	4½	..	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5-6
—— 4 per cent. Debenture Stock	100	..	97-100
River Plate Electric Light and Traction, Deb.	100	..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	1¾-2¼
—— 4 per cent. Debenture Stock	100	..	80-90
South London, Ordinary	5	..	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14¼-15½
—— 7 per cent. Pref.	5	..	8¼-9¼
—— 3½ per cent. Deb.	100	..	97-100
Westminster, Ordinary	5	..	10¼-11¼
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	..	5¾-6¼
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	..	4¼-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	125-130
Blackpool and Fleetwood Tramroad	10	..	13¼-14¼
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	102-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	..	7-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	..	9¼-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	..	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	..	12¼-13¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	12¼-12¾
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	..	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	..	102-105
—— Prov. Cert., all paid	100	..	96-98
Cape Electric Tramways, Nos. 1-400,000	1	..	2¼-2½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	..	4¾-5¼
—— 4 per cent. 1st Mortgage Debentures	100	..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	..	13-14
—— 5 per cent. Cum. Pref.	10	..	11-12
—— Debentures	100	..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	14¾-15¾
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	..	96-99
Imperial Tramways, Ordinary	all	..	22-22¼
—— 6 per cent. Cum. Pref.	all	..	14¼-15¼
—— 4½ per cent. Deb. Stock	100	..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5	..	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	..	10¼-11
—— ,, ,, ,, ,,	5	..	8-8¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	107-109
—— ,, ,, Prov. Crts.	50	..	81-83
New General Traction, Ordinary	5	..	2-3
—— 6 per cent. Cum. Pref.	10	..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10¼-10¾
—— 5 per cent. Cum. Pref.	10	..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9¼-10¼
—— 4½ per cent. Debenture Stock	100	..	108-111
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £51,132 6 per cent. Preference	14s.	..	¾
—— £50,000 ,, ,,	1	..	1
—— £500,000 4½ per cent. Debenture Stock	70 p.c.	..	70 p.c.
Telephones.—			
National Telephone, Preferred	100	..	95-98
—— Preferred, 590,001-790,000	3½	..	4¼-4⅜
—— Deferred Stock	100	..	56-60
—— 6 per cent. Cum. First Pref.	10	..	12-14
—— 6 per cent. Cum. Second Pref.	10	..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	..	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100	..	95-98
—— 4 per cent. Deb. Stock, Red.	100	..	102-106
Oriental Telephone and Electric Company	1	..	15/16-1 1/16

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NOTES.

King's College.—The council of King's College have elected Prof. Henry Robinson "Professor Emeritus" on his retirement from the chair of civil engineering.

The Rangoon Tramways.—We understand that these lines have been bought by Messrs. Darwood and Co., and that they hope to introduce electric traction shortly. With the older system of horse traction the lines have not had a brilliant success financially, and they will require relaying for electric traction.

Indian Telegraph Department.—A resolution in the *Gazette of India* announces an increase in the course for Indian telegraph students at Coopers Hill to three years, and putting them on the same footing as officers of the Public Works Department as regards pay, in order to secure the required standard of efficiency.

Crystal Palace Engineering School.—Sir William Chandler Roberts-Austen, K.C.B., D.C.L., F.R.S., will to-day award the certificates for the summer term at the Crystal Palace Company's School of Practical Engineering. Visitors will be admitted to the various departments of the school at 11 a.m., and the function begins at noon.

Ostend Accumulator Car.—One section of the Ostend tramways is still being being worked by accumulator cars, and these work in with a schedule which include steam cars on the same track. We understand that it is now found advisable to recharge the accumulators after a four hours' run. Evidently this is found more economical than using heavier cells with a larger capacity.

Faraday House.—As a result of the recent scholarship examinations the Board of Control of the Electrical Standardising, Testing, and Training Institution, Faraday House, have made the following awards: to Mr. Herbert Stanley Phillips, of Oakham School, Oakham, Rutland, an exhibition of the value of 30 guineas, tenable for two years; to Mr. John Nelson Nayler, of Kingswood School, Bath, a prize of 20 guineas.

Platinum.—It has been shown that platinum anodes are attacked more readily in concentrated than in dilute hydrochloric acid. Mr. F. Bran has now found that in an acid of given strength the attack diminishes as the current density increases. This is explained by the diminution of the concentration of the acid in contact with the anodes which is produced by the current, the diminution being greater with high current density. Platinum-iridium is less attacked than platinum.

New York Central Railway Conversion.—The Mayor of New York has made a statement as to the plans which the New York Central Railway Company have submitted to him for the improvement of the present conditions in the long tunnel that leads to the terminus station of the line. This scheme includes the total abolition of steam as a motive power over this last section of the line, and the substitution of electricity to work not only this but also the sections within 30 miles of the terminus. The cost would be, according to the estimate, almost £3,000,000. The scheme would seem to involve a very large outlay, but the frequency of the traffic is all in favour of the alteration being commercially successful.

Flood-proof Dynamos.—We have recently heard of an accident to an English dynamo which was by the inadvertence of a crane man, or, we believe, to give him his true position, a donkey-man, a dynamo was deposited in the bottom of the dock instead of on board ship. The machine in question, in spite of this immersion, worked well, which showed that the varnishing of its armature and field coils had not been in vain. A more complete immersion, however, is that recorded of a power-house in America, which was flooded out for 24 hours. The illustration we have seen shows the water almost to the top of the windows on the ground floor. In spite of this, the dynamos and the whole of the plant were found to be in working order on the flood going down, and they are said to have worked quite satisfactorily ever since.

E.M.F. of Metals in Solutions of Cyanide.—The following data are given by Mr. S. B. Christy as the results of an enquiry into this matter: The E.M.F. of potassium cyanide against silver decreases from $+0{\cdot}34$ volt for M solutions to $-0{\cdot}5$ volt for M/1,000,000 solutions. Similarly, for zinc, the values decrease from $+0{\cdot}945$ to $+0{\cdot}330$ volt; for lead from $+2$ to $+0{\cdot}04$ volt; for mercury from $+0\,15$ to $-0{\cdot}635$ volt; in the case of iron, the values increase from $-0{\cdot}03$ to $-0{\cdot}16$ volt (M = gramme-molecule per litre). The solubility of gold in solutions of potassium cyanide of different strengths was determined; for all practical purposes the cyanide ceases to act at a dilution below 0·001 per cent.

Cathode Depolarisation.—In alkaline or acid solution, acetylene acts as a depolariser towards a platinised cathode. Mr. Jean Billitzer has found that when a current is passed between platinised electrodes in a voltameter containing aqueous acid or alkali, through which acetylene is bubbled, and the potential of the cathode measured against a free hydrogen electrode in the same acid or alkaline solution, ethylene, and afterwards ethane, are given off before the potential of the cathode has fallen to that of the hydrogen electrode. With a higher E.M.F., hydrogen is added to the products. With platinum electrodes, the presence of acetylene, nitrogen, or carbon dioxide results in a rise in the E.M.F. required for the liberation of hydrogen. Electrolysis of acetylene in normal sulphuric acid solution with a mercury cathode leads to the formation of traces of alcohol.

Electrical Resistance of Steel.—The following abstract of a paper by Mr. C. Benedicks on the above subject is given in the current number of the *Journal* of the Chemical Society: Equivalent quantities of carbon, chromium, and other elements dissolved in steel cause an equal increase of hardness, and determinations of the resistance of a number of samples of steel containing silicon, sulphur, phosphorus, and manganese indicated that the resistance is also equally affected by equivalent quantities of these elements, and may be calculated by the expression $S = 7{\cdot}6 + 26{\cdot}8\Sigma C$, where S is the resistance in microhms per cubic centimetre, and ΣC is the percentage of foreign substances calculated as equivalent quantities of carbon. The dissolved carbon alone is of influence, the precipitated carbon having no effect, but the experiments indicate that pure steel always contains about 0·27 per cent. of dissolved carbon, a result in accord with many metallurgical analyses. The resistance of perfectly pure iron is hence 7·6 microhms per cubic centimetre; this value is less than any directly determined, but absolutely pure iron has never been investigated.

Some Phenomena of Voltaic Polarisation.—The current number of the *Journal* of the Chemical Society has an abstract of a paper on this subject by Mr. M. Berthelot. In the simple voltaic cells investigated by the author, it is shown that the addition of hydrogen or a reducing agent to the liquid at the negative electrode develops an E.M.F. of opposite sign, and hence causes polarisation. Thus, in a cell containing solutions of sodium chloride at different concentrations, the E.M.F. fell from 0·12 volt to 0·26 volt when placed in an atmosphere of hydrogen, and again rose

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to the normal value when the hydrogen was replaced by nitrogen. Similar results were obtained with cells of lactic acid and sodium hydrogen carbonate. In an element of a Grove's battery, the electrodes are gaseous hydrogen and oxygen, and the E.M.F. is about 1·05 volts, although the decomposition of water necessitates between 1·5 and 1 6 volts. This the author considers to be due to the formation of platinum hydrides, the heat of formation of which, although variable for different states of the platinum, would be equivalent to about 0·6 volt. Experiments are also described on the polarisation effects of the addition of hydrogen peroxide and of pyrogallol to the different electrode liquids.

The Bournemouth Tramways.—The recent decision of the Court of Appeal, which was given in our issue of July 4, has raised in Bournemouth considerable feeling against the Poole and District Electric Traction Company. On Thursday of last week a ratepayers' mass meeting was held, at which resolutions were passed supporting the Corporation in their appeal to the House of Lords against the decision above referred to. It will be remembered that the right to construct a certain section of tramway was to lapse from the Corporation and come into the hands of the company unless work on the same had been commenced by Aug. 1, 1901. As Major Balfour, the M.P. for Bournemouth, explained to the meeting, under the Tramway Act, which was drafted for horse traction, the laying of rails was the accepted sign that work was substantially commenced. In the case of the Bournemouth Tramway Committee they had ordered their electrical plant and bought their station site before that date. The judges in the Appeal Court held that this was not sufficient, and hence their decision. The line in question is now completed, and was opened for service under the Board of Trade's approval on Monday, the 27th ult. It seems to us that the Corporation have a strong case to present to the House of Lords against the handing over of the line to the company.

British Medical Association.—The members of the industrial health hygienic section of the British Medical Association, at the combined invitation of the Chloride Electrical Storage Company, Limited, and Messrs. Pilkington's Tile and Pottery Company, Limited, Clifton Junction, near Manchester, visited the works of the two firms on Wednesday, the 30th ult., for the purpose of inspecting them, and more particularly the provision and preventatives employed for dealing with lead-poisoning, and the systems of periodical examination which are voluntarily adopted by both firms. The visitors, among whom were Dr. Whitelegge, H.M. chief inspector of factories, Mr. Richmond, the superintendent inspector, Dr. Oliver, the Government expert, Dr. Glibert, chief medical inspector of factories of the Belgian Government, and Major E. M. Roe, inspector of factories, were entertained at lunch by the two firms at the works of the Chloride Company, between 50 and 60 members of the section being present. The chair was taken by Dr. F. H. Bowman, of the Chloride Company, supported by Mr. Chas. Pilkington, of the Pottery Company. After luncheon the respective works were inspected throughout under the guidance of Mr. Grindle on behalf of the Chloride Company, and the Messrs. Burton for the Pottery Company, the visitors manifesting a keen interest in all they saw.

Coopers Hill College.—In his capacity of Secretary of State for India, Lord George Hamilton attended the annual prize distribution to the students of the Royal Indian Engineering College at Coopers Hill last week, when he made an interesting speech with regard to the future of the college. Touching first upon the reorganisation of the institution last year, Lord George said that during the considerable time he had been Secretary for India the question had perplexed him and the council as to what should be done with the college. Was it to be abolished? It was pretty clear that if the idea of abolition was summarily put on one side, changes must be made which would bring the teaching and the course of instruction up to modern requirements. Changes in the management of the staff of a great college like this were always unpleasant, and always painful to make, and in this connection he wished to say that the professors and tutors whose services had been dispensed with had left the college under no suspicion of incompetency or inability. He concluded with an exhortation to the students who were shortly going out to India to deal with the Indian people in a just and tolerant spirit, for he had always felt that the foundation upon which British rule in India rested was in the knowledge that we could steadily advance the material prosperity and improve the condition of the people of the country.

Lighting Weaving Sheds.—It is interesting to contrast the report on which we commented in our last issue on the lighting of the Birmingham Art Galleries with the annual report of H.M. Inspector of Factories (Mr. W. Williams) on the ventilation and lighting of weaving sheds. In this last report Mr. Williams comments on the difficulty of giving statistics of the general improvement in ventilation in the past few years, but instances the fact that in well-ventilated sheds the cases of faintness amongst the weavers have almost disappeared. "Further evidence in the same direction is furnished by managers, many of whom testify to the improved health and increased vigour of the workers. Some of the operatives in one shed where the ventilation had been much improved volunteered the statement that they were now less fatigued after a full day's work than they previously were in the middle of the day; and in other cases managers have remarked that the freshness of the weavers has increased with the freshness of the atmosphere of the sheds. . . . There seems to be a general belief that cotton spinners are worn out at an earlier age than the workers in many industries, and that young workers find that employment in cotton-spinning rooms is extremely exacting." The abolition of gas lighting in favour of electric lighting and the adequate ventilation of spinning-rooms would, Mr. Williams is convinced, do much to reduce the fatigue and improve the health of the workers.

Surging in Transmission Lines.—The question of the surging set up in electrical circuits when a current is interrupted is one which some years ago, when the Deptford station of the London Electric Supply Corporation was first opened, engaged the attention of our electrical engineers and professors. There is no doubt that a number of cables in this country, when high-voltage working was first introduced, had their insulation pierced by the increased voltage due to the surgings set up when the circuit was broken or made. That such is not the case to-day is due to the good cables employed, rather than to the prevention of the surging. We reproduce elsewhere in this issue an interesting paper by Prof. F. G. Baum, which was read on June 18 at San Francisco before the Pacific Coast Transmission Association. In this instance the lines dealt with are the overhead wires of the large power transmission undertakings of California. As the voltages employed on these in ordinary working are often over 40,000 volts, it follows that when surging is set up enormous and destructive voltages can easily be reached. The paper in question is well worthy of most careful reading, and its mathematics should present no difficulty to any electrical engineer. One interesting point is that with branch lines at frequent

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intervals on the transmission line the rise of voltage is limited. One also sees that the most dangerous surging is set up when a short-circuit is opened. It is for this reason that a number of transmission engineers object to the use of any switches in the high-tension side of their systems.

Huddersfield Tramway Report.—The report of Major Druitt, who enquired into the Huddersfield tramway accident on behalf of the Board of Trade, has just been issued. The report refers to the accident which took place on June 28, in which three persons were killed and many injured. The conclusion from the report seems to be that the brakes provided on the cars were not ineffective, but that the driver had not been taught the best way to use the same when descending inclines. On such grades as those at Huddersfield Major Druitt says the correct way is to keep the slipper brake on all the way down and to regulate with the hand-brake, thus leaving the electric brake for an emergency. He did not think that the driver used the brake until he had lost control. The inspector could not account for the negative result when the electric brake was applied in view of its working satisfactorily when tested later in the evening, unless some temporary insulation of some contacts had occurred, but the accident could not have happened had the slipper brake been properly used down the incline. The inspector adds that it cannot be sufficiently borne in mind by managers of tramways that to drive a car down steep hills, steady men of good nerve, intelligence, and a high standard of training are required. In addition, he thinks definite instruction should be given to drivers in case of the failure of any part of their equipment, and as to where to find someone in authority to remedy it. Before the car is used for carrying passengers, he considers that a driver should be allowed a quarter of an hour to test his car, for which time he should be paid.

The Armstrong-Orling Wireless Telegraphy.—The end of the London season and the closing of the parliamentary session always inaugurate the great gooseberry season in the daily papers. The first in the field this year is the Armstrong-Orling Company, with its £185,000 of privately subscribed capital. The information respecting the various telegraphy and telephoning systems controlled by this company is vouched for only by the inventors, and is being accepted by the editors of the daily papers by the column. For happy insinuation and absence of statement of fact we have seldom seen these articles surpassed. The following extract is from the *Manchester Guardian*, and is, we presume, a verbatim report of Mr. Armstrong's statements: "The instrument I have shown you is capable of transmitting and receiving messages over a distance of five miles. But then the power of this instrument may be supplemented by 'relays,' and whereas the best relay in the market—we will mention no names—with eight volts is equal to a transmission of 1,699 miles, ours, with 0·1, is equal to one of 12,990 miles." "Have you actually tested it over this distance?" "No; but we have tested it by opposing to it resistance equal to that distance." We presume that this system of equation will be universally adopted for the simple reason that it is quite meaningless. We shall have more to say on the subject if we find the shares of the company quoted regularly in the financial papers, and we would remind our financial friends that a Post Office license is required before any system of telephoning or telegraphy can be used for public purposes within the United Kingdom.

Cable Rates.—Sir Edward Sassoon, M.P., presided over a conference between representatives of the Liverpool Chamber of Commerce and the Imperial Telegraphic Committee at the House of Commons last week, when the subject of cable rates was under discussion, especially in regard to communication with West Africa. It was explained by the chairman, in welcoming the deputation, that private cable companies were gradually becoming more amenable to reason, and during the past few years there had been some reduction in the telegraphic rates to West Africa. These reductions, however, he admitted were inadequate, and the tariff was still very excessive, especially when compared with the moderate charges for cable communication from France to the Gold Coast. The landing rights of the company owning the lines to West Africa would expire next year, and that fact, Sir Edward hinted, might be used as a lever to exact fairer terms. He also advised that it might be well to send a deputation on the subject to the Postmaster-General and the Secretary of State for the Colonies. Sir A. L. Jones, the chairman of the Liverpool Chamber, remarked that the French rates were less than half those charged against English traders. British merchants would use the cable much more largely if the rates were reasonably cheap. As a result of a further discussion, it was resolved to write to the West African Direct Cable Company requesting that company to consider the expediency of reducing the rates to West Africa to the uniform charge of 2s. 6d. per word for a tentative period of 12 months, and assuring them that such a reduction would conduce both to the increased earnings of the cable company and to the material prosperity of British trade with West Africa.

Sulphuric Acid by Electrolysis.—Faraday and a host of subsequent experimenters have investigated the electrolytic oxidation of sulphur dioxide in aqueous solution, and have found that under normal conditions one-half the oxide undergoes oxidation to sulphuric acid at the anode, the remainder appearing as sulphur or sulphureted hydrogen at the cathode. In 1895, however, Dr. Leonard Wacker succeeded in rendering the oxidation quantitative by the concurrent use or production of carriers of oxygen, such as the persulphates, or even the halogens. Mr. Charles B. Jacobs now finds that the same result may be accomplished by a judicious application of the principle that oxidation is facilitated by a concentrated solution and low current density at the anode. In Jacobs's apparatus the anode is a porous composition through which the gas is injected in a continuous stream into the cell, and the anode area is 33 times that of the cathode. The vessel is provided with horizontal electrodes, and an interposed diaphragm. The porous anode constitutes a partition near the base of the cell, and into the lower compartment so formed sulphur dioxide is injected through the pipe, passing through the previous anode and undergoing oxidation therein. An outlet is provided for withdrawal of the sulphuric acid when the hydrometer shall indicate that the desired density has been reached. A refrigerating jacket is provided in order that advantage may be taken of the increased solubility of sulphur dioxide at 0deg. C. Jacobs, like Wacker, finds that by continuously injecting sulphur dioxide, the sulphuric acid may be brought to standard concentration. While, as stated, the reaction, chemically considered, is quantitative, all of the sulphur dioxide being converted, the electrolytic efficiency is given as 54 per cent.; this result is attained with a potential difference of two volts and a current density of 15-20 amperes per square foot of anode surface. The above note is taken from an article by Mr. Clinton Paul Townsend in the *Electrical World*.

Alternator Engine Speeds.—Mr. Edgar Knowlton contributes to the current number of the *Electrical World* a paper on engine speeds for direct-current alternators, in

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which the question of the influence of speed on the amount of flywheel effect required is discussed. He shows by means of formulæ that while for ordinary power work the flywheel effect varies inversely as the square of the speed, for alternator driving the same effect has to vary inversely as the fourth power of the speed to give success. The author starts with the assumption that for driving two alternators in parallel satisfactorily, the phase displacement between them must not exceed 5deg. In other words, the revolving parts of either machine must not vary more than 2·5 electrical degrees from a mean position. It follows from this that with any given type of engine the weight of flywheel required varies directly with the frequency of the alternator. In addition to preventing a too great displacement of either alternation in one revolution, the flywheel must also be heavy enough to prevent a too great variation in speed during the interval between a change in load and the final adjustment of the governor for that load. As a rule, if the weight of the flywheel is enough to ensure the first requirement, it will secure the second requisite also, but the author mentions one case in which this was not so. The article concludes with advocacy of high engine speeds and of the flywheel type of alternator. According to his calculation, with the flywheel type of machine 20 per cent. is saved in the first cost of machines over others of the same output and size requiring a separate flywheel. He comments on the fact that engines are now made for speed which would have been considered prohibitive a few years ago. We think that the author is quite correct in this, and that in many cases the speeds are still prohibitive at the present time—in other words, the extra cost of maintenance and the reduced life of these high-speed engines make them most uneconomical from a commercial point of view.

The Cauvery Transmission Scheme.—Under the heading of "The Cauvery Conceit," our contemporary *Indian Engineering* writes as follows: "They have succeeded at last in sending a 'thrill' from Sivasamudram to the Kolar goldfields, and all concerned have held a great 'Jambooree' in consequence. In the resultant heady excitement the wirepullers have confused their book, and several different statements have been made as to what we are to expect in a few days. Thirty-thousand volts is the shibboleth of one party, while another prefers the more prosaic 4,000 h.p. If the latter had not forgotten his recent history of the scheme, he would probably have tacked on the 185 h.p. which was to have been given as compensation for the excess over estimate for which the Mysore State had to pay. However, it seems that no serious work is to be attempted until the arrival of the Viceroy in August. There may be some more preliminary trials, which, as likely as not, will kill a few villagers on the way, despite the rules and regulations promulgated. When the population of Calcutta have to be safeguarded by such elaborate precautions from the comparatively harmless overhead wires, it is distressing to think of the danger of the ignorant bucolics of the Mysore State through whose homes a wire of such terrible possibilities as that conveying 30,000 volts has to pass, and there is a cynical brutality in the order which specifies that if the husbandman escapes death by electrocution he will probably find himself in gaol for trespass. At the 'Jambooree' a gallant officer made merry at the expense of the croakers who had prophesied disaster. We do not know of anybody who challenged the ability of the originator of the scheme to transmit power in the manner proposed, but we do know of several who questioned the feasibility of the scheme for Mysore, and who still doubt that it will ever pay." Surely our contemporary does not suggest that the live wires go through the native homes, nor even that the native is used to roosting on the telegraph wires, and will therefore make their homes on the power wires.

Disintegration and Pulverisation of Cathodes.—Messrs. F. Haber and M. Sack have recently published a valuable paper on this subject, which is abstracted at some length in the current number of the *Journal* of the Chemical Society. At the outset, the authors point out that the disintegration and pulverisation of cathodes in alkaline solutions were observed by Bredig and Haber in 1898, and ascribed to the formation of alloys with alkali metals. The subject is now more fully investigated by observing the polarisation at lead and tin cathodes, and by measuring the potential difference between alkali metal alloys and a solution of lithium chloride (1·56 per cent.) in methyl alcohol cooled by a mixture of solid carbon dioxide and ether. All the P.D.'s given are referred to an anode of mercury in contact with a mercurous oxide and a normal solution of sodium hydroxide. With a lead cathode in a solution of sodium hydroxide, pulverisation of the cathode began at 2·4 to 2·5 volts, a P.D. slightly lower than that between sodium and the lithium chloride solution, 2·7 volts. (The latter is not very different from the P.D. between sodium and a solution of sodium hydroxide at the ordinary temperature.) At a lower P.D. (1·7 volts) hydrogen begins to be envolved, and the surface of the cathode is more or less disintegrated. Alloys of sodium and lead containing 4·5 per cent. of sodium are brittle, act very slowly on water, and exhibit the same P.D. as lead (0·6 volt); those with 8 per cent of sodium and more give a sudden pulverisation with water. The P.D. increases from 1·8 volts at 8 per cent. to about 2 volts with 30 per cent. of sodium. The pulverisation of the weaker alloys is only observed for a moment when a fresh surface comes into contact with water, whereas the more concentrated sodium alloys are pulverised completely and rapidly. Tin behaves in the same way as lead; hydrogen is first evolved at 1·3 to 1·4 volts, and the metallic surface is etched; pulverisation begins at 2·3 to 2·4 volts. Alloys containing 8·6 per cent. of sodium show indications of pulverisation. Those with less than 6 per cent. do not. The P.D. between alloy and cooled lithium chloride solution shows a sudden increase from about 0 3 volt to about 1·4 volts at this point. Zinc is neither disintegrated nor pulverised. The authors also failed to prepare alloys of sodium with it. Platinum, heated to redness with sodium and then placed in alcohol, lost several decigrammes of grey powdered platinum. The P.D. between frozen sodium amalgams and the lithium chloride solution is about 0·7 volt less than the value found for sodium for all amalgams containing more sodium than corresponds with the formula Hg_2Na. Those containing less sodium have the same P.D. as mercury. The authors conclude that the dilute amalgams consist of a solution of Hg_2Na in mercury. The measurements throw no light on the composition of those containing more sodium.

The American Electro-Chemical Society.—We have received the first issue of *Proceedings* of this society which was inaugurated in Philadelphia in April last. It is a volume of some 250 pages of most interesting reading. We have to compliment the society on the concise way in which the matters dealt with by the various authors were presented and the interesting discussions which followed. The president for the inaugural meeting was Prof. Joseph W. Richards, Ph.D., of the Leigh University. Mr. Charles J. Reed is the secretary of the society, and may be addressed at 929, Chestnut-street, Philadelphia. Besides his introductory remarks, Prof. Richards read a paper on "A University Course in Electro-Chemistry." According to

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his views, the student who wished to enter the electro-chemical profession had three courses open to him at college — *i.e.*, the chemistry course, the metallurgical course, and the electrical engineering course. The author's views are that the course in chemistry concerns so many departments of chemical activity that but a very small part of it is devoted to the mutual relations and inter-reactions of electrical and chemical energy, and still less to what may be called electrical engineering. The graduate of this course has usually a very slight acquaintance with electrical subjects. A course in metallurgy usually differs from the chemical course in going less into detail in unusual analyses, in containing very little organic chemistry, and in place of these taking up the elements of some mining, mechanical, or electrical engineering subjects, such as petrology, geology, dressing of ores, steam-engines, mechanical technology, and electrical laboratory. The graduate of this course is well equipped in chemistry, and has considerable engineering knowledge, but is no more an electrician than he is a mining or mechanical engineer. He is, however, in Dr. Richards's opinion, better equipped for electro-chemical work than by the purely chemical course. The course in electrical engineering is unsuited as a preparation for electro-chemical work because of the very minor part necessarily assigned therein to metallurgy and chemistry studies, which must be begun early to be learned properly and well. It is less suited to the prospective electro-chemist than the metallurgy course, because of this deficiency Assuming that the above is a fair statement of the present status of those three courses, the most satisfactory preparation for the would-be electro-chemist has been to first complete the chemical or the metallurgical course and then to take electrical engineering in addition—a matter of at least six years' study, but a splendid combination if the student can devote that time. Even in this combination, however, some very desirable elements may be found wanting, such as thorough instruction in the inter-relations of chemical and electrical energy and experimental laboratory work in an electro-chemical laboratory. There is a certain borderland between the two sciences, electricity and chemistry, which requires a very thorough understanding of the fundamental principles of both sciences in order to be properly comprehended, and hence the exploring of this borderland is generally left out of both the chemical and the electrical curriculum, because it would not be easily understood by the student in either course. Study and work in this borderland require for their proper performance and appreciation a chemical and an electrical training such as those who take chemistry alone and electricity alone usually lack, and, therefore, such studies are usually not to be found in either course. Prof. Richards's conclusion is, therefore, that the end is best attained by starting with the metallurgical course, and modifying it to include the fundamentals of electrical engineering, and the study of electro-chemical subjects both by lectures and laboratory work. At the conclusion of the paper a course extending over four years is recommended, and details are given as to the way in which students should be occupied each term with various subjects. This question of electro-chemistry requires to be much more fully dealt with in the technical colleges in England.

Pike's Peak Power Transmission.—While we have had frequently to praise the large power schemes of America from an electrical point of view, there is much to be said for the ingenious civil engineering work which is done in connection with the same. An example of this is the work of the Pike's Peak Power Company in connection with their reservoirs and pipe lines on the East and West Beaver Rivers. These streams are noted for their high falls, and they have also a sufficient quantity of water to make them exceedingly valuable for power purposes In the dam for the first station of the company, which is now completed, a steel-faced construction is employed. The structure is in length 405ft. along the cap, 220ft. length of base, 148ft. cross-section of base, and 20ft. cross-section of cap. The upper slope, being the steel face, is 30deg. from the vertical, and the lower slope 50deg. vertical. The height of the dam from bed rock to the top of the sixteenth plate (being the spillway) is 70ft. The spillway is 40ft. wide, cut in granite formation, and passes around the north-west end of the dam. The granite back-fill, to which the steel plate is laid, is carefully laid in "dry wall" of heavy granite boulders, usually 20 to 80 cubic feet each, as broken by heavy blasting, with loose, fine granite filling the intervening space. The steel plate is built up of sheets 5ft. by 15ft. and $\frac{1}{4}$in. in thickness for the bottom, eight plates in height. Continuing, the plate is reduced in thickness to $\frac{3}{8}$in., and finally at the cap it is $\frac{1}{4}$in. The entire sheet is riveted with horizontal butt straps, and 4in. by 5in. by $\frac{1}{2}$in. angle bars are placed vertically the entire height of the dam across each interval of 15ft. for the entire length. The 5in. leg of each pair of angle bars project into the reservoir and constitutes a standing joint seam, with an iron liner $\frac{3}{8}$in. by 2in. riveted between the extreme outer points of these angle bars, thus making a thorough expansion joint for each section of 15ft. The bottom and end connection of the entire sheet is concreted into a deep channel-way, quarried out of bed rock, and the bottom terminates in two pairs of 5in. by 8in. angle bars, which are riveted through the plates. The end connections are prepared in exactly the same manner, but are applied vertically. The quarrying of the bed-rock channels was carried out horizontally in each case to a point rising to an elevation, and thence the rise was made abruptly in terrace form. The entire sheet is riveted up and caulked in the same thorough manner as in boiler practice. A space of 6in. was left between the steel plates and smooth surface of the granite back-fill. This narrow space is taken up by sand, gravel, and sedimentary deposit, the filling being applied with ample water and permitted to dry before water pressure was allowed to enter. The reservoir has a surface area of 130 acres, and holds 102,000,000 cubic feet of water. From the dam the water is taken through a wooden pipe 30in. inside diameter and no less than 23,200ft. long. It is made of $1\frac{1}{2}$in. redwood staves fastened together with $1\frac{1}{2}$in. steel bands and cast-iron lugs. After the pipe line has fallen some 200ft. a change is made to a steel pipe 29in. diameter. This finally reaches the power-house after a vertical drop of 1,165ft. in a horizontal distance of 3,100ft. With such a high fall Pelton wheels become the most economical. With the effective head of 1,160ft. a nozzle 1in. diameter will develop 236 effective horse-power. When the other stream—the East Beaver River—has been developed it will discharge into the tail race of the station in question, and the whole of the water will then pass on to the next station where some 5,500 h.p. will then be developed. At present, at station A there are fixed four 400-kw. General Electric three-phase dynamos, which are each coupled to a Pelton wheel. They run at 450 revolutions per minute, and generate 600 volts at 30 frequency. The current is then transformed up to 12,600 volts, and distributed by overhead wires to various mines within a radius of eight miles. We understand that Mr. R. M. Jones is responsible for the engineering undertaking, the details of which he has described in the columns of the *Electrical World*.

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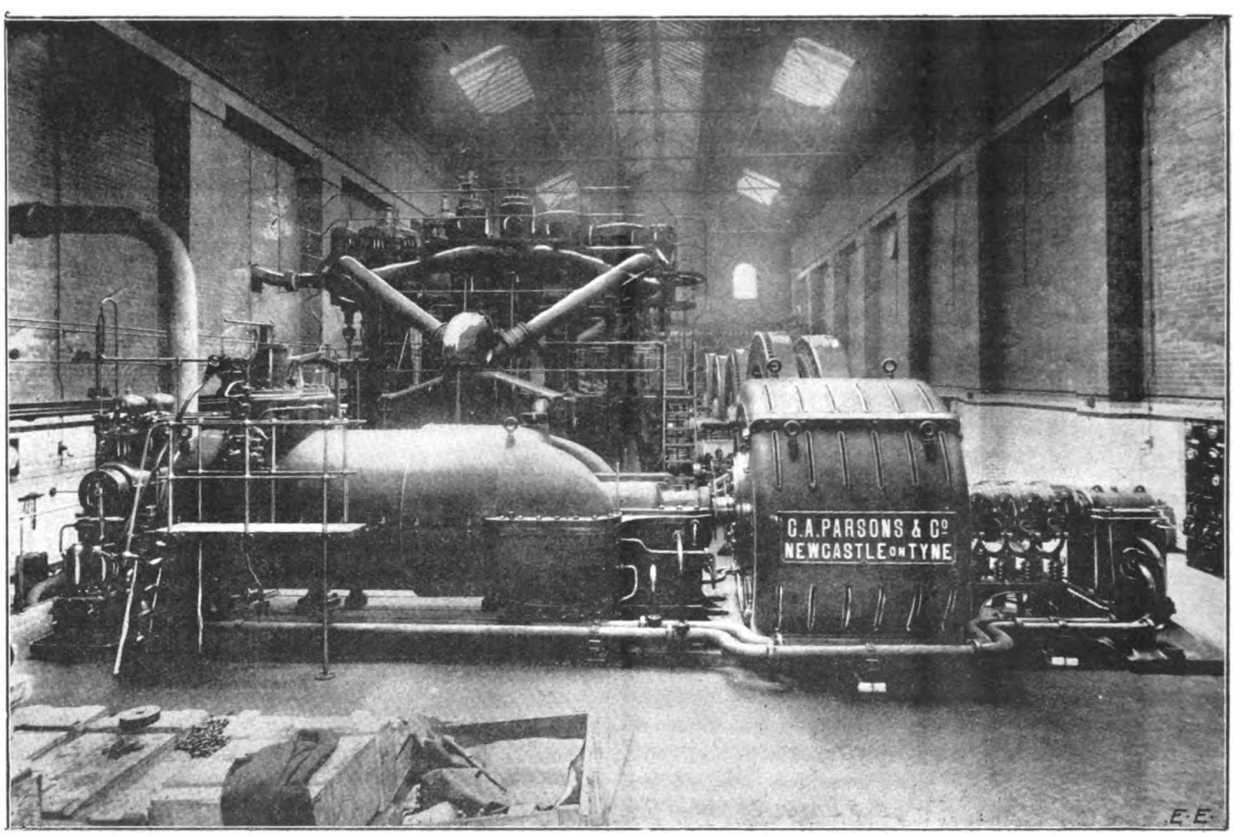
THE PARSONS TURBINE AT NEPTUNE BANK STATION.

Through the courtesy of Messrs. C. A. Parsons and Co., we are able to reproduce herewith a view of the 1,500-kw. turbo-alternator which that firm has supplied to the Newcastle-on-Tyne Electric Supply Company, and which is now running in the Neptune Bank power station at Walker. We have described (vol. xxvii., p. 886) the steam-engine equipment at these works, but the following information, obtained from the paper read last week at Newcastle by Mr. W. B. Woodhouse before the Institution of Mechanical Engineers, is of interest. The machine in question is designed for a voltage of between 5,000 and 6,000, with a frequency of 40 complete cycles per second at a speed of 1,200 revolutions per minute. Mr. Woodhouse proceeds to say that the alternator is direct-coupled to the turbine and is mounted on its own bearings; a forced circulation of oil and cooling water passes round each bearing. The air-pump and condenser are situated beneath the turbine; the three-throw air-pump being direct-coupled to a slow-speed electric motor running at 100 revolutions per minute. The circulating pump is direct-coupled to a 45-h.p. motor. As a prime mover of electrical machinery the steam-turbine approaches the ideal; it runs steadily, is free from vibration, and needs little attention. The question of steam consumption has been the difficulty. In a communication made to the Institution of Mechanical Engineers last year, the steam consumption per kilowatt-hour was given for a number of turbines; the figure steadily improved with the size of the machine. The Neptune Bank turbine bears comparison best with that supplied by Messrs. Parsons to Elberfeld—a machine of 1,000 kw. output. The figures of a test made at Neptune Bank are given in the table, from which it will be seen that the Elberfeld results are beaten. With units of 3,000 kw. to 6,000 kw. output, such as will be demanded in the near future, the turbine promises to outstrip all competitors.

Steam Consumption Tests of Slipway Engine and Parsons Turbine.

	Slipway engine.	Parsons turbine.
Mean revolutions per minute	101·2	1,200
Mean total indicated horse-power	1,030	—
Mean total kilowatts load	625	1,442
Pressure of steam at engine stop valve, pounds per square inch	193	196
Superheat, degrees F.	90·5	76
Vacuum in condenser, inches	26	27
Pounds of steam per indicated horse-power	10·35	—
Pounds of steam per kilowatt-hour	17·1	18



View of the Parsons 1,500-kw. Turbo-Alternator in the Neptune Bank Works of the Newcastle-on-Tyne Electric Supply Company.

ELECTRIC PLANT FOR RHODESIA.

The declaration of peace in South Africa will cause an opening out of the whole country, and will give an impetus to all engineering trades. While the mechanical branches will be largely employed in rebuilding bridges, repairing and relaying the permanent way of the various railways which have been damaged during the progress of the late war, yet the greatest advance will be in electrical engineering branches. Telegraph and telephone wires, notwithstanding the advent of wireless telegraphy, will be laid in all directions to connect the various commercial centres; but it is not in telephony and telegraphy alone that the progress will be made: improved and more rapid conveyance of passengers and goods will be called for between city and city, and this will probably be obtained by electric power, whether the ordinary track or the mono-rail system be adopted, and electric transmission of power will be almost universally adopted, especially for pumping, haulage, and similar work, where the power has to be transmitted some distance.

One of the first electric plants to be supplied since the war is now being shipped from England for a Rhodesian mining company. The whole plant consists of an engine, dynamo, motors, pumps, with switchboard and necessary cables. The engine has been built by Messrs. Robey and Co., Limited, of Lincoln, while the electric plant and pumps have been manufactured by Messrs. Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne. From the views of the dynamo and pumps it will be seen that the dynamo, which is of 72 kw. capacity, and designed to generate as its normal output 288 amperes at 250 volts with 750 revolutions per minute, is of Messrs. Ernest Scott and Co's. standard bipolar design, with undertype slotted-drum armature. This type of dynamo has in the past given the highest satisfaction both in England and the

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Colonies, and repeated trials have shown that, although the rated output is 72 kw. for temporary and emergency purposes, the output may be safely increased 25 per cent., to 90 kw. The dynamo, which is belt-driven, is in every respect similar to Fig. 1, and is in addition mounted on slide rails and fitted with the usual belt-tightening gear. Two sets of pumps, built by the same firm, are also being shipped. These pumps are shown in Fig. 2, and are of

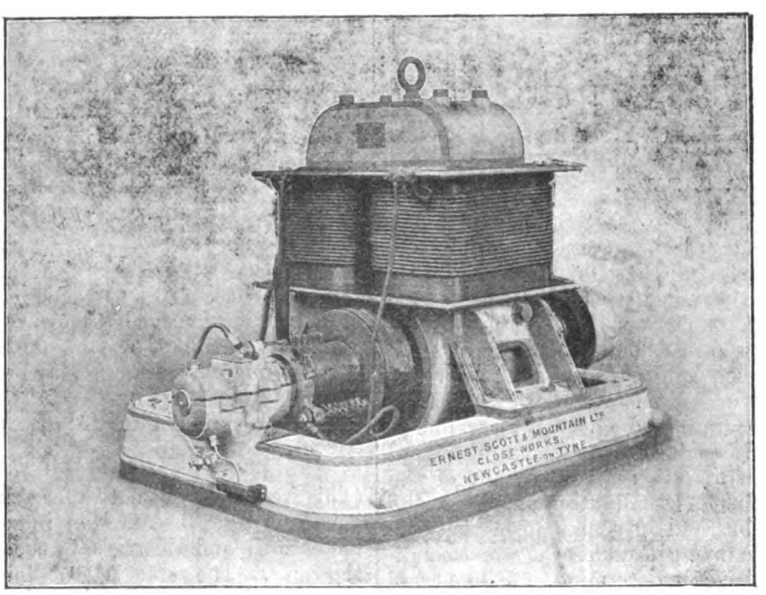

FIG. 1. Ernest Scott and Mountain's Dynamo.

Messrs. Ernest Scott and Mountain's horizontal three-throw mining type; in each case the pumps are belt-driven, a system which the makers prefer, except for very large sizes, when ropes are adopted, in order to minimise the jarring on the motor which would occur in starting up under heavy load if the motors were direct connected. The first set of pumps is designed to deliver 330 gallons of water per minute against a head of 80ft. through 6,000ft. of 6in. piping. The diameter of each ram is 10in. and the length of the stroke is 12in, the speed being 35 revolutions per minute. This set is driven by a 30 h.p. motor running at 800 revolutions per minute and working at 220 volts, a loss of 30 volts being allowed for in the cables between the dynamo and the motor.

The second set of pumps is similar but rather smaller than the above. This set is designed to deliver 85 gallons of water per minute against a head of 500ft. through 1,000ft. of piping, the speed being 40 revolutions per minute. The diameter of the rams is 6in., and the length of the stroke 9in. In both cases the rams are made of gun-metal, and the greatest care is taken to make the pumps thoroughly substantial and capable of withstanding rough usage. This set is driven by a motor designed to develop 20 h p. at 800 revolutions per minute on a 220-volt circuit. Both motors are in every respect similar to the dynamo shown in Fig 1, and each is controlled by a suitably arranged starting switch fitted with automatic no-volt release and overload preventer. In passing, it may be mentioned that no electric installation can be considered up to date, or even safe, in which modern and suitable starting switches are not included, as if these are not provided, there is always danger of breakdown to the motors, either from self-induction effects in stopping, or through the burning out of the armature owing to a too high starting current. Included in the plant is a well-arranged switchboard mounted with the necessary switches, fuses, and instruments. The current is conveyed from the switchboard through 2,000 yards of $^{19}/_{14}$ bare cable, to be carried overhead on insulators to the shaft head, and through 1,000 yards of $^{19}/_{14}$ heavily insulated cable for carrying the current down the shaft, and through the workings to the motors.

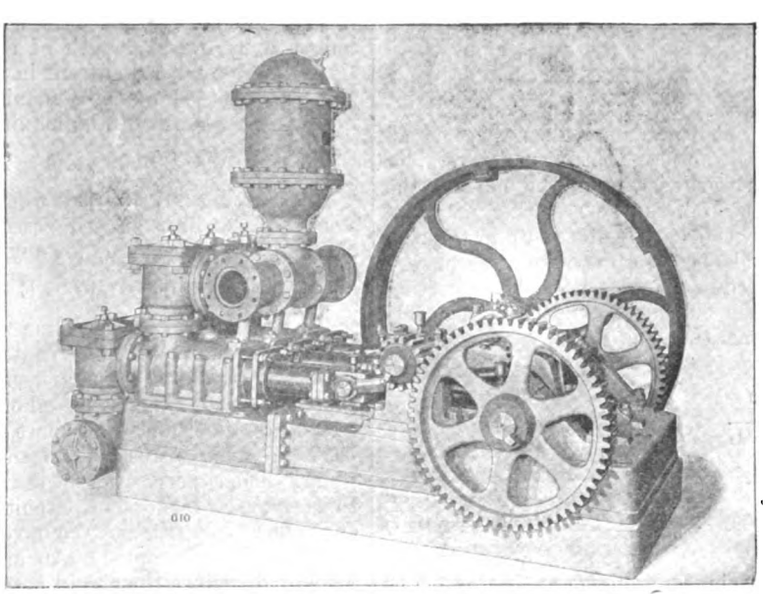

FIG. 2.—Belt Driven Pump for Mine Work.

Although the generators and motors are strongly built, and the makers consider the risk of breakdown or burning out of any of the windings to be very small, they are sending out spare armatures for each machine in order to

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make the chance of stoppage as remote as possible The mine owners have fully grasped the fact that the expedition and facility with which any damaged part can be replaced, added to the great freedom from breakdown in a well-equipped installation, constitutes one of the great advantages of electric driving. Seeing that in case of even such an extensive breakdown as the burning out of the armature of the generator, the dynamo can be stopped, the spare armature fitted, and the whole installation at work again within an hour, it is extremely doubtful if any with other system of driving so little annoyance would result from a breakdown.

SURGES IN TRANSMISSION CIRCUITS.*

BY F. G. BAUM.

A paper was presented by Mr. C. P. Steinmetz at the annual meeting of the American Institute of Electrical Engineers a year ago, discussing the subject of the causes and probable effects of the rise in potential over transmission circuits, but the paper was remarkably mathematical, and for that reason probably did not receive the attention it deserved. The subject has since been discussed by Dr. Kennelly and by Mr. Percy H. Thomas. These men are to be congratulated on their clear line of reasoning. The subject is an interesting one to us, as we have all seen lightning arresters fused on account of the sudden opening of a circuit. I shall attempt to put the matter as briefly as possible, and in such a form that the rise in potential which we may get under the worst conditions may be easily and quickly determined. Three cases will be discussed: (1) opening a line under a load or short-circuit; (2) closing a high-potential line switch to charge the line; (3) opening a high-potential line switch to "deaden" the line.

(*a*) *Opening a Line Under Load or Short-Circuit.*—Let us consider the case of a long line with a receiver load concentrated at the end. The line capacity will be assumed equivalent to a single capacity at the centre of the line. We will consider one leg of a three-phase system. The self-induction of one wire from the generator to the centre of the line—that is, up to the capacity—is L, and the capacity of the entire line as a condenser is C (C is the capacity between one line wire and neutral). A current, I, flows over the line and is suddenly interrupted. As is well known, the energy stored up in the magnetic field (due to the current, I) between the generator and the centre of line is $L\ I^2/_2$. If the current is suddenly interrupted, this energy must flow into line condenser, since there is no other outlet. (It should be noticed that when the receiver is opened, the line condenser is in series with one-half the line and the generator.) If V is the resulting potential across the line condenser, the energy stored up in the condenser is $C\ V^2/_2$. But this is the same amount of energy which was previously stored in the magnetic field, neglecting the small loss due to the current flowing over the line resistance in flowing over the line into the condenser. Therefore

$$L\ I^2/_2 = C\ V^2/_2,$$

or,
$$I = V\sqrt{C/L} = V\ C\left(\frac{1}{\sqrt{L\ C}}\right) \quad . \quad . \quad . \quad (1)$$

The current produced in a condenser capacity C by an E.M.F. having a frequency F is equal to (applied E.M.F.) $\times\ C\ 2\pi\ F$.

Comparing terms with (1), we see that $\frac{1}{\sqrt{L\ C}} = 2\pi\ F$, in which F is the frequency of the current in the condenser. (1) may therefore be written

$$I = V\ C\ 2\pi\ F \quad . \quad . \quad . \quad . \quad . \quad (2)$$

in which F is the natural periodicity of one-half the line. What really happens, then, when we interrupt the current, I, is that the same current, having its natural outlet cut off, flows into the line condenser and charges the line. But the line condenser cannot remain charged, and, therefore, the condenser discharges again into the line self-induction, and the energy again is in the form of magnetic energy. The magnetic field, then, again breaks down, giving up its energy to the capacity and the whole cycle is gone over again and again, until the resistance of the line consumes the energy originally stored in the line of self-induction. The frequency of the give-and-take of energy between the capacity and line self-induction is determined by the natural periodicity of the circuit, F. The frequency, F, in the equation (2) is therefore the frequency of the current, I, after this current has been interrupted at the receiver. If the circuit is working normally at a frequency *f*, the current, I, changes from a frequency *f* to a current of frequency F—that is, from the normal impressed period to the natural period of the circuit.

The natural periodicity of a circuit may be easily found from the equation

$$2\pi\ F = 1/\sqrt{L\ C},$$

or,
$$F = 1/2\pi\sqrt{L\ C} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

For a three-phase transmission line we may take the self-induction for one-half line, for one wire, as ·08 henrys per hundred miles, or L = ·08 H, H being the length of line in hundred miles. C may be taken as two microfarads per hundred miles, or $C = 2\ H/10^6$ farads. Substituting for C and L in equation (3), gives us approximately

$$F = 400/H \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

(This frequency will not differ much for different distances between wires, because an increase in the distance will increase L and decrease C, the product remaining nearly the same. The same is true for different sizes of wire.) That is, a line 100 miles long has a natural periodicity of about 400; a 200-mile line a periodicity of 200, etc. If we are operating normally at 60 cycles, a 200-mile line has a natural periodicity of little more than three times the frequency of operation.

From (2) we get the potential across the line condenser due to interrupting the current, I, equal to

$$V = I/C\ 2\pi\ F \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Substituting for C the value $2\ H/10^6$, and for F the value 400/H, we get the simple equation

$$V = 200\ I\ (\text{approximately}) \quad . \quad . \quad . \quad (6)$$

That is, the rise in potential is as a first approximation independent of the length of the line, and equal to 200 times the interrupted current in amperes. If I is equal to 100 amperes (141 amperes maximum), and the current is interrupted when it has its maximum value, then

$$V = 28{,}200 \text{ volts} = 200 \times 100\ \sqrt{2}.$$

Interrupting 200 amperes would give us double this rise. This E.M.F. will be superimposed on the line E.M.F., so the maximum strain possible for any interrupted current is

$$\text{Maximum strain} = E\ \sqrt{2} + 200\ I\ \sqrt{2}.$$

E is the voltage between line wire and neutral, and I is the current in amperes interrupted. It has been frequently noticed that a line having been short-circuited, and the short-circuit broken, the short-circuit will frequently re-establish itself or a new short start at some other place between points across which the line voltage could not jump. The superposition of the oscillating E.M.F. due to the removal of the short-circuit to the line E.M.F. is no doubt the explanation. We have assumed that the current is instantly interrupted. An arc will always be formed which will reduce the rise in potential.

On account of the inductive drop over the line, it is very probable that the current to be transmitted over one wire of a long-distance transmission (100 to 200 miles) must be limited to about 100 amperes, unless the frequency is reduced below 60. One hundred amperes, at 60 cycles, transmitted over a line 200 miles long, gives us an inductive drop of about 50 per cent. with 50,000 volts between wires. The generators will probably deliver four times full load current as a maximum on short-circuit. A short-circuit in the centre of the line would, therefore, give us about twice full load current, so that the maximum rise in potential due to the interruption of the short-circuit would be about

* Paper read before the sixth annual meeting of the Pacific Coast Electric Transmission Association at San Francisco.

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56,000 volts. If the line is operating at 30,000 volts (equals 30,000 $\sqrt{2}$ maximum) between neutral and line wire the strain would be a little more than twice the normal. Under certain conditions a greater rise may take place.

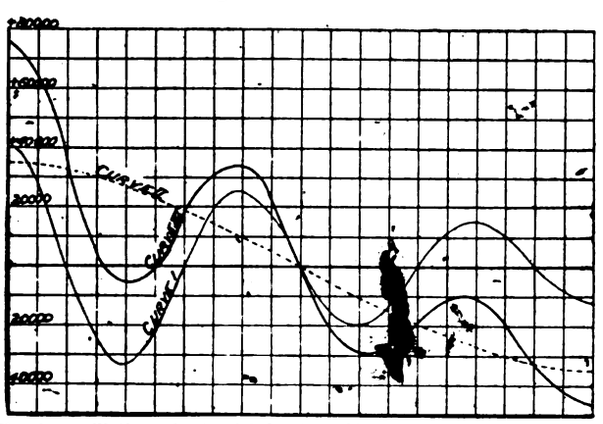
In the above we have assumed a long trunk line with a receiver at the end. When the receiver current is interrupted, the line current is forced into the condenser. On our long lines, however, we usually have loads distributed along the entire length, and if there is a load on at different points the line discharges a portion of its energy into the local distributing circuits, and the rise in potential is therefore limited.

The amount of energy stored in one-half of a 100-mile line is quite small. For 200 amperes it is

$$L\,I^2/_2 = \frac{\cdot 08\,(200)^2}{2} = 1{,}600 \text{ joules};$$

that is, 1,600 watts for one second. This amount of energy can be easily consumed by the local distributing systems and the line relieved of excessive strains. It is therefore important in a long line to have the loads distributed as much as possible, and then if we have even the worst condition of a short-circuit no excessive rise in potential will probably take place.

(*b*) *Closing a High-Potential Line Switch.*—On first closing a line switch on a dead line, a current will flow into the line condenser. But this current to reach the condenser must flow over the line self-induction, and energy will be stored in the magnetic field. This energy will then discharge into the condenser and add to the charge already in it. The maximum rise in potential is double normal working value.



Showing oscillations of potential due to suddenly interrupting 150 amperes. Length of line about 130 miles. Line voltage 25,000 between neutral and line wire. Curve I., oscillations due to interrupted current. Curve II., generator impressed wave, 60 periods per second. Curve III., resultant line potential. Current is interrupted so as to produce maximum rise of potential.

(*c*) *Opening Line Switch.*—If we open a line switch to deaden the line, we have the condenser of the line discharging at the periodicity of the line across the switch terminals the moment they are separated. Due to the charging current of the condenser, the potential of the line rises to its maximum working value at the normal frequency of the circuit. Before the switch jaws can be separated very far, the line potential due to the oscillating current in the line will be superposed on the potential across the switch due to the generator. This may cause the arc to re-establish itself several times before the line is finally dead. The maximum possible rise in potential in this case is double normal working value. We see from the above that the most dangerous condition is brought about when we suddenly open a short-circuit. Curve I. in the figure shows the oscillating potential due to interrupting 150 amperes on a line about 130 miles long. Curve II. shows the generator potential. Curve III. the resultant line potential. The resultant potential, we see, is very much different from the impressed generator pressure. If we continue to lengthen our lines until the natural periodicity of the circuit becomes nearly equal to the impressed periodicity, it is very probable that we will have some new problems to solve. It may be that this will prove the determining factor which will limit the distance of transmission. It is intended to carry on some experimental work in this direction in the near future to determine, if possible, what new problems would have to be met if our lines should reach a length of from 400 to 1,000 miles.

ELECTROLYSIS IN WATER-PIPES.*

BY W. H. HUMPHREYS, WATERWORKS ENGINEER, YORK.

With the advent into this country, during the 'eighties, of the single-wire system of electric tramways came the danger of electrolytic action on underground pipes; but it was not until 1893 that this danger was realised by the gas and water authorities. Probably there are few subjects about which greater diversity of opinion has been expressed by experts; many have maintained the danger as very real, some as illusory, and others as only a question of degree. That very serious damage can be caused by stray currents to the underground pipes is abundantly proved by evidence from many sources. In America, in great part owing to the careless and inefficient manner in which many of the electric tramroads have been laid, it is a much more serious question than with us, and the water authorities there have produced a mass of incontrovertible evidence of the havoc wrought by this agency. Here parliamentary committees have discussed safeguards, and the Board of Trade has devised regulations; but there yet remains considerable doubt among those most concerned as to the sufficiency of these regulations. As the subject has not been before our association, and is one that deeply concerns us, it may not be inopportune to bring it before this meeting in order to consider some of its various bearings.

There are in this country to-day few towns of any importance without some system of electric traction; in some of the local Acts special clauses have been inserted for the protection of the water authorities, and to those clauses the author will refer generally, after ascertaining something about the cause and the effect produced by electrolytic action. In this connection, we may premise that we have nothing to fear from electric light installations. The Board of Trade requires that all conductors for electric lighting shall be continuously insulated, and if any leakage occurs it can be readily detected, and it is to the interest of the electric lighting authorities to remedy the fault at once. In the case of electric traction by the single-wire system it is otherwise, as the current is sent from the generating station along the overhead wire, through the trolley rod to the motors in the cars, thence to the rails, along which it returns to the generating station. If the whole of the current was so returned, there would be very little to trouble about; unfortunately, that is not the case, it being one of the laws of electricity that, when an electric current can pass by different routes to a given point, the current will split up into parts inversely proportional to the resistance of the routes, the greater part passing by the route of least resistance, and so on. Although the rails are bonded by copper wires at each joint, and cross bonds are also used so that they may convey the current with the least possible resistance, yet a considerable portion of this current may leave the rails and pass through the earth (which, when moist, is an excellent conductor) to the underground pipes, along which it will travel until it reaches a point where the rails again offer a route of lesser resistance. What happens in this case has been pithily described as follows: "Where an electric current leaves a metallic conductor, and passes through the earth to another metallic conductor, the metal of the first conductor is eaten away"; where an electric current leaves a water-pipe the metal is pitted and eaten away in this manner, consequently very serious damage has been done to water-pipes from this cause. Ample evidence of this has been afforded by the discussion in December, 1900, by the New England Waterworks Association of a paper prepared by Mr. Knudson, an electrical engineer of New York. Mr. Knudson particularly looked into the causes of the deflection of currents from well-bonded tracks to water-mains, and he came to the conclusion that the bonding could not, however well done, be accepted as a cure for

* Paper read before the British Association of Waterworks Engineers at Leicester.

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electrolysis; a safeguard our own Board of Trade have always placed great reliance on. And to show to what a serious extent the subject has troubled our brethren in the States, a report drawn up by a special committee of the American Waterworks Association, and read at their meeting on June 19 of last year, is given in the appendix.

These deeply interesting experiences of our American cousins show to what an extreme point the evil has extended in their country. Let us now ascertain something about our own position. Prominence was first given, as already stated, to the subject in 1893, when the Board of Trade were desirous that Parliament should lay down a principle governing the amount of protection that should be afforded to telephone and telegraph companies who were using the earth return, and who were then endeavouring to secure the insertion in the various electric lighting and tramway provisional orders, and in tramway Bills, of protective clauses to prevent tramway companies using electricity for traction purposes, and electric lighting companies from using high-tension current on their circuits so as to interfere with the circuits of the telegraph and telephone systems. Up to that time the action of Parliament had not been uniform; four special clauses, each somewhat differing from the other, had been inserted in a similar number of Bills. In order to obtain uniformity, Parliament was asked by the Board of Trade to appoint a committee of both houses, which they did, and this committee was presided over by Lord Cross.

It was not until Sir Courtenay Boyle, the permanent secretary of the Board of Trade, startled the committee and alarmed the gas and water authorities by his evidence, that they became aware of the danger of electrolysis. He mentioned an instance where gas and water pipes were eaten away by "arcing," and a very serious accident was narrowly averted. This "arcing," however, as afterwards explained by Major Cardew, who had very thoroughly examined into the phenomena, was caused by the current supplying an electric light being deflected to a lead pipe and fusing it. The committee were further impressed when shortly afterwards Sir W. H. Preece (then Mr. Preece) told them that he was anxious that they should appreciate the question of voltage, and he went on to explain that "this electrical pressure formed between gas and water pipes is by far the most serious disturbance that is likely to be brought to your notice. The effect of it, if not checked, would be that the water-pipes or the gas-pipes, whichever was connected with the positive side of the current, would in course of time become decomposed; the constant action of the current on pipes covered with moisture, when it exceeds a certain voltage, means electrolytic decomposition, and unless some steps were taken to prevent this, then there certainly will be leakage of gas or water and possibly accident." Evidence of this nature, coming from such an authority, did not fail to impress the committee; moreover, Lord Kelvin also spoke strongly against powerful currents being allowed an earth return as being fatal to gas and water pipes. The result was that the committee decided to hear counsel on behalf of the gas and water companies. With the conclusions of Mr. Preece and Lord Kelvin Dr. Hopkinson agreed; but Mr. Crompton, Major-General Webber, and other noted electrical experts, thought that the question of electrolysis due to leakage from continuous currents had been either non-existent, over-estimated, or exaggerated. Major Cardew, the electrical adviser of the Board of Trade, produced for the inspection of the committee a piece of lead water-pipe, very much corroded throughout, and showing that where there had been a weak place in the lead, a hole was eventually formed; he had no hesitation in stating that "the greater part of the corrosion, and the rapid nature of it, was due to electric current." He had, further, made an interesting calculation as to the amount of metal corroded by a given current in a given time; for a continually flowing current of one ampere it would, he said, take five days eat away 1lb. of lead, 16½ days to eat away 1lb. of opper, and 27 days to eat away 1lb. of iron. Prof. Dewar raised the question in another form—namely, that it was not a question of specific electrolytic action on the pipe itself; but it was a graver question, as to how far the additional cause of corrosion, added to natural causes of corrosion, would accelerate the destruction of the pipe, and that the whole danger was preventable.

The result of the evidence given caused the associated water companies to suggest the following clauses to the committee as absolutely necessary to protect the gas and water pipes from electrolytic action; Clause (*d*) being copied from Section 29 of the Gasworks Clauses Act, 1847: "(*a*) The undertakers shall not make use of or permit to be used any conductor other than an effectively insulated conductor for carrying any supply of electricity from or to the generating station, nor shall they in any manner connect or permit to be connected to earth or any part of any circuit, except for the purpose of testing or indicating; (*b*) the undertakers shall employ all practicable means for preventing, detecting, and, as soon as practicable, stopping any leakage of the electric current to earth; (*c*) the undertakers shall not use or employ or permit to be used or employed any gas or water mains or pipes as conductors for the purpose of completing any electric circuit, or for the conveyance of electric current; (*d*) nothing in this order contained shall prevent the undertakers from being liable to an indictment for nuisance, or to any other legal proceeding to which they may be liable in consequence of generating, using, or supplying electric currents; (*e*) the undertakers shall compensate every person who suffers any damage by reason of any failure to observe the provisions of this order, or caused without any default on his part or on the part of any persons for whom he is responsible, by an electric current generated, transmitted, or employed by the undertakers."

The committee, however, agreed that the clauses which follow should be inserted in all Bills and provisional orders (other than those for electric lighting) which authorised the use of large electric currents: "(1) The undertakers shall in the use of electric power under the provisions of this Act employ either insulated returns or uninsulated metallic returns of low resistance. (This clause not to apply in the case of railways, tramways, or tramroads in which the motive power is entirely self-contained.) (2) The undertakers shall take all reasonable precautions in constructing, placing, and maintaining their electric lines and circuits, and other works of all descriptions, and also in working their undertaking so as not injuriously to affect, by fusion or electrolytic action, any gas or water pipes, or other metallic pipes, structures, or substances. (3) The exercise of the powers by this Act conferred with respect to the use of electric power shall be subject to the regulations set forth in the schedule of this Act, and to any regulations which may be added thereto or substituted therefor respectively, by any order which the Board of Trade may, and which they are hereby empowered to make from time to time, as or when they may think fit, for regulating the employment of insulated returns or of insulated metallic returns of low resistance for preventing fusion or injurious electrolytic action of or on gas or water pipes, or metallic pipes, structures, or substances, and for minimising as far as is reasonably practicable injurious interference with the electric wires, lines, and apparatus of other parties and the currents therein, whether such lines do or do not use the earth as a return. (4) The undertakers using electric power contrary to the provisions of this Act, or to any of the regulations set forth in the schedule to this Act, or to any regulation added thereto or substituted therefor by any order made by the Board of Trade under the authority of this Act, shall, for every such offence, be subject to a penalty not exceeding £10, and also the case of a continuing offence to a further penalty not exceeding £5."

The committee also agreed upon certain resolutions, which it may be interesting to briefly reproduce. For instance, they were not of opinion that it was necessary, in the then state of electrical science, to insist upon electrical tramways using insulated return conductors, as it would retard the development of electric traction; although they were good enough to say, in another resolution, that they regarded with apprehension a large extension of the system of overhead wires in crowded centres. The danger from fusion or electrolytic action appeared to them to have risen from a faulty system of constructing

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electric tramways, and their opinion was that it could be so reduced by improved methods of construction as to become a practically negligible quantity. They recommended that the Board of Trade should have power conferred on them to make regulations to secure the best system of construction; one being that a return conductor, if in contact with the ground, should be of such section and resistance as to have no difference of potential sufficient to set up injurious leakage currents in the earth. They also said that if the regulations were altered after the use of electric power had been sanctioned, the undertakers should not be required to alter anything, except for the public safety, or unless it were proved to the satisfaction of the Board of Trade that any system of metallic pipes was being substantially injured by the action of electricity escaping from the conductors; and this had to be done only providing that it did not cause substantial additional expenditure. This was rather ambiguous wording, as expenditure in such a case could hardly be otherwise than substantial. Moreover, it left the owners of the pipes to part with their substance to protect themselves against the attacks of an insidious enemy who had come on to the ground at a later period.

We now come to the regulations issued by the Board of Trade as a result of this enquiry, and will also take a glance at some of the Bills, in which restrictive clauses have been adopted, passed since that enquiry. The regulations provide for "regulating the employment of uninsulated metallic returns of low resistance; for preventing fusion or injurious electrolytic action of or on gas or water pipes, etc." Clause 2 requires the conductors for transmitting energy from the generator to the motor to be insulated and known as the "line." The return may be uninsulated, according to the following regulations, which, being important, it may be desirable to place on record for convenience of reference.

Extracts from Board of Trade Regulations.

5. When any part of a return is uninsulated it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections which shall be placed not less than 20 yards apart. Provided that in place of such two earth connections the company may make one connection to a main for water supply of not less than 3in. internal diameter, with the consent of the owner thereof and of the person supplying the water, and provided that where, from the nature of the soil or for other reasons, the company can show to the satisfaction of an inspecting officer of the Board of Trade that the earth connections herein specified cannot be constructed and maintained without undue expense the provisions of this regulation shall not apply. The earth connections referred to in this regulation shall be constructed, laid, and maintained so as to secure electrical contact with the general mass of earth, and so that an E.M.F. not exceeding four volts shall suffice to produce a current of at least two amperes from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with. No portion of either earth connection shall be placed within 6ft. of any pipe, except a main for water supply of not less than 3in. internal diameter, which is metallically connected to the earth connections with the consents hereinbefore specified.

6. When the return is partly or entirely uninsulated, the company shall, in the construction and maintenance of the tramway (*a*) so separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity; (*b*) so connect together the several lengths of the rails; (*c*) adopt such means for reducing the difference produced by the current between the potential of the uninsulated return at any one point and the potential of the uninsulated return at any other point; and (*d*) so maintain the efficiency of the earth connections specified in the preceding regulations as to fulfil the following conditions — viz.: (i.) that the current passing from the earth connections through the indicator to the generator shall not at any time exceed either two amperes per mile of single tramway line or 5 per cent. of the total current output of the station; (ii.) that if at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return. In order to provide a continuous indication that the condition (i.) is complied with, the company shall place in a conspicuous position a suitable, properly connected, and correctly marked current indicator, and shall keep it connected during the whole time that the line is charged. The owner of any such pipe may require the company to permit him at reasonable times and intervals to ascertain by test that the conditions specified in (ii.) are complied with as regards his pipe.

7. When the return is partly or entirely uninsulated, a continuous record shall be kept by the company of the difference of potential during the working of the tramway between the points of the uninsulated return furthest from and nearest to the generating station. If at any time such difference of potential exceeds the limit of seven volts, the company shall take immediate steps to reduce it below that limit.

8. Every electrical connection with any pipe shall be so arranged as to admit of easy examination, and shall be tested by the company at least once in every three months.

9. Every line and every insulated return or part of a return except any feeder shall be constructed in sections not exceeding one-half of a mile in length, and means shall be provided for insulating each such section for purposes of testing.

10. The insulation of the line and of the return when insulated, and of all feeders and other connectors, shall be so maintained that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged. If at any time it should be found that the leakage current exceeds one-half of an ampere per mile of tramway, the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 hours. Provided that where both line and return are placed within a conduit this regulation shall not apply.

In the Bristol Tramways (Extensions) Act, 1896, the following clause was inserted for the protection of the Bristol Gas and Water Companies: "22. If the company desire, under the authority of this Act, to do any act which shall or may render necessary the removal, displacement, or duplication of any of the then existing mains or pipes, valves, siphons, plugs, or apparatus, or other works belonging to or controlled by the Bristol Waterworks Company or the Bristol Gas Company, the company shall give to the company to be affected by such Act 14 days' notice in writing of such desire, and such company shall forthwith (without prejudice, nevertheless, to the protection afforded them by the Tramways Act, 1870, and subject to the proviso in this section hereinafter contained) make such removal, displacement, or duplication as may be necessary, and do all works incident thereto, and all expenses to be thereby incurred shall be defrayed by the company. Provided always that if the company are of opinion that such Act does not render necessary any such duplication, the question as to the necessity thereof shall be determined by an arbitrator to be appointed by the Board of Trade on the application of either party, and such arbitrator shall also determine as to whether the whole, or, if not the whole, what proportion of the costs of such duplication shall be paid by the company, and by whom the costs of the arbitration and award shall be borne out without prejudice to any existing rights of the company or of either of the said companies to refer any question other than the necessity of such duplication to arbitration under the provisions of the Tramways Act, 1870. Nothing contained in this Act shall interfere with the exercise by either of the said companies of the powers and privileges

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conferred upon them respectively by any Acts or Act of Parliament of laying down and maintaining, and, as occasion may require, of repairing and altering any mains or pipes in and under any of the roads upon which the tramways may be laid or works executed under the authority of this Act. And the provisions of the Tramways Act, 1870, shall extend and apply to all works by this Act authorised, and to the company in respect thereof, and the provisions of that Act in favour of the local authority or the road authority shall be extended to and include each of the said companies."

The question of compensation for damage to underground pipes became prominent during the consideration of the Wrexham Tramway Bill in 1900. It was then endeavoured to obtain the insertion of the following clause—viz.: "Notwithstanding anything contained in the Wrexham District Tramways Act, 1873, or the Wrexham District Tramways Order, 1899, the promoters shall be liable for any loss or damage to the water mains or pipes of the Wrexham Waterworks Company resulting from fusion or electrolytic action caused by any currents generated or used for the purpose of electric traction on any of the tramways authorised by the said Act or order." This clause was asked for because the model Bill clauses were considered to actually protect electric traction companies against any claim for compensation for any damage which they may cause by wilful or culpable breach of the Board of Trade regulations, as well as damage which may be done even when those regulations were most carefully complied with. So long as the tramway companies take *reasonable precautions* (a widely expansive term), their liability ceases.

The Sheffield, Birmingham, and Dublin (St. James) Acts, and other Acts or orders, have had special clauses inserted, almost identical in expression, providing for compensation for injury to mains by electrolytic action. This clause, known as the "Sheffield Clause," was only obtained after a very stiff fight, and the usual conflict of opinion between the expert witnesses; and has been described as the outcome up to the present of the wisdom of Parliament on this subject. The clause says: "Provided that notwithstanding anything contained in the said Acts or this Act, if it be proved that any injury or damage to any mains, pipes, or apparatus of the Sheffield United Gaslight Company shall have resulted from fusion or electrolytic action caused by any currents generated or used for the purpose of electric traction on any of the tramways for the time being belonging to the Corporation, nothing in the said Acts or this Act shall relieve the Corporation from any liability to make compensation for such injury or damage which would have existed but for the passing of the said Acts and this Act." We thus see that the seeds sown in the Wrexham case have borne fruit in the above.

So far as it has been possible to ascertain from a search through the columns of the *Journal of Gas Lighting and Water Supply*, scarcely any direct damage has been recorded as having taken place in this country. No doubt this will be ascribed by many to the action of the Board of Trade and the great care they have exercised in the supervision of the construction and working of electrical tramways, and to some extent to the comparatively short time they have been in existence. That much damage may have been, and is being, done under the Board of Trade regulations is an opinion held by many who are well able to form an opinion on the subject. When the author a short time ago had occasion to bring this subject before the Board of Trade, the Permanent Secretary stated that "no case of electrolysis in connection with electric tramways working under the Board regulations directed against electrolytic action had been proved to them"; and it is to be assumed that until such time as direct evidence can be brought before them, it is almost hopeless to expect them to make their regulations more stringent. Major Cardew, the Board of Trade expert already referred to, has stated that two volts were sufficient to produce electrolytic action; and Mr. James Swinburne, one of the greatest experts of his day, has also stated that one ampere of current would eat away six or seven grains of iron per hour. These facts are mentioned to give an idea of what injury can be done. On the other hand, the Glasgow Corporation gas and water departments in 1898, being anxious to know if any injurious effect had been produced on their pipes by the electric tram system, instructed their electrical engineer to examine the subject; and from the very able report made by that gentleman they concluded that there was no reason for alarm, their opinion being that if the regulations of the Board of Trade were observed and carried out there did not appear to be any danger of the pipes laid along the route being injuriously affected by electrolysis. They instructed their electrical expert to report at once any facts or circumstances which might thereafter come to his knowledge; and after a period of four years it would be very interesting to know the result.

The opinions of Mr. Wordingham, the electrical engineer of the Manchester Corporation, are not so sanguine, which may be accounted for by the fact that a period of three years has elapsed since the Glasgow report was made, and meanwhile his opinions have matured—an important factor in the present rapid advance of electrical knowledge. He unhesitatingly declares that the Board of Trade regulations are insufficient, and that unless their limits are substantially curtailed, the destruction of pipes to a similar extent as in America is only deferred. Prof. Perry, whose opinions all should listen to with respect, told the Institution of Electrical Engineers, in his presidential address, that if the tram returns were not insulated, gas and water pipes would suffer such harm that time alone could only show. He further kindly complimented gas and water authorities for their "ignorance" in quietly sitting still and allowing their pipes to be eaten away in something like 20 years! Whilst the authorities mentioned cannot be exactly described as sitting still, yet their efforts, through want of unison, have not had the effect of gaining the increased protection which their vast interests entitle them to. What have those authorities done in the matter? The chairman of the Chelsea Company has stated that the gas and water companies were uniting in order to bring pressure to bear upon the Board of Trade to introduce some regulations under which those who cause the damage shall be made to bear the cost of repairing it. It would be interesting to know the names of the companies which have so combined, and what has been the result of their combination; as, beyond a deputation comprising members of the Gas Companies' Protection Association, which waited on the President of the Board of Trade in April of last year, and whose proceedings were strictly private, nothing appears to be known of the result. In the case of the London United Tramways Bill last session, the opposition certainly succeeded in producing sufficient evidence to induce the House of Lords to place a clause in the Bill giving powers to the Board of Trade to impose insulated returns should they at any time deem it expedient to do so. In pursuing enquiries into this subject, it has become evident that individual authorities have taken the subject up with more or less thoroughness, but what is wanted is united action on the part of the gas and water authorities throughout the country. Whether the water supply is in the hands of the public or of private authorities is immaterial; both must suffer. The Board of Trade will not alter their present model clauses until unanimity of action has produced evidence sufficient to justify them in doing so. It has been suggested by several authorities, and its expediency is manifest, that the gas and water authorities should unite in asking the Board of Trade to institute an enquiry; or, as Mr. Hunter, the engineering director of the Grand Junction waterworks, has suggested, induce the Government to appoint a Royal Commission. How either of these desirable ends are to be attained might, perhaps, be decided if a conference between this association and representatives of the gas industry could be arranged. The remedies suggested for the evil are many; but where even electrical experts are so much at variance, the ordinary layman can do no more than chronicle their ideas, premising, however, that only by entire insulation from the earth—that is, by the conduit or double-wire system—can electrolytic action be entirely prevented. It is too late in the day, however, to think of that. Daily, in all parts of the country, the single-wire system is being extended, and it is under those circumstances that a remedy must be found. Another means has been suggested

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that by connecting the negative terminal of the dynamo to the underground pipes, the result of which would be to raise the whole of the electrical circuit, in potential positive with the pipes and the general earth, and when that is the case any leakage current passing between the electric system (including the uninsulated rails) and the pipes will tend to corrode the rails and preserve the pipes. As this arrangement is all right for the pipes, we may probably see no reason why it should not be adopted. There is also Mr. Wordingham's system, a costly one, of feeding the tramway system from stations or sub-stations spaced at such short intervals along the lines as will keep down the loss of pressure in the rails to a very low amount. The Ganz system of electric traction; the Schuckert system of surface-contact tramway traction, with alternating current; and the Westinghouse alternating-conduit system, all much used abroad, are reported as free from the faults ascribed to the single-wire system. There is another system of electric traction which has met with much success on the Continent, and should be welcomed by water engineers in this country—namely, the double-wire overhead system which runs the cars without rails at all. The rapid advancement in electrical knowledge and invention should cause our municipal authorities to "ca canny," otherwise we may soon have repeated the process which we have recently witnessed of pulling up the rails laid for horse and steam traction in order to replace them with others.

Much more of interest might be said, particularly of the great amount of information collected in the United States; but the facts presented in this paper will amply suffice if they induce this association to take up the matter by collecting information as to the extent which our underground pipes suffer from electrolytic action, and as to the best possible means of remedying the evil. Those who may desire to look at this subject from an electrician's point of view are referred to the very able paper delivered, since this article appeared in type, to the members of the Gas Institute by Mr. James Swinburne, president of the Institution of Electrical Engineers.

Appendix.

Report of Special Committee of the American Waterworks Association on Electrolysis.

A very large number of mains and service pipes have been already actually destroyed by the stray return currents of electric railways operating under the single trolley system, many instances of such destruction of pipes by these currents having been reported from practically every city where the single trolley system has been in use for any considerable length of time. Even where the action is too slow to be immediately discovered, the life of mains and service pipes is inevitably greatly shortened, and their value thereby necessarily proportionately increased.

2. In the single trolley system, no matter how large the capacity of the return feeders, nor how good the bonding of the rails, and even when the continuous rail is used, some electric current will, under the law of divided circuits, flow along the water-pipes, the amount of this current bearing the same proportion to the total current used that the conductivity of the return path of which the water-pipes form a part bears to the total conductivity of all the return paths offered to the current. As neither the rails nor the pipes can practically be insulated from the soil in which they are laid, the proportion of current conveyed by the pipes is considerable, even with the best track bondage known to modern science, including the welded joint.

3. The electric current, once on the pipes, must leave them to return to its source—the generator; and whenever the current leaves the pipes to pass through the soil, the pipes are damaged.

4. Electrolysis also results from differences in potential between water-pipes and any other underground metal conductor, such as gas-pipes, and as long as the return current is not entirely removed from the earth such action will continue.

5. The extent of the electrolytic injury at any point is directly proportionate to the number of amperes of current leaving the pipe. The smallest measurable difference of potential is sufficient to produce electrolysis.

6. A cast-iron water-main is not a continuous electric conductor, and its joints offer very much higher resistance than an equal length of plain pipe.

7. The inevitable effect of any resistance at the joints is to cause a part of the current carried on the pipes to be shunted around the joint, either through the soil on the outside or through the water on the inside, or by both paths.

8. Wherever the current leaves the pipe to pass around the joint, either outside or inside, or both, the pipe is injured. The action of a fraction of an ampere flowing around successive joints will in time do great aggregate damage to any cast-iron main on which it flows.

Your committee is convinced, after careful consideration of reliable data on the subject, that there is no known practical method by which owners of underground pipes can protect them against electrolytic injury from single trolley currents, but that there are two methods of operating electric railways by which the return currents can be kept out of the ground—namely, the conduit system, as in use in New York City and in Washington, D.C., and the double overhead trolley system, as operated in Cincinnati, Ohio, and on the suburban lines in the district of Columbia. The conduit system is more expensive to construct, and is peculiarly adapted to the larger cities. The first cost of installing a double trolley system would be little greater than that of a single trolley system for the same service; while the cost of converting an existing single trolley system to a double trolley system would be trifling, as compared with the enormous interests endangered by the single trolley system. Ten years' experience with the double trolley in Cincinnati proves that that system is entirely practical, possesses many advantages over the single trolley, is more economical in operation and maintenance, and that it completely stops the injury to the pipes.

Your committee therefore respectfully makes the following recommendations: Street railway companies should be compelled, as are electric light companies, and all other electric power companies, to provide a complete metallic circuit for the current, absolutely insulated from the rails and ground. This will keep the return currents out of the ground and off the pipes, and can be accomplished either by the conduit system or by the double trolley overhead system.

2. No connections by which a current is carried to the pipes, or induced to flow thereon, should be allowed from pipes to rails, or to other return conductors; and no other alleged remedy which permits the mains to carry any portion of the current, should be countenanced by those in charge of waterworks plants. Even the failure to prohibit or to protest against such connections might be construed by law to be a tacit consent on the part of the waterworks management to the use of the pipes as conductors, and might relieve the electric railway company from responsibility for the injury which would inevitably result if the mains were allowed to convey current.

In the further discharge of the duties for which it was appointed your committee respectfully submits for your approval the following preamble and resolutions as an expression of the attitude of this association on the question of electrolysis: Whereas, the report of the special committee on electrolysis shows that wherever the single trolley system is in use a portion of the return electric current will flow on the water-pipes, and that whenever water-pipes become positive to rails or gas-pipes, or other underground metal structures, the water-pipes are injured; and that whenever water-mains, whether positive or negative to the rails, convey electric current, they are liable to injury thereby, near the joints; and, whereas, it further appears from the said report that there is no known practical method by which owners of water-pipes can protect themselves against electrolytic injury resulting from the operation of single trolley cars, but that electric railways may, by means of the conduit system or of the double overhead trolley system, be operated successfully and economically and without any injury to the water-pipes; now, therefore, be it resolved: that the American

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Waterworks Association, as a national organisation, herewith unanimously maintains that street railways have no right to so operate their cars as to cause injury and destruction to pipes; and be it further resolved: that street railways now operating under the single trolley system ought to be required to remove their return current from the ground; and that if they continue to operate by current transmitted from the power station to motors on the cars, they should be required to provide a complete metallic circuit of sufficient capacity to convey all the current, and in a manner to absolutely insulate it from the rails and from the earth.

SOME NOTES ON ELECTRICAL ENGINEERING PRACTICE IN EUROPE AND AMERICA.*

BY JOHN DENHAM, MEMBER.

At very short notice I have been asked to furnish a paper to be read and discussed before this local section dealing with electrical matters which I came across during my recent tour through Europe and America. This paper must necessarily be very incomplete, as my time has been largely taken up since my return with official reports, etc., and I have not had time to sort out the large amount of different data collected. Being much interested in central-station working and the transmission and utilisation of electric power, I visited many modern stations and a few ancient ones.

The plant installed at Shepherd's Bush for the Central London Railway is made by the General Electric Company of America. It consists of six three-phase generators, each of 850 kw., 5,000 volts, 25 periods, driven by Allis's cross-compound engines with Corliss gear, speed 95 revolutions. Considerable difficulty has been found in running these sets in parallel, and it is not usually done. Three-core cables convey the high-tension current to different sub-stations, where it is transformed down by 300-kw. air-cooled transformers to 330 volts, and works rotary converters of 900 kw. running at 250 revolutions, and giving 500 to 550 volts on the direct-current side. The section of line nearest the station is fed from rotaries located in the power station. The rotaries work well, and are very small for their output. Each train, consisting of seven cars, was originally hauled by an electric locomotive of about 500 h.p., there being four motors built direct on the axles. There was, however, considerable trouble experienced with the vibration which was communicated to the tube tunnel and thence to adjacent buildings. It has now been decided to abandon the direct-driven axles, and use single-reduction motors fixed to passenger cars instead of separate locomotives, and some of these are already in use. It is found that the weight is lessened (the motors being smaller) and the tractive effort and the vibration much reduced. The tube and track is arranged so that the stations are on the top of a rise, there being a grade of about 1 in 40 down on either side. This has the advantage that trains entering a station run up the incline with their own momentum, and it needs but little current for restarting, as the train on leaving is at once on a steep down grade. An elaborate system of electric lifts, each holding 50 to 60 people, is installed at each station to convey passengers to and from the surface, and I was informed that 25 per cent. of the total power is required for this particular service.

Many of the London lighting stations are changing over from 220-volt three-wire system to the 440-volt, and as they are using the original cables, there are numerous serious breakdowns constantly happening. The tendency now is to build high-tension polyphase generating stations on the outskirts of London, and use the present generating stations as sub-stations and centres for distribution. The Metropolitan Electric Company have already built a large station for this purpose at Willesden, but I did not see it. At Hampstead single-phase alternating current is in use, and although the alternators and engines are of different patterns and manufacture they run well in parallel. The synchronising is done by spots painted on the poles, which, when lighted by alternating arcs, indicate to the engine driver whether the incoming set is running too fast or too slow. This plan works well, but as it often happens that a new set has to be run up during daylight, the spots cannot be seen very clearly in the conflicting light. At East Ham three-wire 480 volts lighting system has been adopted, mainly to enable the same generators to be used either for lighting or traction, but not simultaneously, of course. Difficulty is experienced in getting 240-volt lamps of efficient make and having a fair life.

I joined the Institution of Electrical Engineers on their trip to Germany. We reached Hanover on a Sunday, and were invited to a banquet the same evening. The city electrical engineer presented each of us with a little insulator as a memento. We did not know whether it was intended for an ash-tray or a mustard-pot, but finally it was put to the satisfactory use of a liqueur glass. From Hanover we proceeded to Berlin, and went over numerous works and power stations. Some of these were equipped with obsolete machinery, but the one that attracted my particular attention was at Moabit. There were three magnificent sets, each consisting of Sulzer horizontal double-tandem triple-expansion engines of 4,000 h.p., coupled to gigantic three-phase alternators of 3,000 kw. 6,800 volts, running at 83 revolutions, periodicity 50. After inspecting this station in company with the members, I was privileged to return the following day, and examined it with more attention. Three sets were running in parallel on about two-thirds full load, and at my request the engineer-in-charge was good enough to transfer the load from one to another, synchronise, and, in other respects, prove how perfectly the plant was under control. The synchronising current was very small, and the sets ran perfectly in parallel, notwithstanding their very low speed. The result was largely, if not entirely, due to the system of damping coils inserted in the laminated pole-pieces. These consisted of a number of bare copper rods about ½in. diameter sunk just below the level of the iron of the pole-pieces, and these rods were all short-circuited at the ends by a rectangular casting. This casting also acts as a flange to hold the exciting coil in place. Each field pole is removable separately sideways, so that a burnt coil can be readily replaced. As regards the stationary armature it was of the utmost simplicity and practically indestructible. The laminated plates of which it is built up have rectangular slots punched out very close to the periphery (a slit being afterwards cut through), a rectangular tube of micanite about ¼in. thick is pushed into the slot, and a copper bar is inserted into the tube. The micanite projects a couple of inches beyond the core to prevent surface leakage, and as there are no convolutions there can be no internal short-circuits of coils. The copper bars are coupled at the ends by suitably shaped connectors of copper strip. Being such large machines the solid rods are capable of generating the full pressure of 6,800 volts, and it seems impossible that such a machine could break down electrically.

By the courtesy of the Allgemeine Electricitäts-Gesellschaft, I was enabled to meet Prof. Dobrovolsky and to have certain points explained upon which I was not clear. Chiefly among these was the question of damper windings. It seemed to me that if eddy currents were induced in them such currents meant wasted horse-power, and if no currents were there, what was the object of the coils. It was explained to me that if alternators fitted with the damping coils and driven by engines (or turbines) having a uniform torque were run in parallel, there would be no eddy currents, and consequently no waste of power. The coils would simply be idle. But if the prime movers were not of uniform torque, eddy currents would be generated in proportion to the tendency to get out of step, which would hold the machines in phase. The worse the engine the more work would be thrown on the coils. The coils, therefore, though being located on the electric generator would really be acting as an additional flywheel to the engine. A very ingenious boosted rotary was at work in the Moabit station. Naturally, a drawback in using an ordinary rotary is that the ratio of transformation from alternating current to direct is fixed once for all. Therefore, in case of a heavy load on the direct side of one rotary, it would be necessary to raise the alternating voltage, which might be inconvenient to other lightly loaded rotaries fed from the same source. This difficulty appears to be overcome by a method patented by Dobrovolsky, which consists of an ordinary rotary coupled on the same shaft to a booster provided with a shunt-wound field magnet. The polyphase current (in this case six-phase) was fed to six rings. From each ring a certain number of convolutions were taken round the booster armature and then coupled to six points on the armature windings of the rotary proper. The booster windings and pole-pieces would be suitable in number to the periodicity employed. Now the action is as follows: if the field magnets of booster are not excited, the polyphase current is converted to direct in the ordinary manner and in the ordinary ratio of voltage; but if the field coils are excited in one sense, they add volts (due to the booster windings passing them at the proper periodicity) to the incoming alternating current, and if the fields are excited in opposite sense, the induced voltage opposes that incoming. By this means a considerable variation—about 15 per cent.—can be obtained on either side of the normal.

The Allgemeine Electricitäts-Gesellschaft showed the members all over their works, and treated them in a royal manner, and gave every facility for investigating any process that was going on. The English members were much struck with their enormous erecting and machine shop, which measures 650ft. by 350ft., and which is provided with about a dozen electric overhead cranes. All the machine tools are driven by three-phase motors, and there is not a belt to be seen in the whole shop. One lathe of the horizontal pattern was capable of dealing with work up to 33ft. diameter. An additional 3,000-kw. generator was being constructed in the works for the Moabit station. Half of the armature was standing vertically in the shop, and in walking under it one felt as if passing under a railway arch, so huge were its dimensions. We were shown various high-tension experiments similar to those of Tesla, but with a mercury jet interrupter, and although a ½in. sheet of glass was successfully punctured, I was not much impressed with this exhibition, as 20 years before I had seen a block of glass no less than 2in. thick which had been punctured by an induction coil spark. A good exhibit of the Nernst lamp was on view in Berlin. (I also saw the same lamp in London and Buffalo.) There seems to be a difference of opinion about the peculiarities of this lamp. In Berlin I was told it would work on an alternating or direct current circuit, and that its life was between 200-300 hours; efficiency, 1·4 to 1·5 watts per candle-power. For the large-sized lamps, an iron resistance to steady the current is enclosed in a glass tube to prevent oxidisation. For the small sizes a platinum resistance is used. A temperature of about 600deg. F. is required before the filament becomes a conductor, and this is usually attained in from 10 to 30 seconds. In London I was told that the life of the lamp was not determined, but that it was about the same as an ordinary incandescent lamp. I was also informed that it would not work on an alternating circuit, and that when used with a direct current, its polarity must not be altered once it was started up. Two kinds of lamps are manufactured, one with an automatic heater and the other without. Of course no vacuum is required, and it is very interesting to blow out a lamp. If fitted with self-lighter it restarts in a few seconds; if not, it must be relit with a wax match or spirit lamp. I arranged for a few hundred lamps, automatic and otherwise, of

* Paper read before the Cape Town Section of the Institution of Electrical Engineers, Dec. 2, 1901.

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16 c.p. to be supplied to the C.G.R., but up to the present they have not been received here. When they arrive I shall be very pleased to show them to anyone interested.

Electric Trams.

In Berlin and Hanover electric trams are running which take power from an overhead system when outside the town, and from accumulators they carry when within the city limits. The cells are charged from the trolley wire. In Naples the trolley wire has an insulated strip on its upper surface to obviate the use of guard wires. This strip appeared to be sufficiently flexible to follow the vertical movements of the trolley wire. It seems to be successful, though I hear that in other towns where strips of wood have been tried, the system has been abandoned owing to the difficulty of attachment and to the tendency of the strip to twist round. The present English practice as adopted in London, Glasgow, Portsmouth, and other towns is to have double-deck cars with a pedestal trolley, but with no top roof. In passing under bridges the trolley pole is sometimes horizontal and the live wire within reach. It seems strange that the English conservatism, which prevented the early adoption of the overhead trolley wire, owing to its danger, should have now gone to the other extreme and sanctioned the universal use of cars with exposed upper seats; because in the event of a trolley wire breaking and falling on a passing car, or of any other wire hanging down over the live conductor, the risk to passengers seated above would be very considerable. The American cars are practically all single-deck, either on four-wheel trucks or bogies. In New York the original cable conduit has been converted to an electrical system, and there is a splendid service along the principal streets of the city, the cars having but a few yards headway. There are a few accumulator cars in use, and still a few horse cars running in the lower part of the city. There is an excellent run between Buffalo and Niagara—about 30 miles—where long bogie cars are used. Outside the town they run at a very high speed, probably 45 miles an hour in some places. A very fine piece of engineering is the line between Lewiston and Niagara, where the track is cut out of the solid rock and follows the Niagara River gorge for several miles.

At the Glasgow Exhibition there was a fine exhibit of machinery, but nothing particularly novel. Willans and Robinson exhibited some direct-coupled tramway generators of about 1,200 h.p. each, and most of the English engineering firms were well represented. An entirely new type of engine was on exhibition, but I did not see it work. The principle is as follows: there are two cylinders, one called the expansion cylinder and the other the working cylinder; the upstroke of the piston causes air to be compressed in the cylinder, and at the proper moment a charge of pulverised coal is injected, combustion takes place, and a working downward stroke is performed. It is claimed that the combustion gives a more gradual rise of pressure than in gas-engines, and a more even turning movement.

In August I went across to America to join the convention of the American Institute of Electrical Engineers. Several of the existing New York power stations are located in the city itself, and owing to lack of water work non-condensing. The Edison three-wire 110-volt system is practically universal, and one does not see any 220-volt lamps. The arc lamps in the streets are chiefly of the original Brush or Thomson-Houston pattern, and often on wooden poles, and they do not compare as regards steadiness, brilliancy, or neat appearance with the Brockie-Pell lamp, now almost universal in England. I must here mention, however, that the very worst arc lighting I saw was in the city district of London, where Brush lamps are installed and fitted into lanterns with corrugated glass panes. These corrugations may be of the correct shape to give a theoretically perfect distribution of light, but unfortunately the ribs collect the dust to such an extent that the actual light given off is very poor in quantity and very unsteady. The new lighting and power stations for New York (to replace those in the centre of the districts) are located on the eastern side of the city, and at the water's edge. The first one visited was that of the New York Edison Company, not yet working. This, when complete, will be the largest steam-power station in the world. There will be 56 boilers (Babcock and Wilcox type), in two tiers, capable of working up to about 100,000 h.p. The engines are vertical, 16 in number, three-cylinder compound, made by the Westinghouse Company, are each of 9,000 maximum horse-power or 5,200 economical horse-power, and arranged to work with superheated steam. The Westinghouse generators, direct coupled to engines, are three-phase, 6,600 volts, maximum output 4,500 kw., speed 75. At present but two sets are being erected, and eight more are being built. The station is provided with four steel smoke stacks, brick lined, 17ft. in diameter, and 150ft. and 200ft. high above grates. The engine-room is necessarily of immense height, and the floor space measures 272ft. by 118ft., which works out at ·6 of a square foot per horse-power.

The next station visited was that of the Metropolitan Street Railway Company. Here Babcock and Wilcox boilers to the extent of 21,000 h.p. are installed, eight Allis vertical cross-compound engines are erected (three more are under order), each of 6,000 maximum horse-power. The generators are of the General Electric Company, 6,600 volts, three-phase, 3,500 kw., 75 revolutions, 25 cycles. This plant is running. From there we went to the Manhattan Street Railway Company's power-house, where provision is made for 32,000 h.p. of Babcock and Wilcox boilers; eight compound engines of Allis manufacture, combined vertical and horizontal cylinders, each of 12,000 maximum horse-power. Each engine will drive a 5,000-kw. 11,000-volt three-phase Westinghouse generator. There was only one set being erected at the time of our visit, but we were all more or less staggered at the gigantic size of the generators. The revolving field was 32ft. in diameter, and the external diameter of the armature 44ft. Two other smaller stations were afterwards inspected. That of the Brooklyn Edison Company had four 1,000-h.p. engines, each driving a Westinghouse three-phase alternator of 750 kw., 6,600 volts, 94 revolutions, 25 cycles; and the Bay Ridge Brooklyn station had two engines of 6,000 h.p., one of 2,500 h.p., and one of 1,500 h.p. driving generators, two of 2,850 kw., one of 2,000, and one of 1,000, all three-phase, 6,600 volts, 25 cycles. It is interesting to note that whether the power station is for lighting or power purposes the generators are three-phase, usually 25 cycles, and 6,600 volts seems to be a standard both in America and Germany. Probably this pressure is the highest that is produced when using solid copper bars in the armature, and when the generators are of about 3,000 kw. The largest machine, 5,000 kw., is for 11,000 volts for probably the same reason. There is very little difference between the generators built by the Westinghouse, the General Electric, or the German companies. They all have stationary armatures with solid copper bar conductors and revolving field magnets. The shapes of the armature slots vary slightly, some being oval, and others with parallel sides, in which case the conductor is held in with wooden wedges. The Germans prefer narrow armatures of large diameter, the Americans wider and smaller. The switches for dealing with high-pressure and heavy currents are of the oil submerged pattern operated either by compressed air or by motors. The motors wind up a spring, which is suddenly released, thus causing a very quick break, or rather a series of breaks, under oil. Overload circuit breakers are used; no fuses. Three-core paper-insulated cables are favoured for underground work up to 11,000 volts. It is not unusual to find transformers in use which step down from 11,000 to 350 so as to give 550-600 volts direct current through rotaries for tram service.

After visiting the Crocker-Wheeler works at Ampere, and staying a short time at Albany, we reached the works of the General Electric Company. Here we saw all the various kinds of plant in process of manufacture, including generators, direct and alternating current transformers, switchboards, arc lamps, right down to lampholders and one-ampere fuses. Most of the apparatus was identical with that we had already seen in various power stations, but we had better opportunities of examining high-tension switches, etc., at close quarters. One novelty noticed was the winding of field magnets with bare copper strip put on edgeways. A high-speed experimental car, driven by three-phase motors, was running on a short experimental track in the works. It was only working at about 500 volts, but the idea was to have 10,000-volt lines, and the three wires being one above the other at the side of the track, and carry transformers on the car. An electric train on the multiple-unit system, where the movement of the master controller operated electric switches simultaneously on all the other cars, so that all the motors on the cars were working under the same conditions, was shown in motion.

From Schenectady a special train took us to Buffalo. As this city, including the Pan-American Exposition, obtains its power for all electrical purposes from Niagara Falls, I will describe that station first. At the new Niagara Falls power-house, 10 5,000-h.p. two-phase generators, built by the Westinghouse Company, are installed. These are of quite unusual pattern, having vertical shafts, stationary armatures, and umbrella-shaped revolving fields. The turbines that drive these machines are on a level with the river bed, the vertical shafts therefore being about 170ft. long. Each generator runs at 250 revolutions and gives two-phase currents at 2,200 volts. The general scheme is as follows: for local service, such as lighting and trams, and for manufacturing industries, such as aluminium, calcium carbide, carborundum, lead reduction, and many others, to a total of 17,000 h.p., the 2,200-volt current is supplied direct and transformed to the various kinds of current and pressures as required at the different factories. The transformations are made by static transformers, rotaries, or two-phase motors driving generators, thus any voltage, direct, alternating, and any phase, can be delivered. For intermediate distance transmission the 2,200-volt two-phase is transformed to 11,000 three-phase and sent direct underground, and finally transformed to two-phase and down to 2,200 volts as originally delivered—total 11,500 h.p. For long-distance transmission such as to Lockport (28 miles) and Buffalo (26 miles) the 2,200-volt current is transformed to three-phase 22,000 and run overhead—total, 20,000 h.p. The switchboard in the power station has two sets of 'bus bars with five machines on each; these 'bus bars can be paralleled if desired. The switches are pneumatically controlled. The measuring instruments are of a novel pattern, being of a revolving disc type on vertical spindle; the pressure or current is marked on the edge of disc, and comes into view through a small window on face of the board. A new synchronising device is adopted, which consists of a large dial upon the face of which a hand revolves either one way or the other, depending upon whether the incoming machine is going too fast or too slow. I was not able to ascertain the connections, but it worked very well, as we could see from the way in which a new generator was run up. No written description can give an adequate idea of the immensity of the mechanical, electrical, and hydraulic engineering skill that has been brought to bear upon this unique plant with such satisfactory results. When one descends by a lift to the different galleries and finally reaches the level just above the turbines and feels the vibration and hears the rushing of thousands of tons of water just beneath one's feet, one recognises the terrific power that is being dealt with. The cables from the 'bus bars pass underground through a tunnel, where they are suspended on hangers, to the transformer-house, where they are connected to seven step-up transformers each of 1,875 kw. capacity. They are about 12ft. high and 8ft. diameter, are oil insulated, and have a cold-water supply laid on which is allowed to run to waste—there is plenty of it. These transform from two-phase 2,200 volts to three-phase 22,000. Before the high-tension current leaves by the overhead lines it passes through various lightning arresters of the Wurtz, disc, and other patterns, and through large choking coils. I happened to be in the place when the lines were repeatedly struck, but no damage was done, though there was a brilliant display of fireworks and much noise. The extra high-tension switches have breaks of about 5ft., and are coupled together in sets of three. There are three three-phase lines to Buffalo, two of copper and one of aluminium. The latter is not so neat as the copper, but I understand that the saving in cost by its use was 12½ per

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cent. The joints are made mechanically. The lines are run on insulators fixed to wooden poles, and the wires are spiralled. A telephone line is run on same poles for 26 miles, and speech is quite easy. The loss of potential on the lines at full load is 3 per cent. The line is tapped for a branch to Lockport, where 1,000-h.p. rotary feeds the trolley lines, and 300-h.p. rotary a three-wire 220-volt system for lighting. At Tonawanda, some 2,000 h.p. is also tapped from the lines for trams and arc and incandescent lamps. The lines continue to Buffalo, where there is a sub-station, in which seven 2,250-kw. transformers, one spare, reduce the 22,000 to 11,000; the 11,000 three-phase is sent by seven underground feeders to various sub-stations in Buffalo. The 22,000 is reduced to 11,000 because the engineers were not sure of the effects that would be produced by having the higher pressure on an underground network. Each cable carries 4,000 h.p., is lead covered, and laid in concrete. One sub-station in Buffalo receives the 11,000 volts, transforms it down to about 310, when rotaries of 750 kw. each deliver 550 volts for trolley line work. There is no complication, all the transformers are paralleled on both high and low tension sides, and all rotaries are in parallel on both three-phase and direct-current sides. The sub-station is remarkably small and compact considering that it deals with some 4,000 h.p.

The Buffalo Company's lighting station receives its 11,000-volt current, transforms it down and passes it into some dozens of three-phase 200-h.p. synchronous motors. Each motor has two 125-light 6,000-volt direct-current Brush arc machines coupled direct to it. These motors are started up (without exciting current) by inserting a choking coil in the main circuit, and letting eddy currents be generated in copper rings round the pole-pieces. When in step they are suitably excited. These machines make a considerable noise in getting up speed. Some 3,000 arcs are fed by these machines. In the same station is a huge 1,200-h.p. three-phase motor (the largest yet built) driving a pair of direct-current generators, each giving 2,665 amperes at 150 volts at 375 revolutions. This supplies the low-tension three-wire system. The same station contains numerous other rotaries, also three-phase to direct motor-generators. The Pan-American Exposition absorbs 5,000 h.p. for lighting purposes and motors. A branch from the 11,000-volt sub-station is run to a bank of 19 250-kw. air-cooled General Electric transformers, which reduce it down to 1,800 volts for distribution about the grounds. It is further reduced or transformed to direct as required for various purposes. About 300,000 lamps were installed at the exhibition, but not all on at once. For the decorative electric illumination of the various buildings 65,000 8-c.p. clear-glass lamps are employed. This is the first time lamps have been run in any number at such a low periodicity as 25 cycles. It is important to note that no flickering was appreciable to the eye. The decorative lighting was most effective. All the principal buildings, domes, and the great electric tower were lighted right round, so that the full effect could be seen from any point of view. The method of lighting was novel, and gave a very grand effect. At a certain hour in the evening, most of the outside lamps being out, the whole of the 65,000 lamps over the various buildings came up all together and very slowly, at first dull red, then brighter red, then dull yellow, then bright yellow, and, finally, up to full power. This never failed to rivet the attention of thousands of people, and was probably the most attractive feature in the whole exhibition. The electrical arrangement for carrying this out was very simple. It was merely a large water resistance inserted on the 11,000-volt side, suitable plates being gradually lowered into the liquid until finally the resistance was short-circuited. This had the additional advantage of giving the generators and turbines time to get into their stride, as even with a large plant like that at Niagara the sudden turning on of 65,000 lamps might lead to trouble.

All the large American electrical firms were well represented at the exhibition, especially the General Electric Company and the Westinghouse Company. The former exhibited a constant-current transformer designed to feed a number of alternating enclosed arcs in series. It worked well. A novelty also shown by them was an enclosed arc lamp working direct off a 220-volt circuit. This lamp had an arc about 1½in. long and took but a small current. It burnt steadily, but with the usual blueish tinge noticeable with other enclosed arcs. A large forging for a field-magnet ring for one of the new Niagara generators was on the General Electric Company's stand, and it appeared to be the correct thing to walk through it; there was plenty of head room. At an accumulator company's stand various types and sizes of positive and negative plates were nailed to the counter so that they might be easily examined. Over them was a sign reading "Danger—these plates are charged." I have not attempted to enumerate the various electrical exhibits, as most of them closely resembled or were identical with what was installed in the various power-houses or sub-stations. The Westinghouse Company had, however, on view a 300-h.p. gas-engine generating set, which was an object of much interest to engineers, especially Englishmen, who were not accustomed to gas-engines of such power. The exhibition on the whole was very fine; the rectangular area covered was about one mile long by half a mile broad, about half of the space being occupied by buildings and remainder grounds and lake. I am sorry to read that it was a financial failure, the loss being £600,000.

It may be wondered whether the Niagara plant ever fails. I regret to say that it does occasionally. On one evening during my visit the whole of the exhibition lights, street lights, and tramcars in Buffalo shut down for about two hours. It did not seem to me to be polite to enquire from the officials what the cause was, as I knew they must be sufficiently worried already. I believe, however, the trouble was due to faults on the overhead line. Close to the present power station at the Falls an extension is being laid down for another 50,000 h.p. on the same lines as the present one. The wheel pits, penstocks, etc., are in place, but the whole thing is on such a huge scale that it will probably be years before it can be completed. Meanwhile the present station is fully loaded, even during the daytime nine out of ten sets are running, but it appears some of the load comes off before the lighting starts up. The tail-race tunnel is large enough to take the exhaust from the new station as well as the present one. It is worth mentioning that the outflow from the tunnel when compared to the water flowing over the Falls is a negligible quantity. On the banks of the Niagara River exist a few more comparatively small power stations, in which the generators are of the ordinary kind driven by horizontal turbines. The plant is located near the water-level, and in one case the current is conveyed up to the bank by aluminium rods fastened to the penstock. The penstock is about 6ft. in diameter, and the equivalent electrical energy returns by three rods 2in. broad.

I had the novel experience of riding 30 miles on an electric motor-car. This car was one of many electrically-driven vehicles belonging to a Buffalo company. It had two 2½-h.p. motors, one geared to each rear driving wheel, so that no differential motion was necessary. The voltage was 88, and the different speeds were easily acquired without inserting any resistance by changing the cells and motors from series to parallel in various combination. The car held four persons, ran at a maximum speed of 20 miles an hour, and was said to be good for 70 miles on a fair road with one charge. I was rather sceptical on this point, and, as my host admitted a previous run of 30 miles, I persuaded him to keep to the tram route on the return journey, but my suspicions proved to be groundless. Pneumatic tyres are used in winter and solids in summer, as it is found the former are liable to burst with the heat. Many electrically-driven hansoms ply for hire in Buffalo. They appear to be popular and work well, but they are extremely ugly in design. The arrangements for removing discharged cells from the various vehicles and replacing by charged batteries is well thought out, and worked with a minimum of labour. I have no information as to the useful life of the batteries. I was struck with the small number of men who are employed in the running of large stations in America, and also at the youth of the engineers in charge. The gentleman in charge of the great Niagara power station, the overhead lines, and the various sub-stations, is certainly under 40 years of age. I do not think that anywhere in the world can such a variety of electrical machines and apparatus be seen as at Buffalo and Niagara. One returns from these places feeling that if American electricians visited England, we should have difficulty in finding anything sufficiently novel to claim their attention.

In closing this paper I must apologise for the incompleteness of these notes, as the subject is practically inexhaustible, and want of time prevents me from going fully into some of the subjects merely touched upon. I shall be glad to explain as well as I can any points that may not be clear during the discussion, and can show illustrations and photographs of some of the machines, etc., I have mentioned.

GLASGOW MUNICIPAL TELEPHONES.

The first annual report of the Committee on Telephone Service to the Corporation of Glasgow was issued on Aug. 4. We extract from a report which appeared in the *Scotsman* as follows: "As the system was formally inaugurated on Sept. 1 last, the portion of the accounts dealing with revenue is only for a period of nine months. The gross revenue from rentals from Sept. 1, 1901, to May 31, 1902, is £25,854. The terminal fees received from the National Telephone Company, per the Postmaster-General, amount to £121; and with £2,195 of sundry receipts the total revenue is £28,171. The working expenditure amounted to £9,869, leaving a net revenue of £18,302, out of which the following requirements had to be met—interest on loans, £2,680; sinking fund, £1,960; terminal fees paid to the National Telephone Company, £846—making a total of £5,486. This leaves a balance of £12,815. This is dealt with as follows: proportion of repaid rentals applicable to year 1902-3 carried to suspense account, £12,417; surplus for the year 1901-2, carried forward, £398. The borrowing powers (originally £220,000) as at May 31, 1902, after deducting the amount of the sinking fund for the year, £218,040, of which there was borrowed and not repaid at May 31, £172,240. The capital expenditure during the year just ended has amounted to £126,302. 17s. 6d. Adding the capital expenditure of £66,390. 16s. 9d. for the previous year ending May 31, 1901, there is a total capital expenditure of £192,693. 14s. 3d. The capital expenditure for the past year has been incurred not only in providing accommodation for working lines, but in making ample provision of underground ducts for future use, so as to avoid the necessity of an early reopening of streets. Further, in order to facilitate distribution and to provide for connecting subscribers economically later on, as well as to minimise jointing, cables have been laid containing a much larger number of pairs of wires than are required at present. Other works have also been extended. The completed instruments provided number 5,479. There have been 14,572 pairs of cable wires laid measuring 11,061 miles. There are also 104½ miles of enclosing piping. The original scheme, involving an estimated expenditure of £121,000, provided for overhead distribution everywhere, but in the centre of Glasgow subscribers have been served by taking branches of cable underground into their buildings in the same way as gas and water pipes. It was originally intended to serve the suburbs by means of overhead routes, but, in view of the large number of subscribers offering in all directions, it was decided that these routes should be put underground, consequently underground routes have been laid to Clydebank, Rutherglen, Shettleston, Bishopbriggs, Cathcart, Pollokshaws, Langside, Crosshill, and between Lenzie and Kirkintilloch. This has led to a considerably increased outlay, but full benefit will be reaped hereafter in the shape of reduced maintenance charges. As the greater and more expensive part of the work has now been executed, construction expenditure will soon be on a reduced scale, and new subscribers will be joined up at a considerably lower average cost."

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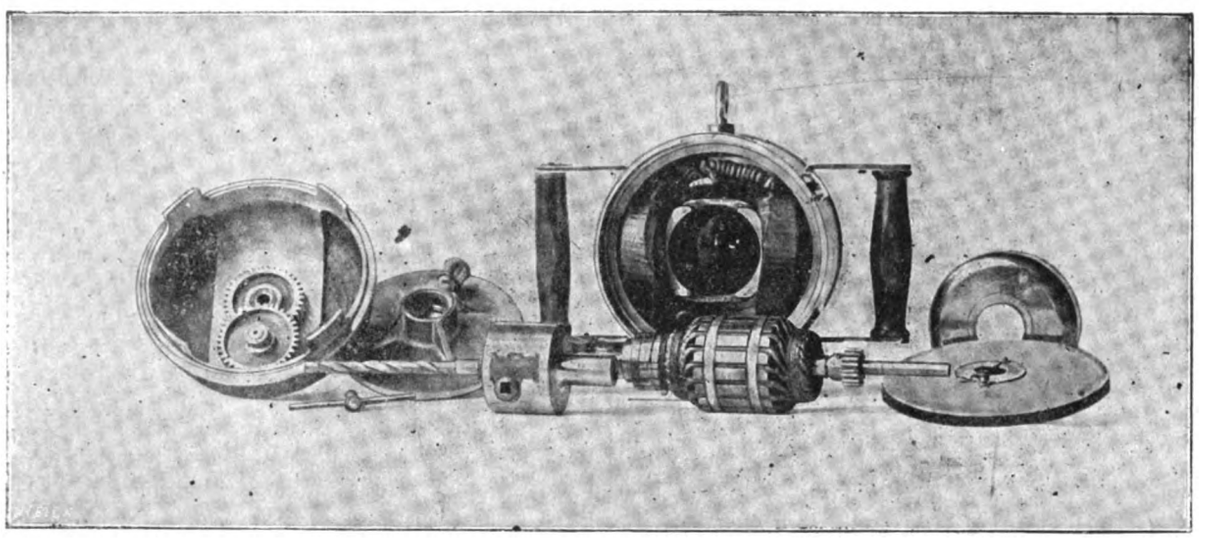
TRADE NOTICES AND NOVELTIES.

Portable Electric Drills.

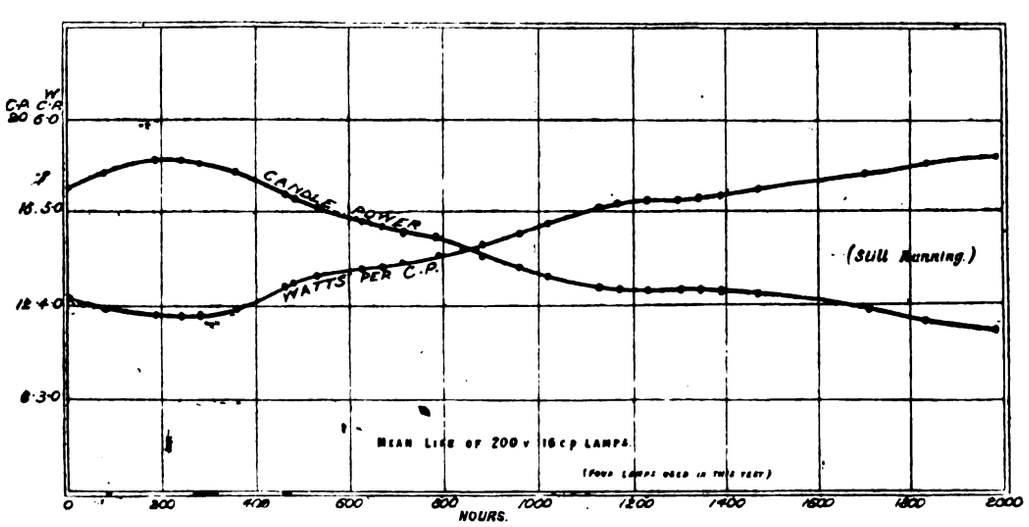
"Oberon" portable electric drills are dealt with in a circular and price-list recently issued by Messrs. O. Berend and Co., Limited, Basinghall-avenue, London, E.C. By the employment of aluminium (wherever practicable) in place of steel or iron, and by the special construction of the electric motor, it is claimed that a very light and portable drill, easy to handle, and of ample power, is obtained in the "Oberon" type. The largest size manufactured weighs only 23lb., and will bore holes up to about $\frac{5}{8}$in. diameter in steel, wrought or cast iron, without overloading the motor. When the drill is required for soft metals only, such as brass, aluminium, or gunmetal, no speed-reduction gear between the motor and drill is needed, but for cast iron, steel, wrought iron, etc., some form of reduction gear is necessary. When provided the gear is completely enclosed. Speed regulation is obtained by a three-way combined regulating and starting switch. The motors can at an extra cost be supplied with a special device by means of which the drill may be run with or without the reduction gear. Very high or low speeds are then obtainable at will. The motor is provided with an aluminium breast-plate and with two handles, by which it can conveniently be held in any position. One of these handles is in connection with the regulating switch, and the speed may be varied by rotating this handle. The starting and regulating resistance is inside the motor case. The accompanying illustration, which we reproduce from the circular under notice, shows the various parts of a motor fitted with reduction gear. The machine is series-wound in order to minimise the risk of damage by overloading. Being dust and moist proof, it may be used out of doors without any fear of damage through wet. The efficiency of the machine is, we are told, about 60 per cent. The motors are wound for 65, 110, and 220 volts continuous current.



"Oberon" Portable Electric Drill.

"Maxim" Lamps.

The Sir Hiram Maxim Electrical and Engineering Company, Limited, 65-67, Gracechurch-street, London, E.C., have recently issued a new catalogue of their electric incandescent lamps. In this catalogue full particulars are given of the various standard types of lamps manufactured by the firm, as also of numerous special lamps, each type being illustrated. Traction lamps designed for working pressures of from 24 to 250 volts are listed, the low-voltage traction lamps being largely used for train lighting, while the 250-volt lamps are intended for running in series on 500-volt tramway circuits. For the low-voltage lamps of all types, marked A, an average efficiency of 3½ watts per candle-power is claimed, while for the high-voltage lamps similarly marked the rated average efficiency is four watts per candle-power. Lamps of a higher efficiency, marked B, are also stocked, we are told. These have an average efficiency of three watts per candle-power for the low and of 3½ watts per candle-power for the high voltages. It is to be noted that all the filaments in the "Maxim" electric incandescent lamps are treated, and in the case of the double-filament lamps both filaments are mounted upon a glass bar stem before the treating takes place, which ensures the filament retaining the same shape in the bulb as it did while undergoing the treating process. As a result of this method, both filaments being treated in series are equalised, and run at the same efficiency. The curve which we reproduce herewith shows how well the candle-power of the "Maxim" lamp is maintained throughout its life. It may be mentioned that this curve was plotted from photometric measurements taken at frequent intervals during the life of four 200-volt 16-c.p. lamps, and shows the result for the first 2,000 hours. The lamps continued burning for 3,000 hours, when the trial was stopped.



Life Curve of Four "Maxim" Lamps, 200 volts 16 c.p.

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CONTENTS.

Notes	181	St. Pancras Accounts	205
The Parsons Turbine at Neptune Bank Station	86	Luton Accounts	206
Electric Plant for Rhodesia	186	Grimsby Accounts	206
Surges in Transmission Circuits	188	Tube Bills in Parliament	206
Electrolysis in Water-Pipes	189	Legal Intelligence	207
Some Notes on Electrical Engineering Practice in Europe and America	194	Companies' Meetings and Reports	207
Glasgow Municipal Telephones	196	Appointments Vacant	208
Trade Notices and Novelties	197	New Companies Registered	208
The London Tube Railways	198	Contracts for Electrical Supplies	209
Forthcoming Events	199	Traction Notes	210
Lecture on Electric Car Driving	199	Lighting Notes	212
Questions and Answers	200	Provisional Patents, 1902	215
		Traffic Returns	216
		Companies' Stock and Share List	216

TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed*

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THE LONDON TUBE RAILWAYS.

The returns are now available for the first half of the present year from all the underground railways in and around London. These, when analysed, are overwhelming arguments in favour of electric traction and of the tube system of construction with deep-level lines. It is true that when looked at from the dividend point of view only neither the Central London Railway nor the pioneer line (the City and South London Railway) return dividends which are quite satisfactory to the original shareholders. That these dividends, however, are improving and will improve still farther is obvious to anyone who will look into the balance-sheets of the two companies in question for several years past. The great point is that on both these lines the traffic receipts are increasing in proportion to the large increases of passengers carried, and that the ratio of working expenses to total revenue is falling. Even then, to value these lines properly, it must be remembered that they are carrying the people at rates which are much lower than any previously existing system of transport. In this way the companies secure a steady public support and disarm competition. Coming back to the actual figures for the lines in question, we have to congratulate the City and South London Railway Company on the great increases resulting from the opening of their line to Islington. This extra length of line is only one mile and a quarter, and yet through its addition no less than 3,300,000 extra passengers have been carried, quite apart from the season-ticket traffic, over those carried over the first half of 1901. The increase in receipts for the half-year amounted to almost £27,000, while the total expenses only increased by about £8,000. The ratio of total expenses to total revenue on this line now stands at the low figure of 44 per cent. In consequence of these improvements the amounts available for dividend for the last half-year was £21,700 as against £8,214 in 1901. The directors of the City and South London Railway are to be congratulated on the success which has attended their scheme of extending the line, which was carried through in spite of the difficulties of financing extensions to an undertaking earning a very small dividend. In the case of the Central London Railway the results of the first half-year's working for 1902 are also most satisfactory, although not so startling as those given above. This is to be expected, because the Central London Railway had no extensions to open. It will be seen from their accounts, however, that they have carried some 23,000,000 passengers in the half-year, an increase of nearly two and a half millions, or over 10 per cent. on those carried in the first half-year of 1901. As remarked by the chairman, the average earnings per train mile have gone up from 5s. 2d. to 5s. 8d. In spite of this, and of an increase of 15,000 train miles, the working expenses decreased by £2,000. The company could have afforded to pay more than the 4 per cent. dividend which has been declared, but the directors wisely held over the surplus balance until the end of the year. On this line a change is being made from locomotives to the multiple-unit system of driving the trains. The cost of the change over will be very considerable, and the primary object is, of course, to reduce the vibration troubles which have so annoyed householders over certain parts of the line. Indirectly the change will be a remunerative one to the company, as with the decrease in vibration will come a large decrease in the maintenance charges both of the rolling-stock and of the track. Any engineer who has been through the locomotive repairing shops at Shepherd's Bush, and seen the frames of the locomotives in for repair, will appreciate the large saving

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which will be effected by the change in this department. It would require an expert on vibration to calculate how much coal is wasted at the central station for energy to set up the destructive vibration which has broken these locomotive frames, but we are sure that it is no inconsiderable amount. The saving also applies to the track, the life of which will be largely increased by the alteration which the company is now making in its rolling-stock. Naturally, the half-yearly balance-sheets of the Metropolitan and the Metropolitan District Railway Companies do not compare at all favourably with those of the electric lines above mentioned. By a liberal reduction in fares these companies have done something to prevent the transfer of their traffic on to the competing railways and tramways, but it is universally acknowledged that the sooner these lines get their electrical systems at work the better it will be for them. With the increase in travelling facilities which now are practically sure of being authorised by Parliament this year, it is clear that steam traction is doomed on the Metropolitan lines. It seems to us, also, that the above reports only promise remunerative dividends to those lines which carry the public at exceedingly low rates, and provide a good system of interconnection with other railways. We are pleased to note that the House of Commons Committee has inserted stringent clauses in the Bills reported to the House to ensure that the new railways in question shall be properly financed and promptly constructed.

FORTHCOMING EVENTS.

SATURDAY, AUG. 9.

Institution of Junior Engineers.—Summer meeting at Blackpool.

The following fixtures for meetings have also been made:

Sanitary Institute.—Sept. 9-13, congress, Manchester. Sept. 9-27, health exhibition.

Waterworks Engineers.—Winter meeting, December, London.

Iron and Steel Institute.—Sept. 2-6, Dusseldorf.

Institution of Civil Engineers.—Birmingham students' visit: Sept. 25, Crewe.

British Association.—Meeting at Belfast commences Sept. 10.

LECTURE ON ELECTRIC CAR DRIVING *

BY E. W. ELSLEY.

On our services being transferred from horse or steam to electric traction, we find in the one many things similar to what we found them in the other. For instance, one requires to be a perfectly sober man to drive any kind of car. Then, in the morning, we go to the sheds to get the car ready for its day's work, and both there and on the road we ought to have four of our senses in proper working order—*i.e.*, the sense of hearing, smell, touch, and sight. On the road we should be able to *hear* any unusual sound about the car; we should be able to *feel* any unusual jerk, skidding, or slipping of the wheels; we ought also to be able to *smell* any parts getting overheated or warm. The overheating of journals, or other mechanical parts of an electric car, will give off a smell similar to any corresponding parts of any other car; but electrical parts overheated from electrical causes will give off a smell as of shellac or burning naphtha, and the inattention or neglect of a driver is sometimes the cause of both.

It goes almost without saying that the sight is the most important sense of all; *that* has previously stood us in good stead on our horse and steam cars, and let us hope it will stand us in good stead on our new cars for many years to come. We are required to see things at a distance as well as near, and I am not exaggerating when I say that we are often expected to see *through* large heavily-laden vehicles by stupid persons in charge of them. The fact, however, remains that we should never turn our eyes from the front, or the direction in which we are travelling, nor take our hands from off the handles, for often, at very short notice, vehicles and other obstacles are suddenly put on the track in front of us, giving little or no room in which to stop the car. Sometimes a horse and cart are turned suddenly on to the rails, in consequence of a hand cart standing by the roadside, and which up to this point was quite obscured from the car driver's view. Sometimes it may be a drunken person, at others a little child at play, or one being chased out of the house by its mother: either may fall down in front of the car, in which case there is plenty of chance for all our faculties to display themselves.

In negotiating the curves, points, crossings, and junctions, we must remember that although one pair of wheels or one bogie has taken the right road, there are others following behind which it will not do to leave to take care of themselves. No, we must slow down, go carefully around, be on the alert, and watch. I find three miles per hour plenty fast enough, for the trolley is more likely to leave the wire at such points, and the guard should give this his attention. We should know that by too suddenly applying the brake we cause the wheels to skid, and that by too suddenly applying power we shall cause them to slip. Both are undesirable, and do not tend to prolong the life of the car. The advantage of an electric brake or hand brake over a steam brake is that you can apply them both slightly and gradually, so that there is no real cause for flat places in the wheels.

Then we must not forget that electric cars, as all others, are run for the benefit of the public, and that while the public use them properly, and conform to the usual rules and regulations of the authorities concerned, they have a perfect right to be properly and well served. We also know that it is the passengers' pennies which go to pay our wage: although when one who only rides on a wet night tells us that "it's the likes o' me as keeps the likes o' you," we cannot help but wonder how much surplus of a penny there is out of a two-mile ride which goes towards our wage and clothing. *And*, if it has *been* raining *all day*—well, we don't quite feel like taking him by the hand and saying, "Shake, pard." We shall find many other similarities, which time will not permit us to go into just now, besides which it is the *dis*-similarities which you require to be shown most of, and these will keep cropping up as we progress.

Now, what I believe to be the most important dissimilarity is this—that you are partly hidden from view on a steam-engine or a horse car; but when an electric car is coming along, the very first to be seen is the man driving it, and he is in full view of the public all the time. I hope I shall not be misunderstood in this, for *you* already know the public have not always been found to be the tram man's friend; more especially is this so when we are the servants of a corporation. We may have a few good friends among the public, but if once we get a bad name, it requires a lot of good, honest friendship to clear us of it. It really is surprising the difference we shall find in working for a company and then for a corporation. A favourite saying of mine, and one which I believe fairly covers the ground, and yet puts the case in a nutshell, is that "Any rag with a penny in its pocket thinks it has a right to boss any tram man." I can go even further. These selfsame people, while they refrain from entering your public free libraries and telling the librarians, "Those large books should be on the top shelves, and those small ones on the bottom," or going into the parks, ornamental gardens, and recreation grounds, and dictating to the gardeners where such and such a flower should be, as soon as it's a corporation tramway, not only want to boss you, but gull themselves into the belief that they can manage it better than the practical heads of the affair, and do not stop at writing them complaints of every little thing they fancy is a flaw, but write a lot of scurrilous stuff to the newspapers with a view, no doubt, to airing their knowledge; or is it to show how little they have got? I can't say which, but I hope I have made it clear to you all that we all ought to be very careful, and as a part and parcel of the concern play our part in such a manner as to give no chance or opportunity to these pernicious persons (who generally sign themselves "Ratepayer"), for such are all over the town.

Open and shut have quite the opposite results in electricity to what they have in water, gas, or steam. You open the tap of a morning to get water to wash with. The engineman opens the regulator to admit steam to the cylinders; but on the electric cars we *close* the switch to admit power to motors. Water or steam will travel down the hollow of a pipe, while electricity would be content to travel down the walls of it, and that more quickly. We may liken steam or water to a farmer driving a flock of sheep into his field, while electricity is the boy sitting on the fence waiting to walk across the top bar as soon as the gate falls to again or *closes*.

There are two terms in use in running an electric car in which a new hand sometimes gets a bit mixed—*i.e.*, series and parallel. The two words mean the same here as if applied to anything else; series, one after the other, so that when we are running in series the motors are using the current one after the other. The nearest simile I can give the horse car man is that when you have two horses a-tandem you also have them in series. The engineman will understand me best if I say it is

* A lecture to be given to horsemen, enginemen, and the novice on their first attendance for tuition in electric car driving.

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like compounding an engine. When the power has done its work in the one cylinder it passes on to the other. Now, when we bring the motors into parallel the current is going to them both at one and the same time. The horseman has brought his leader back, and put it alongside the other one. He has got a pair; they're in parallel. The engineman has turned live steam into his low-pressure cylinder, and has now got a pair of high pressures. *He* has brought them into parallel. On electric cars the driver has no horses to keep on their feet, and no whip to use. The engineman has no fire, water, or steam to attend to, and a very little greasing goes a good long way. The fire, water, and steam are in the overhead wire, and as far as our work as motormen is concerned that is where it commences, and to that wire we require to look almost as often as we used to the steam or water gauge, especially when the trolley is passing under frogs, circuit breakers, and overhead crossings, and the attention and energy the horse driver gave his horses travelling over greasy or slippery setts can now be devoted to the wire in a similar manner.

As to our work commencing at the overhead wire, perhaps there are one or two exceptions—when we can assist the power-house people or upset their apple-cart. If we should do the latter, someone generally gets to know about it; so whenever the power leaves the wire it is most important that every driver should instantly throw the power handle to the off position, switch on the lamps, and remain still until they attain their usual brilliancy, when he can generally again start the car; yet in a general way our work commences *at* the trolley wheel running on the overhead wire, from which it gathers the current that magnetises parts of the equipment, and so propels the car.

Taken on the whole, I honestly consider it to be one of the nicest jobs that the average working-man can aspire to; but he must possess a very strong will power, leaning in the right direction, for there really is a fascinating influence around one when driving an electric car, which if not held in check will very soon land us in disaster.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

505. Give the formulæ and principles on which solenoids are designed as used in arc lamps, cut-outs, etc. (series and shunt). Are they designed to give a certain pull in weight? What is the value of M.M.F., R, H, and B in a coil, length 15cm., with close-fitting core 15cm. long, 2cm. diameter, wound with 48 turns, six layers deep, traversed by 10 amperes?—T. J. G.

506. What is the action of the balancing rings on large traction generators, and how would you ascertain at which points to connect them up to the armature; and if you happened to connect one up in the wrong place, what would be the result?—T.

ANSWERS.

Question No. 495.—Is there any meter similar to a gasmeter for measuring directly the quantity of steam in cubic feet, at a certain specified pressure, passing through a pipe? In the case of a consumer having his own supply of steam, but also being supplied with steam from an outside source, what would be the best means of measuring the quantity of steam supplied by the outside source at the same time as using own steam? A separate steam-ring not to be considered.

Best Answer to No. 495 (*awarded* 10*s.*).—I know of no apparatus for measuring *directly* the quantity of steam passing through a given pipe, although there are a few indirect methods. If the engines were running at constant power, an approximation could be made by means of an indicator test.

The method employed to find the amount of steam consumed by any engine from its indicator diagram is as follows: If the engine is compound or triple expansion, the cylinders being jacketed with high-pressure steam, the last cylinders' diagram is used, the steam there, of course, being driest. Suppose Fig. 1 represents such an indicator diagram. At any point, A, where the steam is driest (between cut-off and release), let the percentage of the stroke be x and let the clearance be y per cent. of the stroke. Then the volume of steam in the cylinder

$$= \frac{x}{100} V + \frac{y}{100} V = \frac{V}{100}(x + y) = \text{A cubic feet (say)}.$$

Now, the pressure is represented by the height of A above the datum level of pressure, so that by Regnault's table of dry saturated steam properties we can find the weight of steam in the cylinder. During compression so much steam

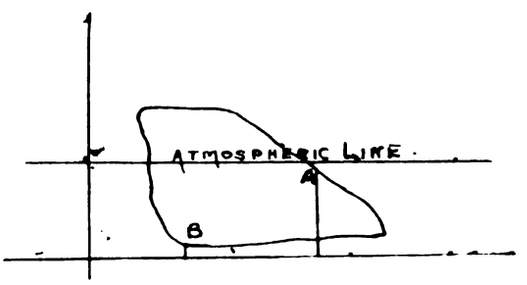

FIG. 1

will remain in cylinder. At any point, B, just about compression let the percentage of the stroke be z.

Then the volume of steam in cylinder

$$= \frac{z}{100} V + \frac{y}{100} V = \frac{V}{100}(y + z) = A_2 \text{ cubic feet (say)}.$$

At the pressure at B we can again find the weight of steam in the cylinder. Therefore, weight at A_1 – weight at A_2 = weight of steam used per stroke. Unless, however, the engine was a steady-running engine, the above method would not commend itself for use.

There are formulæ for determining the weight of steam flowing through any orifice merely from a knowledge of the pressures on either side and the area of the orifice and involving a constant These formulæ only hold if the internal pressure is less than about $\frac{5}{3}$ of the external pressure. Thus Perry gives as roughly correct the following:

$$W = \frac{A\, p_1}{34} \sqrt{\frac{p_0 - p_1}{p_1}},$$

where p_0 = pressure on side of orifice from which steam issues;

p_1 = pressure on side of orifice into which steam issues;

A = area of orifice;

W = pounds per second.

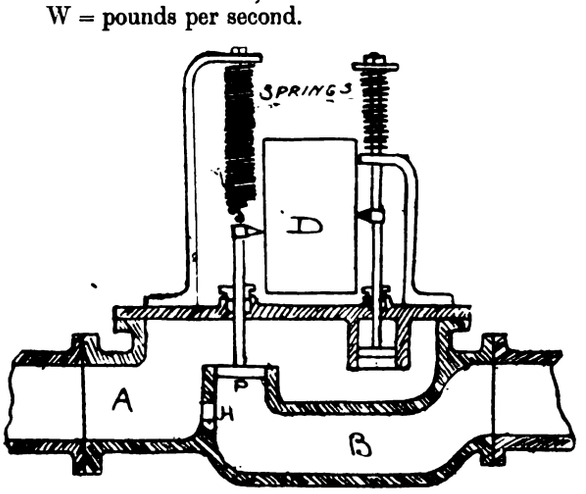

FIG. 2.

If A is in square feet, p is in pounds per square feet.

If A is in square inches, p is in pounds per square inch.

It will be seen from the above that a means of registering the quantity is presented by throttling the steam through an orifice, and it is on these lines that an invention due to a German engineer, Max Gehre, is constructed. It is in the list of patents for 1900.

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Briefly, Fig. 2 represents the invention. Steam is throttled through the small hole, H. The pressure is evidently smaller in B than in A. As the piston, P, is open to both sides, A and B, it registers by its movement the difference in pressure between A and B. The other smaller piston registers in a similar manner the total pressure in A. D is a revolving drum. The two pencils autographically, therefore, record the pressure in A and the difference in pressure between A and B on the drum for the period it takes D to make a complete revolution. Thus a record of the pressures being obtained, knowing the area of H and its constant, we can find W for any period.

The best method of measuring the supply of steam from outside would be to put the apparatus in the company's supply branch, and put after it a non-return valve.—T. T.

Answer to No. 495 (*awarded 7s. 6d.*).—Measurement of the amount of steam taken by a certain correction from steam-pipe range :

CASE I.—Assuming *regular* rate of consumption. Let the steam-range, and the branch in which the consumption has to be measured, be arranged as shown in Fig. 1. $S V_1$, $S V_2$, $S V_3$, are stop valves; $T V_1$, $T V_2$, are throttling stop valves; $P G_1$, $P G_2$, are pressure gauges.

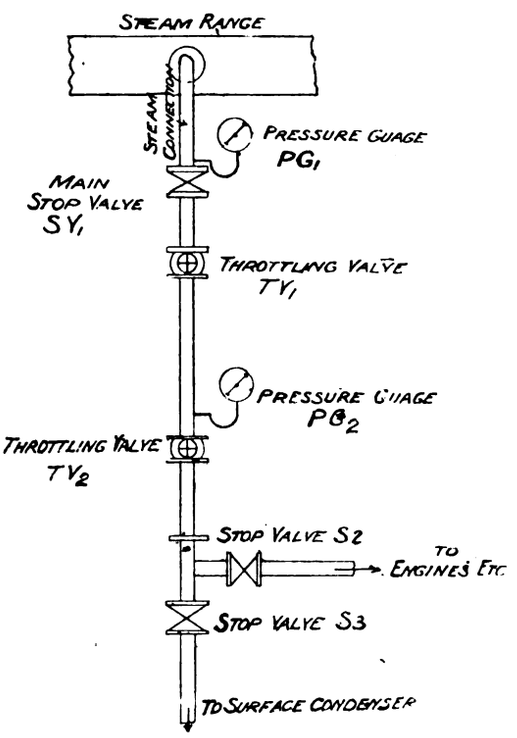

FIG. 1.

Method of Use.—With valves $S V_1$, $S V_2$, $T V_1$, $T V_2$ open, and $S V_3$ shut, and engines, etc., running at ordinary rate, valve $T V_1$ is gradually closed so that the pressure shown on gauge $P G_2$ is a few pounds less than the pressure shown on gauge $P G_1$; the valve $T V_1$ is then locked in this position. When engine can be shut off for a time, valves $S V_1$, $S V_2$, $T V_2$ are shut and $S V_3$ (which leads to a surface condenser or some means of condensing and measuring the condensed steam) is opened. When all is ready, valve $S V_1$ is opened wide and valve $T V_2$ opened gradually so that the pressure on the gauges $P G_1$ and $P G_2$ is the same as in the first case. If under these conditions the steam passing is led into a surface condenser and weighed, the result will be the amount of steam taken by connection when supplying the engines, etc.

CASE II.—Assuming irregular consumption of steam.

Principle of Method.—Suppose the same arrangement as above; if the throttle valve $T V_1$ is kept adjusted properly by hand, according to the consumption of steam, and an arrangement made to record the amount of opening on a chart, the record thus obtained would be an index of the amount of steam which had passed through the branch during that time. By properly calibrating, it can be made to show directly the amount of steam which had passed through. The following is a description of a suggested arrangement of apparatus based on the above lines (see Fig. 2): A A, vertical cast-iron cylinder, closed at the ends by the covers, B B; a piston valve, C, moves freely, steam-tight, in the cylinder, and when in its lowest position rests on the stop, E E, and just closes the ports, D D; a rod, F, is fixed to the piston, passes through the gland, I, on the top cylinder cover, and terminates in the small piston, L, which works in the dash-pot, M. The bracket, N, supports the dash-pot, M, and also the guide, P, in which one end of the cross-head, Q, slides; a pen, J, is fixed to the other end of the cross-head; K is an ordinary clock-work recording drum, on the paper of which the pen, J, traces a curve corresponding to the different positions of the piston valve, E. The recording drum is fixed to the top cylinder cover by the bracket, O; R is the steam inlet; T the steam outlet; D D are the ports through which the steam passes into the space S;

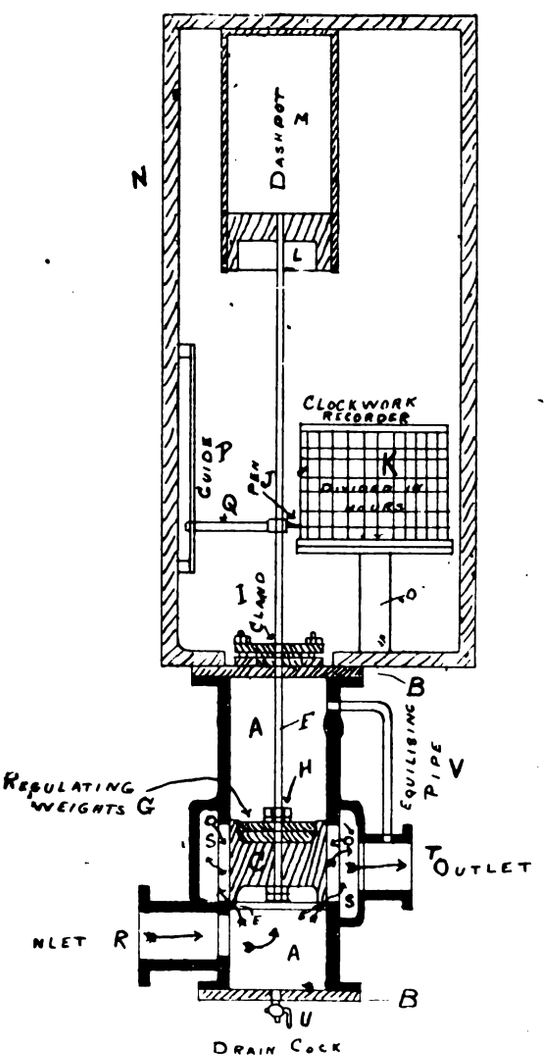

FIG. 2.

V is an equalising pipe, connecting the upper part of the cylinder with the outlet pipe; G are removable regulating weights, held in position by the nuts, H; U is a drain cock for draining the cylinder. The action is as follows: The steam enters at R, flows to the bottom of the cylinder, pushing up the piston valve, C (which partly uncovers the ports, D D), thence through the ports into the space, S, round the cylinder, and from there into the outlet, T. If more steam is being taken, the pressure behind C will tend to fall, and as a result the piston valve, C, will be pushed upwards slightly, thus letting more steam through. The dash-pot, M, is to prevent sudden movements of the piston. If the apparatus has been previously calibrated, with the valve in different positions, the record on the chart on the drum, K, will be a measure of the amount of steam which has passed through during the time that the record was taken.—H. B. D.

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Answer to No. 495 (*awarded* 5*s.*).—Although large rewards have from time to time been offered by various engineering institutes for a practical steam-meter, no such instrument applicable for ordinary working conditions has as yet been brought out. In the absence of any available steam-meter, it is only possible to ascertain the amount of steam taken by a given connection by deduction: supposing, for instance, that there are three connections to a steam range, and that the total quantity of steam raised is known, then we might assume, with a fair approximation to the truth, that each connection took steam in proportion to its bore. A better way would be to make a deduction from actual experiment. We know that the steam is not annihilated, but whether it is used for heating purposes, for engine work, or other purposes, the potential power of doing work is taken from it, but that the steam itself, either as vapour or liquid, remains. It is then comparatively easy to find out the amount of steam raised in the boiler for various weights of coal consumed, and also by means of a surface condenser to collect and measure the quantity of steam taken by each connection; these results could be checked by repeated trials, and the final figures tabulated. Suppose, for the sake of argument, that there are five connections; letter these A, B, C, D, and E respectively. Now let it be assumed that from repeated trial it is found that 8lb. of steam can be raised from the combustion of 1lb. of coal, and that of the total steam used A takes 30 per cent., B takes 25 per cent., C 20 per cent., D 15 per cent., and E 10 per cent.; we can then at any time make a fair approximation of the quantity each range is taking. Let the coal consumption be 4,000lb. per hour, then the total steam raised will be 32,000lb., which will be taken by the various connections as follows: A takes 9,600lb., B 8,000lb., C 6,400lb., D 4,800lb., and E 3,200lb. This is perfectly correct so long as all the ranges are working either at full load or at the same proportion of full load. If, however, as will probably be the case, one range is working at full load and another at one percentage of full load, and the others at differing percentages, the calculations will become more complicated. The percentages of load on the various connections must be found by means of indicator diagrams or other devices, and these taken into account in working out the figures, and at the same time the amount of condensation in the different lengths must not be forgotten. This is a very cumbrous and unsatisfactory method, and the results can only be more or less (probably rather less than more) correct. Unfortunately, until the advent of the long-sought-for steam-meter it is the only method suitable for practical work which is open to us to adopt.—M.

Answer to No. 495 (*awarded* 5*s.*).—Since reading our esteemed editor's kind note on this question in the issue of the *Electrical Engineer* for July 25 I have made several enquiries, but cannot find anybody who has heard of a steam-meter for this purpose. It, however, occurred to me that if such a meter were made my friends (Messrs. Guest and Chrimes, of Rotherham) would probably be the makers, so I have written them, but they also inform me that they do not know a meter suitable for measuring steam under the circumstances mentioned. It is obviously possible under the conditions mentioned in the question that no steam might pass sometimes, while at others a large quantity might pass in either direction. I will therefore make two suggestions.

One is that a steam-pipe should be provided with a piece of thin sheet iron suspended in it by a hinge and a small thick glass window fixed on each side of the pipe, so that the position of the strip of sheet iron might be easily seen. This strip would then be free to move in either direction the steam might go, and if suitably weighted, the sine of its angle of deflection would be an indication of the velocity of the steam, and the size of the pipe being known, and also the pressure of the steam, the quantity in cubic feet could easily be calculated. This would be a fairly cheap device, and would give all the information some people would ask.

The other suggestion is that some vanes might be placed in the steam-pipe so that the passage of the steam would turn them round, as the wind turns an anemometer or a windmill. This might be made self-recording if desired, and doubtless the number of revolutions made by the spindle carrying the vanes would be a fair indication of the amount of steam passed through the pipe. The anemometer has been carefully studied, and information respecting it may be obtained from Tomlinson's "Encyclopædia" and other books of reference.—F. G. A.

Question No. 499.—Describe the best means for testing the resistance of rail return of an electric tramway where the earth leakage is considerable. Also the method of bond test, with description of instrument for same.

Best Answer to No. 499 (*awarded* 10*s.*).—The resistance of the complete rail-return circuit can only be correctly measured at night, when all traffic is stopped both on the particular line to be measured and on all neighbouring lines. A car should be taken to the end of the line remote from the power station, and keeping it stationary by braking or otherwise, a fairly large current should be passed from the trolley into the rails through the controller resistance and an ammeter. A low-reading voltmeter should be connected between the rail and a third wire leading straight back to the negative 'bus bar (to which the rail is also connected) at the station. If no testing wires are already run along the line, this third wire may have to be specially run for the purpose, though usually a feeder, disconnected from the trolley, can be handily arranged for the purpose. Simultaneous readings, E and C, are then taken on the volt and

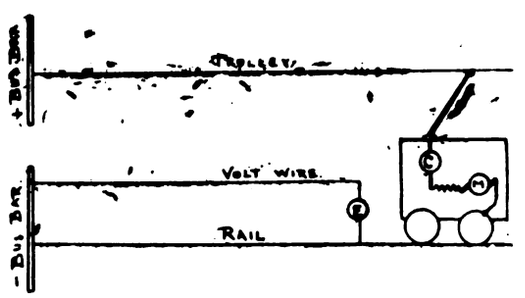

Fig. 1.

ammeters (Fig. 1), and the resistance of the rail return (of course, including apparent reduction in resistance due to earth leakage) is simply $\frac{E}{C}$.

With regard to joint testing, this is a much simpler piece of work, and can be carried out at any time during the day with the ordinary traffic going on. The ordinary test consists in comparing the resistance of a few feet of plain rail without joints with the resistance of the same number of feet of rail containing a joint. The only instrument required for this is a Weston milli-voltmeter, or some equivalent apparatus, and two adjustable resistance boxes for use in series with the voltmeter. The connections required are shown in Fig. 2, and the three contacts to the rail, 1, 2, and 3, are made at fixed distances by means of three spikes. The voltmeter resistances and contacts can be conveniently arranged in a light frame for carrying

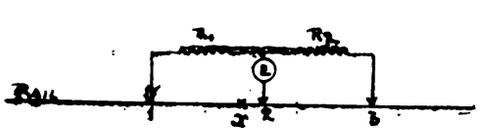

Fig. 2.

along the track by hand and applying to the rail wherever desired. The distances, 1 to 2 and 2 to 3, are 2ft. or 3ft. each. If the resistances, R_1 and R_2, are made equal, and if the resistances of the rail from 1 to 2 and from 2 to 3 are equal—*i.e.*, if no joint occurs in the distance 1 to 3—the voltmeter will show no deflection, but if a joint occurs, as shown at *x*, the resistances 1 to 2 and 2 to 3 will probably be unequal, and the resistances R_1 and R_2 will have to be adjusted to get rid of the deflection on the voltmeter. When there is no deflection again, the ratio $\frac{R_1}{R_2}$ gives the ratio of the resistance of a piece of rail with a joint to that of the same length of plain rail. This ratio should not exceed a certain value (approximately unity), depending on the size of rail and type of joint used, and any decided increase above this value would indicate a faulty joint.

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The objection to this method is the time taken to cover any length of line, and the following modification gets over this difficulty. It can, however, only be carried out when all traffic is stopped. A small extra car, or, at any rate, an insulated rail contact shoe, is connected to one of the ordinary motorcars by means of a long insulated coupling, so that the wheels of the main car and the auxiliary contact are about 20ft. or 30ft. apart (Fig. 3). The car is then run over the track at a steady and fairly slow speed, with as large and as steady a current as possible passing through its motor and measured on an ammeter. A low-reading central zero voltmeter is connected between the frame of the main car and the auxiliary contact so as to measure the volts lost in the rail between the two contacts.

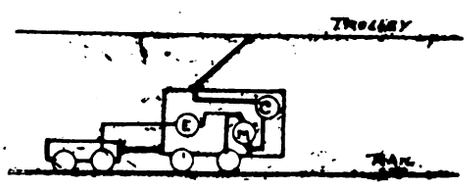

FIG. 3.

Then the ratio of the volts read to the amperes passing gives the resistance of the 20ft or 30ft. of rail, and any sudden kick on the voltmeter will at once indicate a faulty joint. By using a recording voltmeter writing on a drum driven from the car wheels, a complete permanent record of the state of the line can be quickly obtained.—Q.

Answer to No. 499 (*awarded* 5*s.*).—The most important item in this question is in reference to the rail bonding, where leakage may be expected, for if an easier path is to be found by some other route than that through the rails, the current is bound to take that path, or at least enough of the current will do so to make the fall of potential along the shunt paths equal to that in the rails. But with the high resistance of the earth it should not be possible for any great quantity of current to leave the rails unless there is trouble with the bonding; for the rails themselves have carrying capacity enough for most purposes. The difficulty in keeping the bonding in good condition is that there are so many contacts to maintain, and that they are so inaccessible.

From the electrical standpoint, the conductivity of all bonds should be good, especially at the joints. The copper resistance may be the lowest possible, yet with a joint of small area and insufficient pressure "mechanically" between the surfaces, the result will be unsatisfactory. The effect of poor bonding is very far reaching: the power lost and the corresponding drop in potential in the cars amounts to something; but the unseen destruction of pipes and cable coverings is more. Even the loss of power is generally enough to pay for what attention the bonds require. The consumption of power should not be calculated from laboratory tests of the bonds, or even from road tests when the rails are newly laid; but rather when the joints have been subjected to the hammering effects of the cars, and when the weather has had a chance of oxidising, if possible, the contacts. The resistance of the rails and bonding of the road should be made both as a whole and also bond by bond.

By measurements of the resistance of the whole track return any considerable number of bad bonds may be detected, yet if individual joints can be examined the results are much more satisfactory. The method in general use is to measure the current and the drop in volts in the joints, and when convenient it is better to pass a current through by means of a regulating resistance, such as a water rheostat; then by employing a pair of milli-voltmeters—a description of which will be found in almost every text-book on the subject or makers' catalogue—to measure the current and drop in volts caused by the resistance of the joint. By connecting one voltmeter between two points on the rail, the drop in pressure will be proportional to the current, providing the distance of the contacts is kept constant. The contacts may be either brushes or sharp points fixed on the ends of a wooden rod.

In order to translate the readings into amperes it will be necessary either to know the resistance of the rail, or to calibrate the voltmeter by taking reading when some known current is flowing. After the bonds have once been installed the question of the conductivity of the conductor is of but little importance, the resistance of the contact being the main item.

It is comparatively easy to estimate the return resistance a given road should offer, providing we are supplied with a sample of rails laid; the resistance of rails on an average is 0·45 ohm per inch-mile. Then if the specific gravity of the rail be taken as 7·8, the weight per square inch per yard is 10·2lb.; then if the weight per yard of the rail be known, the area is obtained by dividing by 10·2.

A single track of rails weighing 45lb. per yard and having a length of five miles should have a resistance of about ·25 ohm, the two rails being connected in parallel. This is on the assumption that the resistance of the bonds is equal to that of a corresponding length of rail, which is the ideal condition. In using two voltmeters, one is for the indication of current, and the other for to show drop in pressure, the distance between the points for current collecting being, say, 15ft. For location marks the poles can be used, and the results tabulated in the following manner:

Bond.	Location mark.	Drop in rail, millivolts.	Amperes in rail.	Drop in joint, millivolts.	Resistance of joint, milliohms.
79	15	21·2	121	11·4	·09
80	,,				
81	,,				

The true state of affairs can generally be seen from the total resistance of the road then, which is done by sending a current through the rails and making voltmeter contacts at the end of the line by either feeders or telephone wires, or by wires laid for the purpose according to the Board of Trade regulations.—K.

Question No. 500.—A road six miles long, and along the entire length of which an electric tramway is laid, is to be lighted by means of incandescent lamps attached to the tramway poles. Current is supplied to the tramways in the usual way at a mean voltage of 500 volts from a distributing sub-station situate midway between the ends of the tramway. One 16-c.p. lamp is to be attached to each pole, and penalties will be inflicted if the lamps are not maintained alight according to contract. Consider the relative advantages from the tramway company's point of view—they having to supply current free and supply and lay and maintain all cables, fittings, and lamps—of the following methods: (*a*) two lamps in series between trolley wire and earth; (*b*) two lamps in series between tramway feeder and earth; (*c*) five lamps in series off separate lighting distributors run direct from the sub-station; (*d*) five lamps in series run off separate distributors laid in three sections, each of two miles, and each section fed at its centre point with boosted current direct from sub-station. By "earth" in (*a*) and (*b*) is meant the rail return.

Answer to No. 500 (*awarded* 7*s.* 6*d.*).—Viewing the various methods suggested by "C. J." of lighting the tramway from the company's point of view, it will be seen at once that method A would work out cheaper than any of the others. By utilising the existing conductors—*i.e.*, the trolley wire and rail—all that there remains to be done is to make the necessary connections between lamp and lamp. If it could be arranged to make the connection between lamp and lamp with bare wire terminating on insulators, the cost would be less than if these connections were made by means of underground wires. But although this system is to be commended on the ground that it would entail comparatively small expenditure, yet it is doubtful whether it would answer well, owing to the fact that the lamps would have to be switched on or off by two at a time. This lack of control would be a serious drawback to method A, and, considering the trouble of switching the lights on or off, it would seem inadvisable to adopt this plan.

If method B was adopted, it would be expedient to erect a street box, or some other shelter where the joints are made to the feeder, in which to place the switches. The feeder being in the centre of the system, the lamps could be divided into two sections, and each section could be switched on or off independently of the other. If a switch was placed here between the feeder and trolley wire, then in the event of a breakdown or accident which

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necessitated the current being switched off the trolley wire, this could be accomplished here, instead of at the sub-station, without interfering with the lamps.

Method C would be more expensive than B, and would give no better results. By having only one pair of distributers, all lights would have to be switched on at once whether required or not.

As to the arrangement of lamps, the writer is of opinion that more satisfactory results would be obtained by having two 250-volt lamps in series than five 100-volt lamps. The reason of this is obvious. If when five lamps are in series one fails, the other four are extinguished also; and as penalties are inflicted, this a matter for consideration. With two in series, the danger of incurring penalties is greatly diminished. As to the economy of the two combinations, there would be little or no advantage gained by adopting either system.

Method D is to be recommended before C, although its cost would exceed that of any of the other three methods. By dividing the lights into three sections, the danger of an entire breakdown would be eliminated, as if one section broke down, two-thirds of the lights would still be on. Other than the advantage of offering better control, method D possesses no other distinct advantage, excepting, perhaps, that better lights would be procured, owing to having three distinct sections.

Considering, then, the *pros* and *cons* of each case, the writer comes to the conclusion that method B would answer as well as any, provided it was equipped with the arrangement of switches as described above.—W. F. SAUNDERS.

Answer to No. 500 (*awarded* 7*s.* 6*d.*).—This question omits to state the amount of the penalties to be inflicted upon the company in case its lamps are extinguished; it would be possibly worth while risking these penalties, since the difference in capital outlay for some of the methods of lighting will be considerable. In considering these four methods we must pay regard to (1) capital outlay; (2) convenience; (3) pressure maintained at lamps; (4) cost of working and attendance.

We will assume (1) that the maximum drop of voltage allowed at any lamp, independently of that caused by the working trams, will be five volts; (2) that overhead cables will be used in all cases—the Board of Trade's permission having been gained; (3) that the cost of wiring each lamp, independent of switches and fuses, is the same for any of the four methods, as it will actually be. Now, one can consider each case.

Case (*a*).—This method would undoubtedly be the cheapest, as the smallest cable and the least length would be used. The drop due to the lamp current is negligible if we take a cable of $^{3}/_{22}$ for the purpose. We have to provide one high-tension switch and fuse for each pair of lamps. About two-thirds the length of cable required as by other methods. Assuming that the posts are 40 yards apart, the cost of cable for a pair of lamps would be about £1, to which we must add 7s. for high-tension switch and fuse. It would, however, be inconvenient to have a switch on every second post, and would require an attendant to go the round of tramways every night twice to switch on and off. If time switches are used, and a system of magnetic control similar to that used on the lamp-posts at Windsor, the capital outlay would be about doubled, but no attendant would be required. The disadvantages are: (1) liability to being extinguished every time the feeder circuit breaker acts; (2) liability to great variations of voltage at the lamps due to cars passing; (3) therefore short life of lamps.

Case (*b*).—There would be 22 lamp-posts in the half-mile section (= 2,640ft.). Cable is required to carry three amperes with five volts drop. The total length of cable on which the drop takes place we will assume to be 3,200ft. The formula for finding the size of cable is the following:

$$\text{Volts drop} = V = c\ r\ (n+1)\ \frac{n}{2},$$

where r = resistance of cable from one post to the next;
c = current per lamp;
n = number of lamps taking c amperes = 11.

Let V = 5 volts;
c = 0·25 ampere;
$r = x$;
n = 11 (two in series, making 22 in all per half mile);

then, $$5 = 0{\cdot}25\ r\ (11+1)\ \frac{11}{2};$$

or $$r = 0{\cdot}3 \text{ ohm (nearly).}$$

The cable required would be $^{7}/_{23}$ S.W.G. This cable would cost, approximately, twice as much as the cable in case (*a*). On the other hand, one time switch only would be required, and no magnetic device for the other posts in each half-mile section. On the one hand, we have the cost of magnetic switching-in devices for every third post, or 10 in all—case (*a*); on the other hand, we have the extra cost of cable to set against the extra switches, as well as extra fuses. But the cost in case (*b*) should be less. Advantages: (1) better regulation of voltage, and therefore longer life of lamps; (2) less capital outlay; (3) no extra attention. Disadvantages: same as in case (*a*), but not to same extent.

Cases (*c*) *and* (*d*).—These would be more expensive in capital outlay. The cost in case (*d*) would depend, as far as the cables are concerned, on the extent or degree of boosting. As nothing is said as to whether a booster is already installed, one may assume that it is not, and, therefore, the extra cost of the booster, amounting to, say, £75, might as well be put into the cable. Case (*c*) has only the advantage of better regulation over case (*b*); its cost would be much greater, and in the event of one lamp burning out there would be no light on five posts, or for the space of 200 yards, which would mean a serious inconvenience to the public, and probably involve the company in the payment of numerous fines. Something like a $^{19}/_{17}$ cable would be required if there were only two lines from the sub-station for case (*c*). In case (*d*) the distributors would be somewhat smaller, about two-thirds size of cable in case (*c*), say $^{19}/_{18}$ cable, in addition to which we require two feeders. For the feeders the following formula can be used:

$$\text{A sq. in.} = \frac{\text{L} \cdot \rho \cdot \text{C}}{\text{V}};$$

where A sq. in. = area in square inches of cable; L = total length of cable; V = total drop in volts; C = current in amperes; ρ = ·000025 = resistance of one yard of copper one square inch in section; which would mean each feeder also to be $^{19}/_{18}$ cable.

Summing up, case (*b*) would be found to be cheaper and fairly reliable; cases (*c*) and (*d*) are equal as far as reliability and good distribution; case (*d*) is most expensive of all, but also most reliable and gives equally good distribution with case (*c*), but no advantage unless boosted to a very high pressure.—G. H. P. M.

Answer to No. 500 (*awarded* 5*s.*). — *Construction.* — Method A—In Fig. 1 is shown the method employed in this system of wiring: A, tapping taken from trolley wire to B; B, single-pole switch fitted in watertight case; C, single-pole cut-out fitted in watertight case. One terminal of the cut-out is connected to the lamp on the same pole, and then from the lamp a wire is run down the pole through a trench in the ground, up the next pole to the lamp. From the lamp a return wire is run to the track rail; the other end of the cut-out is joined to the switch, and from there to the trolley wire. The whole of the six miles of poles has to be treated in pairs in a similar manner. B—It will require same construction as described for A and shown in Fig. 1, with the exception that the wire marked A will have to be taken down to the feeder D, instead of to the trolley wire. C—In the method used for five lamps in series off two feeders, a tapping is taken off feeder B, then up the first pole to the cut-out, A, then to the lamp. The five lamps are joined in series. From the fifth lamp a wire is run down the pole and tapped on to feeder C. D—Same construction as C, only feed in three sections.

Cost.—Method A is the cheapest way of construction. B costs a little more than method A owing to the number of joint-boxes required. C way of doing it will cost more than either A or B, but against the extra cost of feeders there will be a reduction in the number of cut-outs and joint-boxes; also the switches on the poles will not be

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required, so that there will not be a very great increase in price over A or B. D—Owing to being fed in sections, the cost of feeders for D will be more than C.

Operation.—A—Liable to frequent interruption, owing to circuit breakers coming out in the section boxes during rough weather, through the trolley wire being damaged by falling trees, walls, etc., and during snowstorms, or owing to having too many trams on one section; very expensive, having to send men round to every other pole to switch on or off the lights; large number of small fuses and switches to keep in repair. B is a little better than A, the lights not being as liable to interruption. The number of cars varying on each section will show up on the lamps both in A and B method. C—The lights can all be switched on from the power station, thereby saving the cost of sending men round; not liable to interruption during rough weather, etc. D—Being operated in sections, one fault does not put all the lights out. There will be very little saving in using boosted current over the method C.

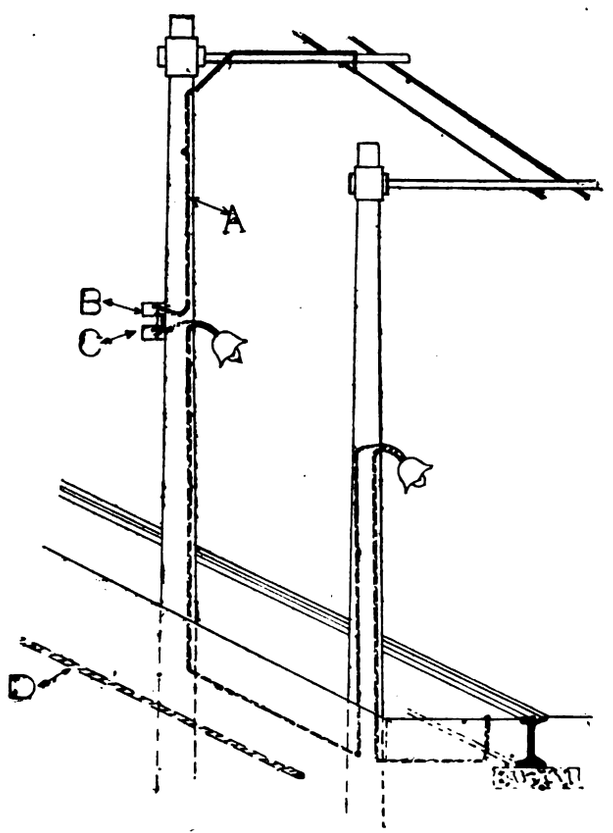

FIG. 1.

In either C or D, if a fault takes place on one main, and that happens to be the positive, it is possible to change the mains over and get the earth on the negative main until it can be repaired, thereby saving having to put the lights out. C or D methods are better than either A or B methods, in not having the same number of points at as high potential above the earth. In a series of five lamps in C or D methods: first lamp, 500 volts; second, 400; third, 300; fourth, 200; fifth, 100 volts above earth. A or B methods: one lamp 500 volts and the other 250 volts above the earth.

The method described in B seems to be the best, take it all round, for the tramway company.—C. G.

ST. PANCRAS ELECTRICITY ACCOUNTS.

The following is the report of Mr. Albert E. Pycraft, chief clerk to the St. Pancras Borough Council, on the working of the electric lighting department during the 15 months ended March 31, 1902. Abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., are also appended:

The loans received during the 15 months amounted to £74,520, making the total loans sanctioned and borrowed £335,620, of which £27,840. 18s. 2d. has been repaid. The expenditure on account of capital during the 15 months was £45,140. 0s. 1d., making a total capital expenditure at March 31, 1902, of £380,126. 18s. 9d. The gross revenue for the 15 months amounts to £74,503. 18s. 9d., and the net revenue £25,894. 14s. 1d., which, after providing for interest and repayment of loans, etc., leaves a profit on the 15 months' trading of £5 090. 11s. 9d. I would call attention that in the expenses for distribution is included an exceptional item—viz., £724. 16s. 9d. for alterations in connection with changing pressure on mains to 220 volts. It should also be stated that during the additional quarter included in the accounts a larger aggregate of repayments of loans has been met than is proportional to the period. On the credit side of the account, it was found desirable to take the meter readings earlier than formerly, and this has had the effect of reducing the net profit by some £2,250, the benefit of which will accrue in the current year's account. The following table shows the progress of the electricity undertaking since the commencement:

Year ending Dec.	No. of consumers.	Current sold to consumers (not including public street lighting). 3d. per unit. £ s. d.	4d., 5d., and 6d. per unit. £ s. d.	No. of lamps etc., applied for. Incandescent. 16 c.p.	Arc.	Motors.
1892	172	—	8,167 7 8	9,990	82	11
1893	238	384 11 6	9,161 6 0	12,851	110	19
1894	349	1,236 13 9	10,819 15 9	15,542	129	22
1895	447	2,142 9 6	12,682 6 0	19,195	139	37
1896	672	2,948 19 9	19,430 8 8	26,423	187	47
1897	808	4,081 10 0	25,220 11 5	32,250	251	78
1898	984	8,415 0 0	23,446 5 2	38,124	292	91
1899	1,184	11,699 12 3	25,992 17 6	46,172	315	126
1900	1,438	12,563 16 7*	25,914 5 9	57,456	426	152
1902	1,806	20,996 4 1*	38,228 8 5	66,999	523	211

*2d. and 3d. per unit.

REVENUE ACCOUNT.

Dr.			£ s. d.
Generation of Electricity.			
Coal or other fuel	£20,602 8 8		
Oil, waste, water, and stores	1,900 17 2		
Proportion of salaries of engineers	658 6 0		
Wages at generating stations	4,873 8 4		
Sundry petty expenses	177 9 11		
Repairs and maintenance	5,077 11 9		
			33,290 1 10
Distribution of Electricity.			
Proportion of salaries	541 18 4		
Wages of outdoor staff	1,401 19 9		
Repairs, etc., buildings	107 17 5		
Repairs, etc., of mains	2,366 1 9		
Alterations in connection with changing pressure on mains, etc., to 220 volts	754 16 9		
Repairs, etc., of meters, etc.	850 3 6		
Repairs at distributing stations	102 10 6		
Water, etc., at distributing stations	6 10 10		
			6,131 18 10
Public Lamps.			
Carbons	972 12 9		
Repairs	350 2 6		
Attending	1,295 11 2		
			2,618 6 5
Licenses and wayleaves			34 5 6
Rents, rates, and taxes			2,125 1 5
Management Expenses.			
Salaries—viz., engineer's department	2,404 14 2		
Stationery and printing	269 8 3		
General establishment charges	520 11 7		
			31,194 14 0
Law expenses			5 0 10
Special Charges.			
Insurances, etc.	475 7 10		
Fees, testing meters	4 0 0		
Expenses obtaining loans	142 14 6		
Compensation claims	190 0 0		
Alterations to engine-room	6 14 7		
Professional charges	73 2 0		
Sundry chargeable works	317 16 11		
			1,209 15 10
Total expenditure			48,609 4 8
Balance carried to net revenue			25,894 14 1
			£74,503 18 9

Cr.	£ s. d.
Sale of current per meter at 6d. per B.T.U.	25,949 9 0
,, ,, 5d. ,,	9,863 10 5
,, ,, 4d. ,,	2,415 9 0
,, ,, 3d. ,,	14,678 7 9
,, ,, 2d. ,,	6,317 16 4
	59,224 12 6
Sales of current (minimum charges)	12 10 0
Public lighting (sale of current and all charges)	14,263 9 3
Indicator rentals	213 14 0
Sundry chargeable works	340 9 8
Fees for testing installations	12 10 0
Rents receivable	249 3 4
Proportion of office expenses chargeable to the Lighting (Gas) Department	187 10 0
	£74,503 18 9

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GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	335,620	0	0
Amount received on loan from bankers	47,977	8	7
Sundry creditors	10,153	1	4
Amounts due under contracts	4,058	2	3
Interest and repayments accrued on loans	3,880	12	7
Net revenue account	6,229	19	9
Reserve fund	10,433	18	6
	£418,353	3	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	380,196	18	9
Stores in hand	7,297	2	10
Debtors for current supplied—less deposits	18,453	6	3
Sundry debtors	59	10	4
Amounts due on account of street lamps, etc.	989	8	3
Reserve fund investment account	10,433	18	6
Suspense account	923	3	2
Cash in hand	69	14	11
	£418,353	3	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			5,608,436
Quantity sold	Public lamps	1,141,077	4,729,840
	Private consumers by meter	3,588,763	
Quantity used on works and testing-room			365,686
Total quantity accounted for			5,095,526
Quantity not accounted for			512,910
Number of public lamps			450
Total maximum supply demanded (kilowatts)			2,610

LUTON ELECTRICITY ACCOUNTS.

The expenditure on capital account by the electricity department up to the present amounts to £25,165. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., which are for nine months only:

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	392	12	6
Distribution of electricity	12	18	9
Repairs of public lamps	33	9	6
Rates and taxes	158	12	0
Management expenses—salaries, etc.	152	16	3
Special charges—insurance, etc.	37	2	9
	787	11	9
Balance to net revenue account	134	2	3
	£921	14	0

Cr.	£	s.	d.
Sale of current per meter and for power	790	14	9
Public lighting	111	7	5
Rental of meters	19	11	10
	£921	14	0

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	26,173	10	6
Sinking fund account	760	0	0
Interest on loan accrued due	211	5	0
Amount due to general current account	1,067	0	0
Balance due to treasurer (revenue account)	1,673	11	8
	£29,885	7	2

Cr. Assets.	£	s.	d.
Capital account—amount expended	25,165	13	0
Stores on hand	15	12	6
Sundry debtors for current supplied, meter rents, etc.	409	14	5
Securities held (cost price)	760	0	0
Balance at debit of net revenue account	1,459	9	9
Cash with treasurer (capital account)	2,074	17	6
	£29,885	7	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			53,129
Quantity sold	Public lamps	10,338	50,972
	Private consumers by meter	40,634	
Quantity used on works			2,157
Total quantity accounted for			53,129
Total maximum supply demanded (kilowatts)			92

Number of public lamps: 10 arcs, 24 incandescents.

GRIMSBY ELECTRICITY ACCOUNTS.

According to the accounts of the Grimsby electricity department for the year ended March 31, 1902, the total expenditure on capital account amounts to £57,874. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	1,735	15	4
Distribution of electricity	93	1	11
Attending and repairs of public lamps	258	4	1
Rent payable	43	6	8
Management expenses—salaries, etc.	624	17	3
Special charges—insurances, etc.	59	16	8
Total expenditure	2,815	1	11
Amount set aside for bad debts	10	0	0
Balance carried to profit and loss account	1,557	9	4
	£4,382	11	3

Cr.	£	s.	d.
Sale of current per meter at 5d. per Board of Trade unit	2,302	15	2
Under contract (traction)	577	10	9
Public lighting	1,327	0	2
Rental of meters	66	13	8
Sale of incandescent lamps	60	9	2
Fees for wiring of consumers' premises	33	1	3
Fees for tests, charging batteries	15	1	1
	£4,382	11	3

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	54 962	0	0
Sundry creditors and bank balance	8,220	18	7
Sinking fund account	1,390	17	10
Provision for bad debts	10	0	0
	£64,583	16	5

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	57,874	13	5
Stores in hand	575	9	4
Sundry debtors for current supplied	2,277	7	1
Other debtors on wiring account and for goods sold	135	6	0
Balance at debit of profit and loss account	3,721	0	7
	£64,583	16	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			357,472
Quantity sold	Traction	90,492	290,247
	Public lamps	88,012	
	Private consumers by meter	111,743	
Quantity used on works			24,069
Quantity unaccounted for			41,084
Total maximum supply demanded (kilowatts)			392

Number of public lamps, 65 arcs, 1 pair incandescents.

TUBE BILLS IN PARLIAMENT.

SIR LEWIS M'IVER'S COMMITTEE.

THURSDAY, JULY 31.

The committee resumed the consideration of the clauses of the Brompton and Piccadilly-circus Railway Bill. On the previous day the Committee had passed the preamble and had decided not to accede to a demand of the Piccadilly and City Electric Railway Company that a joint station should be constructed for the use of the two companies in the Haymarket, but to authorise the making of a subway between the companies' stations at joint expense.

A clause to carry out an agreement which had been entered into with the London United Electric Company with regard to the point at which the two companies' lines are to cross one another at the northern end of Sloan-street was approved. It was to the effect that if the London United Company's Bill were sanctioned by Parliament the Brompton and Piccadilly Company should not deviate their railway to any greater extent than 3ft. downwards from the level shown on the deposited plan at the point of crossing, and that a clear space of 5ft. should be left between the respective tunnels of the companies. A clause making the return half of workmen's tickets not available till after noon on the day of issue was accepted by the committee. The London County Council asked for a clause to provide for street improvements being made at the company's station sites before rebuilding. An agreement was finally made that any land which the company could spare should be purchased by arbitration.

The remaining clauses were then adjusted, and the Bill was ordered to be reported for third reading.

Halifax.—The question of extending the Corporation tramways to Brighouse, *via* Hipperholme, and to Greetland was raised at the meeting of the Town Council on Wednesday. A report was presented from the Tramways Committee declaring that the proposal was at present inopportune. An amendment that the whole question of tramway extensions or non-extensions be referred to a special meeting of the Council was adopted.

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LEGAL INTELLIGENCE.

THE POOLE AND DISTRICT TRACTION COMPANY v. BOURNEMOUTH CORPORATION.

The injunction authorised by the Court of Appeal has been suspended pending an appeal in the House of Lords. The Corporation have given an undertaking to transfer to the plaintiff tramway No. 6 for the reasonable cost of the construction of the permanent way and overhead equipment if the House of Lords affirms the decision of the Appeal Court.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-AMERICAN TELEGRAPH.

The half-yearly meeting of shareholders of the Anglo-American Telegraph Company, Limited, was held last week at Winchester House. Mr. Francis A. Bevan presided.

The **Chairman** said the receipts for the half-year decreased by £13,167, but he believed there had been a falling off in the receipts of submarine telegraph companies generally, and it was probably owing to a diminution in the volume of business. Commenting on the development of wireless telegraphy, he remarked that nothing had occurred, as far as he knew, to make them alter the opinion they expressed on a previous occasion—namely, that although wireless telegraphy would produce a certain class of telegram, such as between the ship and the shore, or between ship and ship, there was no reason, as far as could at present be seen, why it would compete with the class of telegrams which the Anglo-American and other companies sent. He quoted Lord Kelvin, who had said to him, "I have given careful consideration to this subject, and I do not believe that the shareholders in your Company need be alarmed at the prospect of wireless telegraphy." As far as any decision had been given in the French lawsuit it had been in this Company's favour, and the directors had no reason to think that it would be otherwise. A dividend of 12s. 6d. per cent. on the ordinary and £1. 5s. per cent. on the preferred stock was declared for the first and one of 15s. per cent. and 30s. per cent. for the second quarter.

PAISLEY TRAMWAYS.

The thirty-second ordinary general meeting of the directors and shareholders of the Paisley Tramways Company was held on Wednesday last week. Mr. J. G. Stewart presided.

The **Chairman,** in moving the adoption of the report, expressed regret that the result of the past half-year's work were not more satisfactory, there being a debit balance of £15. 4s. 9d. on the working for that period.

The report was adopted.

On being asked if the directors had had any communication with Mr. Murphy, the **Chairman** replied that they had had no communication with him. The directors, however, had agreed to ask Mr. Murphy to at once implement the agreement come to when his Bill was passed. It was also resolved to call upon the arbiter, Mr. More, C.E., of Edinburgh, to make a valuation of the property and thereby try to bring matters to a point.

METROPOLITAN RAILWAY.

The ordinary half-yearly general meeting was held on Aug. 1, **Mr. John James Mellor, J.P., D.L.,** chairman of the Company, presiding, who largely dwelt upon the progress made with the electrification of the undertaking. He said the directors had fully carried out the pledges given at the last half-yearly meeting, that not a day nor an hour should be lost in pushing forward this work. Contracts were let early in the year with the British Westinghouse Company for the supply of the complete installation of their power-house at Neasden. They had been able to make their contracts on exceptionally favourable terms, not only for the steam and boiler power and electrical plant at Neasden, but also for the various sub-stations. The contracts for the installation at Neasden had been given that morning to the British Westinghouse Company. The contract for the conducting rails had also been let. The design for the rolling-stock had been approved, and the contract for this portion of the equipment was in hand. With regard to carriages they had concluded that there is a demand for two classes by the public travelling on their system, and to have first and third class carriages.

Sir Charles McLaren, K.C., M.P., deputy-chairman, seconded the motion, which, after some congratulatory remarks by shareholders on the satisfactory statement made by the chairman, was unanimously agreed to.

GREAT NORTHERN AND CITY RAILWAY.

The eighth half-yearly meeting was held on Aug. 1.

Sir Charles Scotter, J.P., chairman of the Company, who presided, said that the contractors were of opinion that the line between Drayton-park and Finsbury-pavement could be opened for traffic in the course of four or five months. He thought that it will probably be completed and ready for opening at the end of the year. The generating station near the Regent's Canal was very spacious and one of the largest in London. The engine-house was practically finished. Its dimensions were 52ft. by 129ft. by about 60ft. high, excluding the basement. It contained four engines, each capable of developing in continuous running about 1,600 i.h.p., and with a capacity for sudden overloads up to 2,500 i.h.p. These engines of the most modern type, especially designed for this work, were being manufactured by the well-known makers, Messrs. Musgrave and Co., of Bolton, Lancashire. They will be supplied with steam from 10 Davey-Paxman boilers of the cylindrical marine type. The coal to be burned in the furnaces will be conveyed direct from the barge in the canal at the end of the boiler-house without being touched by hand. There will be a 30-ton electric crane constructed by Messrs. Booth and Rodley in the engine-house. There are auxiliary engines of the "Peache" type supplied by Messrs. Davey-Paxman, of Colchester. The whole of the steelwork for the power station had been manufactured by Messrs. Dorman, Long, and Co., of Middlesbrough. The dynamos, motors, and electrical equipment generally are to be supplied by the British Thomson-Houston Company, of Rugby; the economisers by Messrs. Green, of Wakefield; and the mechanical stokers by Messrs. Vicars, of Earlestown. The rails for the permanent way were in process of being raised. They are 85lb. per yard, and were supplied by Messrs. Cammel and Co., of Sheffield and Workington. Special rolled-steel chairs support the rails, and are fixed every 2ft. 6in. These will ensure an elastic cushioned road, and will thereby reduce vibration to a minimum. The rolling-stock, which is being constructed by the Electric Railway and Tramway Carriage Works, of Preston, in Lancashire, and also by the Brush Electrical Engineering Company, of Loughborough, in Leicestershire, was most luxurious and roomy for this type of service. The carriages will be 9ft. 4in. wide overall by 50ft. in length. Seven will form a complete train, three of them being motor-carriages, and equipped with six 125-h.p. motors. They are to be controlled on the multiple-unit plan, and will be of the same type as those about to be adopted by the Metropolitan and District Railways. The lifts to be used at the stations will be by Messrs. Easton and Co., of Erith. All the equipment had been supplied by British firms. Their tunnels were larger than those of any tube railway in London, being 16ft. as against 10ft. and 11ft. of the other companies; so that, assuming there was a breakdown, any passenger would be able to get out of the train and walk along the railway on a level footpath. The tunnels would always be lighted whenever there was a train running. After statements with regard to the Company's recent Bill, the vibration clause, etc., in themselves interesting but unfortunately crowded out of this issue on account of want of space, the chairman, in reply to a question, said the estimated further expenditure on lines in course of construction in subsequent half-years was correctly stated to be nil, the fact being that under the contract the contractors, Messrs, Pearson and Son, had to build, equip, and place the line in absolute working order for the total amount of the capital.

The report was carried unanimously, and a hearty vote of thanks to the chairman and directors closed the proceedings.

GENERAL ELECTRIC.

The ordinary general meeting of the shareholders of the General Electric Company (1900), Limited, was held on the 31st ult., Mr. G. Byng (the chairman) presiding.

The report having been taken as read, the **Chairman** at length referred to the recent calamitous fire. He said their premises in Queen Victoria-street had been inspected many times by fire experts, and, on their recommendation, they had spent hundreds of pounds upon a private fire brigade, hydrants, fire-alarms, etc.; but not one of these experts had ever recommended such a thing as, for instance, the placing of a permanent ladder in order to provide an exit to the roof. The directors felt that, to the best of their ability, they had taken every reasonable precaution for the safety of those in the midst of whom they themselves were working daily. The financial year, as regards the general conditions of trade, had suffered from the continuation of the war and the ever-increasing foreign competition to which manufacturers were exposed. They held the amount of £39,000 and of £7,000 debentures in the Uxbridge Electric Lighting Company. In connection with this undertaking, they had acquired a concession for the lighting of Northwood, West Drayton, and the district around Uxbridge, which was rapidly developing. The remainder of their securities was represented principally by a share in the Incandescent Electric Lamp Factory, which had proved an excellent investment, both financially and commercially. As a net result of trading it was proposed to declare the same rate of dividend upon the ordinary shares as last year, but to place in reserve a sum of £3,000 in excess of that placed to this account last year. At Witton, where ample space was provided for the largest possible works, as well as for a colony of workpeople, they had completed their second big works, which was an electric carbon factory, practically a new industry in this country.

Mr. H. Hirst seconded the motion, and the report was adopted.

The retiring director (Mr. H. Bevis) having been re-elected, a similar resolution was agreed to in respect to the auditors (Messrs. Edwin Guthrie and Co. and Messrs. George A. Touch and Co.).

CENTRAL LONDON RAILWAY.

At the ordinary general meeting on Aug. 5, **Sir H. Oakley,** who presided, said that in the 26 weeks constituting the half-year 23,000,000 passengers had been carried—an increase over the corresponding quarter of last year of 2,500,000. The gross receipts amounted to £185,118, or £20,000 above last year's total. The increase was equivalent to 12¼ per cent. on the comparative figures. The average earnings per train mile this year was 5s. 8d., as against 5s. 2d., and they had run 15,000 miles more to earn that increase. This additional revenue had been earned without any real addition to the working expenses. Including the balance brought forward, they had £98,465 to divide, and after providing for the debenture interest

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£82,600 remained. Of that amount the directors recommended that £47,000 be appropriated to the payment of a 4 per cent. dividend on the original and on the preferred stock, and that £9,994 be provided for the dividend on deferred stock, which was not payable until the result of the whole year's working had been ascertained. An available balance of £25,600 would remain to be carried forward to the present half-year. Coming to the question of air in the tunnels, he said every night the air in the tunnel was pumped out, and on the whole the atmosphere was infinitely purer than that in any other tunnel. The air had been examined by the local medical officer, and the Board had also given facilities to enable the scientific advisers of the County Council to examine the atmosphere. The Company were now awaiting their report, and they were led to think that it would be a tolerably good one. They regretted that their Bill this year was unsuccessful, and still thought that the decision of the Select Committee of the House of Lords was wrong in rejecting their proposal to establish a circular route going east and west.

The report was adopted and Viscount Esher elected a director.

NATIONAL TELEPHONE.

The thirtieth ordinary general meeting of the above Company was held on the 31st ult., Sir Henry Fowler, M.P. (the president), in the chair.

The **Chairman** said the report and statement of accounts showed an income during the past half-year of £821,743, or, compared with £774,714 in the corresponding half of 1901, an increase of £47,028. Working expenses for the half-year were £479,122, compared with £453,913 last year. The net result of the half-year, deducting the Post Office royalties, which amount to £75,577, is a profit balance of £267,043, as compared with £247,645 for the corresponding period of 1901, being an increase of £19,397. The directors recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. on the third preference shares, 6 per cent. on the preferred shares and preferred stock, and 4½ per cent. on the deferred stock. Out of the income the Board propose to transfer £70,000 to the reserve fund. The increase of orders obtained in London since Nov. 18 last was, he believed, as large an increase as they had had in any half-year. After giving details of the recent fire at their City exchange, he congratulated the general manager, the London engineer, the London superintendent, and all their subordinates for the zeal, enthusiasm, and ability which they displayed in grappling with the calamity.

The report was adopted.

MAXIM ELECTRICAL AND ENGINEERING.

The ordinary general meeting of this Company was held on the 31st ult., Mr. J. de Meray presiding.

Mr. R. Wright, manager of the engineering department, explained that the present position of this branch was not disclosed by the accounts, inasmuch as the contracts were not completed, wherefore the profits could not be shown until the accounts for the current year were presented. These amounted to about £50,000.

Mr. Hill, manager of the lamp department, gave some figures showing the monthly increase in the output, adding that the sales had been largely increased, despite the great set-back caused by the postponement of the Coronation.

The report was adopted.

BIRMINGHAM AND ASTON TRAMWAYS COMPANY.

At the annual meeting of this Company at Birmingham, the chairman, Colonel E. J. L. Twynam, presided.

The annual report proposed to appropriate the available surplus of £10,570. 7s. 4d. as follows: to payment of a dividend, free of income tax, at the rate of 10 per cent. per annum, on account of which £3,000, being an interim dividend at the rate of 10 per cent. per annum for the six months ending Dec. 31, 1901, has been paid, £6,000; to payment of a bonus of 2s. per share, £1,200; to directors' percentage on excess of dividend over 5 per cent., in accordance with the articles of association, £367. 10s.; to carry to reserve, £3,002. 17s. 4d.

BAKER STREET AND WATERLOO RAILWAY.

The report for the half-year ended June 30 last, submitted at the meeting yesterday, states that the capital expenditure during the half-year amounted to £66,011. The estimate for the current half-year is £175,000. The construction contracts and agreements relating thereto have now been transferred by the Metropolitan District Electric Traction Company, Limited, whose capital was £1,000,000, to the Underground Electric Railways Company of London, Limited, with a subscribed capital of five millions sterling. Satisfactory progress is being made with the construction of the works. The Company's Bill is now waiting third reading in the House of Commons. The engineers' report states that since their last report the works have made progress as follows: The western running tunnel at Waterloo has been completed to Addington-street. The eastern running tunnel has been continued southwards to a point 54 yards short of the Waterloo station tunnel. On the north side of the river the shield chamber for the second station tunnel at the Embankment has been constructed, and the shield is now in course of construction. The eastern station tunnel at Oxford-street has been completed, and the headwall built ready for continuing the running tunnel. The western running tunnel has been continued from the point in Regent-street near Vigo-street, where it was suspended, to a point 230 yards south of Oxford-circus. On the northern section of the railway the eastern running tunnel, which was suspended in May last year at a point in Regent's Park, north of the outer circle roadway, was started again on June 30 last, and is now about to cross under the said roadway. At the station at Waterloo the lift chamber or booking hall has been covered in, and is ready for the internal fittings. At Piccadilly the works remain as they were at the last report, and at Oxford-street preparations are being made to start some underpinning work to enable the large lift shaft to be sunk.

NORTH METROPOLITAN TRAMWAYS.

The report for the six months ended June 30 last, to be submitted at the meeting on 12th inst., states that the Bill for the electrification of the Company's lines in Middlesex, the application for which was authorised at the last meeting, has passed both Houses of Parliament, and by arrangement with the Middlesex County Council and the Metropolitan Electric Tramways, Limited, it is now proposed to apply to the Board of Trade for their consent to a sale of these lines to the Metropolitan Electric Tramways, Limited, and an agreement to this effect will be submitted for confirmation at the meeting. The Act also contains power to increase the number of directors to six, and a resolution to this effect will be submitted to the meeting. The directors recommend that Mr. James Devonshire, the managing director of the Metropolitan Electric Tramways, Limited, be elected as such additional director.

ROTHESAY TRAMWAYS.

The report by the directors states that contracts were entered into for the electrical reconstruction and equipment of the line, and work was commenced upon the roadway on March 3, and finished, fit for resumption of car traffic, on May 17, since which date it has been worked by horses. Concurrently with the road construction, the erection of a power station, car-sheds, and the overhead equipment have been in progress. Unforseen difficulties have arisen causing delay on the power-house and car-shed site, but they are now overcome, and the work is approaching completion. It was hoped that by the end of July the line would have been entirely worked by electric power.

BLACKPOOL AND FLEETWOOD TRAMROAD.

The report for the half-year ended June 30 last, to be submitted to the meeting on 21st inst., states that the receipts from all sources amounted to £9,941. Including the sum brought forward from last half-year, the balance of profit, after providing for debenture interest, is £3,538, and a dividend at the rate of 4 per cent. per annum is recommended.

APPOINTMENTS VACANT.

Various Appointments are vacant under the Woolwich Borough Council Electricity Department, Aug 14. See advertisement.

Switchboard Attendants, Peterborough Corporation, 24s. 6d. per week, Aug. 9; Carlisle Corporation, 25s., Aug 18. See advertisements.

Assistant Engineers, Oldham Corporation, £100 per annum, Aug. 11; Edinburgh Corporation Electricity Supply Department, £100 per annum, Aug. 22. See advertisements.

Junior Switchboard Attendant, Hoylake and West Kirby Urban District Council, £52 per annum, Aug. 12. See advertisement.

Draughtsmen, large shipbuilding and engineering works; experienced in design of central generating station for power and light; practical experience in switchwork. See advertisements.

Meter Inspector, 30s. per 50-hour week. See advertisement.

Wireman and Assistants, Bermondsey Borough Council. See advertisement.

Sub-Station Attendant, Croydon Electricity Works. See advertisement.

Junior Shift Engineer, Croydon Electricity Works, 30s. a week. See advertisement.

Various.—The Colchester Town Council will shortly advertise for a chief assistant, £2. 10s. per week, to have charge of the night shift of men; a shift engineer, at £1. 5s. per week, to have charge of the day shift; a second engine-driver for the day shift, at £1. 15s. per week; and a trimmer for evening shift, at 15s. per week.

NEW COMPANIES REGISTERED.

South Yorkshire Promoters, Limited.—Capital, £99. Objects: to carry on in the West Riding of Yorkshire and elsewhere the business of an electric supply company in all its branches; to erect all necessary power generating stations, works, plant and machinery, cables, wires, lines, accumulators, lamps; as electricians, electrical engineers, etc.

Automobile Supply Company, Limited.—Capital, £21,000. Object: to deal in and with motors and engines of every description, cars, etc.

Concordia Electric Wire Company, Limited.—Capital, £2,000. Objects: to acquire and turn to account any patents relating to improvements in the distribution of light, heat, sound, power, or other effects; as general electricians and electrical engineers, wire-drawers, etc.

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East India Tramways Company, Limited.—Capital, £80,000. Objects: to acquire and work any tram or rail roads in India, with all or any of the undertakings, concessions, lands, buildings, and property of the East India Tramways Company, Limited, in liquidation, etc.

Coston and Co., Limited.—Capital, £6,000. Objects: to acquire the business carried on by W. H. B. Coston, as Coston and Co., at 14, Milbrook-road and Grove-road, Southampton, and to carry on the general business of builders and contractors, electrical engineers, etc.

South American Light and Power Company, Limited.—Capital, £100,000. Object: to carry on in the Argentine Republic or elsewhere in South America the business of electrical engineers, etc.

Electrical Publishing Company, Limited.—Capital, £14,500. Objects: to adopt an agreement with T. J. F. Feilden, and to carry on the general business of printers and publishers, etc.

Sutton District Development Company, Limited.—Capital, £1,000. Objects: to carry on the general business of a land development company, suppliers of electricity for the purposes of light, heat, or power, etc.

Burma Tramways Construction Company, Limited.—Capital, £50,000. Objects: to adopt, to construct, maintain, and work any rail and tram roads, and also undertakings of every kind for generation, utilisation, supply, or distribution of electrical or other power for heating, lighting, telegraphic, or telephonic purposes, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Calarasi-Stirbey (Roumania).—The Municipality require tenders for public electric lighting. Tenders by Sept. 3.

Trujillo (Spain).—The Municipality require tenders for public electric lighting for 20 years. Tenders by Aug. 10.

Plymouth.—The Corporation invite tenders for overhead line construction, etc., in connection with the tramways. Tenders by Aug. 23. See advertisement.

Harrogate.—The Corporation invite tenders for the wiring and supply of fittings for the electric lighting at the kursaal, Harrogate. Tenders by Aug. 18. See advertisement.

Accrington.—The Watch Committee invite tenders for nine arc lamps and pillars. Particulars may be obtained from Mr. H. Gray, Electrical Engineer's Office. Tenders by Aug. 19.

Nisch (Servia).—The Municipality invite tenders for electric lighting of the town estimated at 202,132·47 dinars, and for plant estimated at 366,841·75 dinars. Tenders by Aug. 13. Particulars may be obtained on application to above.

Aberdeen.—The City District Lunacy Board invite tenders for an electric light installation at Kingseat Asylum, Newmachar, Aberdeenshire. Particulars may be obtained from Mr. A. Marshall Mackenzie, 343, Union-street, Aberdeen. Tenders by Aug. 25.

Malvern.—The Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work); engines, alternators, exciters, and switchboard; high and low tension concentric cables; and transformers. Tenders by Aug. 23. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1. The Government also propose to lay a cable between Punta-Arenas and Puerto-Montt.

Halifax.—Tenders are invited for the installation of the electric light to two houses, Stafford-road. Specifications, etc., can be obtained at the offices of Messrs. Richard Horsfall and Son, architects, etc., 22A, Commercial-street, Halifax. Tenders by 4 p.m. on Aug. 11.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Rugby.—The Urban District Council invite tenders for the supply and erection of one 150-kw. and one 60-kw. high-speed steam alternators, three-phase, switchboard, underground mains, arc lamps, public incandescent lamps, etc., and meters. Tenders by Aug. 20. See advertisement.

Wolverhampton.—The Guardians invite tenders for providing and fixing engines, dynamos, mains, wiring, and fittings at their new workhouse (accommodation, 1,400). Specifications, etc., may be obtained from Mr. Arthur Marshall, A.R.I.B.A., King-street, Nottingham. Tenders by 13th inst.

Ilford.—The Urban District Council invite tenders for a combined track watering and sweeping car on maximum traction truck with complete electrical equipment. Specification, etc., may be obtained at the offices of Mr. John W. Benton, clerk to the Council, Town Hall, Ilford. Tenders by 12 noon on Aug. 19.

Bexley (Kent).—The Electric Lighting and Traction Committee invite tenders for tramway and lighting cables, including trenches, and for switchboards, accumulators, motor-boosters, rotary converter, and motor. Specifications, etc., can be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster. Tenders by Aug. 9.

Newport (Mon.).—The Asylum Visiting Committee invite tenders for electric generating plant and electrical wiring and fitting for the proposed new lunatic asylum at Caerleon, Mon. Specifications, etc., can be seen at Mr. A. J. Wood's offices, 22, Surrey-street, Victoria-embankment, W.C., and obtained from the Borough Engineer. Tenders by Aug. 20.

Cork.—The Committee of Management of the Cork District Lunatic Asylum invite tenders for the supply and erection of steam plant, dynamos, storage battery, switchboards, instruments, wires and fittings, etc., for the electric lighting of the Youghal Asylum. Specifications, etc., can be obtained from Mr. Henry A. Cutler, A.M.I.C.E., Municipal Buildings, Cork. Tenders by 10 a.m. on Aug. 12.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

Madrid.—The Public Works Department invite tenders for the extension of electric tramways in the east of Madrid, and also for a new line and working of the same for not more than 60 years. A preliminary deposit of 3,368 pesetas and a final deposit of 16,844 pesetas is required, also the repayment of 3,189 pesetas and interest to the Sociedad del Tranvia del Este for preparation of the scheme. Particulars may be obtained from the above. Tenders by Aug 26.

London, S.W.—The London County Council invite tenders for the supply and delivery of seven tubular fuel economisers, of not less than 320 tubes each, complete with scraper gear, and seven motors with their starting gear for driving the same; for erection of above-named plant in the Council's electricity generating station at Greenwich; and for supply and delivery at the station of dampers and frames for flues and chimney openings to be erected and fixed by the Council. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Aug. 15.

Christiania.—The Board of Trade have received through the Foreign Office, from the British Vice-Consul at Christiania, a notification to the effect that sealed tenders, marked "Telegraf-og-Telefon-materiel," will be received at the Board of Manager's Office Christiania, up to 3 p.m. on 13th inst. for the supply to the Norwegian State Railways of the undermentioned goods: 22,000 kg. of telegraph wire, No. 8 galvanised iron wire 4·1mm. to 4·3mm. diameter; 5,400 kg. of telegraph wire, No. 11 galvanised iron wire 3·1mm. to 3·3mm. diameter; 3,600 kg. of copper wire 2·4mm. to 2·6mm. diameter; 5,900 porcelain insulators; 5,900 insulator holders. Tenders may include part or all of the goods required. Further particulars can be obtained on application to the office of the Inspector of Telegraphs, Stonersgade, Christania. Apart from the usual customs duties a preference from 10 to 15 per cent. is given to native manufactures.

Leicester.—The Tramways Committee invite tenders for electric tramway works and materials, under the following sections, each comprising a separate contract. For supply and delivery of steel girder tramway rails and fishplates; supply and delivery of bolts, nuts, and tiebars; supply and delivery of points, crossings, and special track work; supply and delivery of stoneware pipes and conduits; supply and laying of feeder cables, telephone and test wires, and supply and delivery of roadway frames and covers; supply and erection of overhead electrical equipment, and the supply of copper bonds; supply and erection at the power station of steam-raising plant; supply and erection at the power station of engines, generators, battery, boosters, switchboard, overhead travelling crane, etc.; supply and delivery of electric tramcars. Specification, etc., may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., engineer, Town Hall, Leicester. Tenders by Sept. 3.

Selangor (Malay States).—The Crown Agents for the Colonies invite tenders for certain plant and materials in connection with the electricity supply scheme for the town of Koala Lumpur, in the protected native state of Selangor, Federated Malay States: (Contract A, Section 1) supply, delivery, and erection of a generating station, consisting of two 600-h.p. high-pressure turbines, with pipes, two 400-kw. three-phase alternators, switchboard, and sundries. (Section 2) The supply, delivery, and erection of a sub-station plant, consisting of three 150-kw. motor-generators, two balancers, switchboards, and sundries. (Contract B, Section 3) The supply and delivery f.o.b. at a European port of steel poles, cross-arms, insulators, copper wire, &c., for the high-pressure transmission line. (Contract C, Section 4) The supply and delivery f.o.b. at a European port of arc lamps, iron posts, controlling apparatus, incandescent lamps and fittings. Tenders may be sent in for any or all of above three contracts. Specifications, drawings, general conditions, and forms of tender may be obtained from the Crown Agents for the Colonies, Downing-street, London, S.W., on and after 7th inst., on payment of £2 for Contract A, £1 for Contract B, and £1 for Contract C. Sealed tenders, endorsed "Selangor Electric Lighting Contract," and addressed to the Crown Agents for the Colonies, are to be delivered at Downing-street, London, S.W., by 12 noon on Aug. 21. All information regarding above contracts is to be obtained from Messrs Preece and Cardew, 8, Queen Anne's-gate, S.W.

RESULTS OF TENDERS.

Blackpool.—The Corporation have accepted the tender of Crompton and Co., Chelmsford, for supply and delivery of carbons.

Hampstead.—The Borough Council have accepted the tender of T. Parker, Limited, of Wolverhampton, for the supply of a dynamo, at £760.

Bath.—The Corporation have accepted the tender of Messrs. Kendall, at £272, for installing the electric light at the new and old Royal Baths.

Grimsby.—The Town Council have accepted the tender of Hewins and Goodhand, at £973. 13s. 8d., for the extension of electricity buildings and plant.

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Eccles.—The Town Council have accepted the tender of the Gilbert Arc Lamp Company, Chingford, Essex, for supply and erection of eight arc lamps, at £112. 16s.

Derby.—The Town Council have accepted the following tenders: Brown's Foundry Company, cast-iron condenser piping, £35; Fuller Wenström Manufacturing Company, motor pump, £53.

Bristol.—The Town Council have accepted the following tenders: British Insulated Wire Company, cable required for extending the power mains, £6,080; Dick, Kerr, and Co., for supply of a dynamo, £840.

Rotherham.—The Town Council have accepted the tenders of W. Thornton and Son, at £3,139, for builders' work in connection with the extensions at the generating station, and of Newton, Chambers, and Co., at £338, for the requisite constructional ironwork.

London, E.—The tender of Peirson and Co., 17 and 18, St. Dunstan's-hill, London, E.C., at £6,775, has been accepted for the supply, delivery, and erection complete of the constructional steelwork for the new generating station, Canning Town, E., comprising roofs, stanchions, girders, coal bunkers, and complete electric coal-handling and transporter plant.

Brighton.—The Corporation have accepted the tenders of the Electrical Power Storage Company, Limited, to supply, deliver, and erect a storage battery, at £3,423. 12s., and to maintain the same for 10 years for the annual sum of £186. 10s.; and that of D. Bruce Peebles and Co. to supply and fix an automatic reversible booster with switchboard, to be used in conjunction with the storage battery, at £975.

BUSINESS NOTES.

TRACTION.

Accident.—A collision occurred on the Glasgow tramways on 4th inst., in which five persons were injured.

Wolverhampton.—The new Hampton-road extension of the electric tramways was opened last Tuesday.

Gloucester.—The Council have obtained the Board of Trade's provisional agreement to the purchase of the tramways.

Colchester.—The Colchester Corporation tramways orders have been prolonged till Aug. 9, 1903, and Aug. 9, 1904, respectively.

Wigan.—Mr. James Slevin, the Corporation tramway traffic manager, has been appointed to the position of electrical engineer.

Shoreham.—The draft agreement between the Council and the electric traction company on the subject of the proposed tramways has been approved by the Urban District Council.

Brighton.—At a recent public meeting a resolution was passed in favour of extension of the tramways to the districts covered by the Preston Park, Montpelier, Regency, and West Wards.

Darlington.—We understand that the provisional order for the construction of the Darlington electric tramways has now been completed, and has received the sanction of the Board of Trade.

Ashton.—At a recent public meeting a deputation was appointed with a view of requesting the Corporation not to run the trams on Sundays, and a similar resolution has been passed by the ruri-decanal meeting.

Tilbury Railway.—We learn that the differences of the Tilbury and Southend Railway with the Great Eastern Railway Company in regard to the widening of the London and Blackwall line has been amicably settled.

Worcester.—The City Council will hold a special meeting this week to pass final details in the scheme for converting the city tramways to electric traction. The work will be undertaken by the British Electric Traction Company.

Smethwick.—An electric generating station is to be constructed at Smethwick, and from there the electrical power required for the trams on the Dudley-road route will be drawn. The cars will be built on the eight-wheel bogie principle.

Wallsend.—The Council have decided, subject to the Tyneside Tramways Company altering certain specified levels, to grant permission to carry passengers by a single line over the present bridge across the Willington Gut for a period of 12 months.

Doncaster.—The fourth section of the Doncaster tramway—that to Hyde Park—was passed by the Board of Trade inspector last week, and immediately opened to the public. There are still two sections to be completed—to Bentley and Wheatley.

North-Eastern Railway.—A Laffan telegram states that the North-Eastern Railway of England will purchase in America all, or almost all, of the equipment for electrifying 37 miles of their system in the neighbourhood of Newcastle-on-Tyne.

Lincoln.—A special meeting of the City Council has been summoned for Sept. 2 for the purpose of giving the Lincoln Tramways Company notice under the Act of 1870 requiring them to sell so much of their undertaking as is within the district of the city.

Engineering Standards Committee.—A special sub-committee has been appointed, under the chairmanship of Mr. Howard-Smith, to deal with the standardisation of sections and specifications for tramway rails and other tramway permanent-way materials.

Musselburgh.—The promoters of the Musselburgh-Portobello electric tramways scheme have asked the Board of Trade for an extension of one year in which to construct the tramway. The consent of the Musselburgh Town Council to this step has been obtained.

Salford.—The agreement of the Council with the Prestwich District Council in regard to tramways has been approved; also a tender for the supply of 1,450 tons of tramrails, at £6. 17s. 6d. a ton, with the requisite quantity of fish and sole plates for the same at £8. 7s. 6d. a ton.

Bradford.—The Tramways and Street Improvement Committee of the Corporation are in favour of proceeding with the Church Bank tramway scheme, but of endeavouring to obtain a larger share of the parish church graveyard than is provided for in the powers now being sought for in Parliament.

Barcelona Tramways Co.—At an extraordinary general meeting of this Company on Wednesday a resolution was passed confirming an agreement, dated July 23, 1902, between the Company and Luis Pujol and Juan Llopart, of Barcelona, whereby an option was given to purchase the Company's undertaking.

Barrow.—An agreement has been signed between the Corporation and the British Electric Traction Company whereby the company undertake to lay down an electric system to the docks, Roose, and Furness Abbey, the Corporation reserving the right of purchase at the end of seven, fourteen, or twenty-one years.

Wrexham.—The Wrexham and District Electric Tramways, Limited, have notified the Council that they are still prepared to enter into an arrangement with the Corporation whereby, under certain conditions, supply would be commenced on Oct. 1 next. The position of the trolley poles is being considered by the Council.

Leeds.—The total receipts from the Leeds tramways on Wednesday—the opening day of the Yorkshire Show—amounted to £881. 10s. 5d. Of this amount £290. 3s. 5d. was taken on the route to Roundhay, where the show is being held. The traffic was not much heavier than usual, as the average daily earnings are about £700.

Halifax.—It has been decided, owing to the abuse of the system by the public, to discontinue the issuing of transfer tickets on the tramways. With regard to the proposed tramway extensions it has been decided that a special meeting of the whole Council be called to consider the question of extending the tramways to Greetland, to Elland, to Hipperholme, and to Brighouse, and also the construction of a lift at Salterhebble.

Revised Fares.—The London United Electric and Piccadilly, City, and North-East London Railways, whose Bills are now before the House of Commons, have altered the scale of fares which passed the House of Lords. Nearly all fares have been increased by 1d., the only reductions being that from Sloane-street to Battersea Park, which is reduced to 1d. from 2d., and the fare from Battersea Park to Clapham Junction is reduced to 1d. from 2d.

Wellingborough.—The Urban Council have signed the agreements with the British Electric Traction Company and with the County Council with respect to the widening of Market-street, Wellingborough, which is to be carried out under the Wellingborough and district tramways scheme. The Urban Council will contribute a sum not exceeding £4,000 towards the cost of carrying out the improvement, and the County Council one-fourth of the amount so paid.

Great Central Railway Co.—At the half-yearly meeting of this company, held at Manchester on Wednesday, Sir Alexander Henderson, who presided, said the directors were not losing sight of the possibility of adapting electric traction to some portions of their system, and they were watching with close attention the progress being made by some companies in this direction, but they had no intention at the present moment to do more than keep a sharp eye upon what was going on around them.

Manchester.—Measurements of the roads between Barton and Davyhulme have been forwarded to the syndicate who propose to construct a system of electrical tramways between Barton Bridge and Glossop—a distance of over 15 miles—and an intimation had also been given that where the roads were not of sufficient width to allow of the necessary space required by the Board of Trade between the footpaths and the tramlines the syndicate would have to purchase the land required at their own cost.

Llanelly.—We understand that at a recent private meeting of the Llanelly Property and Estate Committee a letter from the British Insulated Wire Company was discussed, in which it was stated that the company did not intend to carry out the contract which they had made with the Council. The scheme that the Council arranged with the company provided for electric lighting in portions of the town and a service of electric cars running not only in the town, but to the adjacent villages of Felinfoel, Llwynhendy, and Pwll.

Hammersmith.—The following notice of motion has been referred to committee: "That this Council do favourably consider the proposal of the London County Council to construct a tramway from Hammersmith-broadway to Harlesden, and that the County Council be informed that, subject to the scheme being proceeded with, this Council will be prepared to contribute towards the cost of the street widenings necessitated thereby a sum not exceeding £13,500, and also to widen Brook Green-road on the east side, north of the town hall, at its own cost, estimated at £1,500."

Merthyr.—In the House of Commons on Monday, Mr. D. A. Thomas asked the President of the Board of Trade if, before giving any further extension of time to the Merthyr Electric Tramway Company in which to complete their system between Cefn and Merthyr, he would consult the Councils of the Merthyr Tydfil Urban District and Vaynor and Penderyn rural districts. Mr. Gerald Balfour on Tuesday replied that it was the practice of the Board of Trade to consult the local authorities in these cases, and this would, no doubt, be done before a further extension of time was given to this company.

Exeter.—The Town Council have received from the Electric Traction Committee a report as to the probable cost of installing a system of electric trams on the overhead system along the routes recommended by

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them, the annual cost of working, and the probable revenue to be derived from it. The works are estimated at £74,772. The Council have also decided, subject to the sanction of the Board of Trade, to acquire the existing tramway undertaking. An electrical system of trams will be introduced within the municipal boundaries of the city and the suburbs, and an enabling Bill is to be promoted in the ensuing session.

Newcastle.—The General Purposes Committee have appointed a sub-committee to meet the directors of the Potteries Electric Traction Company with a view to the extension of the tramways through the Higherland to Keele and Madeley, and also as to the alteration of the terminus of the trams from Chesterton. A sub-committee has also been appointed to deal with an application by the traction company for sanction to a double line from where the proposed Stoke line will touch the borough boundary to the centre of the town. Three passengers were hurt on Wednesday owing to a car slipping backwards on a steep gradient and colliding with the car behind.

Bournemouth.—The Corporation are taking their tramway dispute, already referred to at length, to the House of Lords. In the meantime the line was opened on Monday, the 28th ult., the number of passengers carried up to Thursday night totalling 31,327, and the receipts amounting to £255. 12s. The daily receipts, with numbers of passengers carried, for last week up to Wednesday night, were as follows: Monday, passengers carried, 5,332; amount taken, £44. 1s. 5d.; Tuesday, 6,775 and £55. 6s. 6d.; Wednesday, 7,270 and £58. 19s. 10½d. In compliance with a memorial received from burgesses and ratepayers, a public meeting of the burgesses was held at the Grand Theatre, Boscombe, last week. A number of resolutions were passed in support of the action of the Council and against the tramways passing out of their control.

Huddersfield.—In consequence of the recommendations of the jury at the inquest into the Moldgreen tramway accident on June 28, the Tramways Committee have decided to increase the stringency of the regulations in connection with the training of drivers of the electric cars. On Aug. 3 the tram drivers and conductors held a meeting and passed the following resolution: "That in the opinion of the men it would be to the best interests of the Tramway Committee and the Huddersfield public if the mayor and a few selected aldermen and councillors would have a thorough consultation with the inspectors and a few experienced drivers with a view to prevent any more accidents or misunderstandings between the management and the men. The men are as much concerned for the safety of the public as any man in the Town Council."

Hampstead.—At the last meeting of the Borough Council it was resolved to again oppose the application made by the Middlesex County Council under the Light Railways Act, 1896, to construct a tramway commencing at High-road, Kilburn, and proceeding in a south-easterly direction along the Edgware-road and High-road, terminating at a point south of Bridge-street, as the proposal was practically the same which has been successfully opposed by the Council on a previous occasion. The Council also decided not to contribute to the cost of the necessary street widenings in connection with the London County Council's proposed scheme for constructing a tramway from the Marble Arch to Cricklewood. The London County Council have notified the Council of their decision not to proceed further at present with the scheme for the proposed tramway from Edgware-road to Child's Hill.

Light Railways.—The Surrey County Council have decided to oppose the light railway from Ockley to Midhurst.—An enquiry has been held at Bath into the proposed North Somerset light railway. As a consequence, if the promoters wish to construct the railway they will have to obtain an Act of Parliament.—Parliamentary powers have been obtained for the construction of 12 miles of electric tramways along the main roads in the urban districts of Barnes, Wimbledon, Surbiton, Esher and the Dittons, Sutton, and Carshalton, in the Croydon rural district, and in the borough of Kingston, but no lines have yet been laid in the county.—The Barton Parish Council have assented to the proposed light railway between Leighton Buzzard and Hitchin.—Enquiries were held last week into the proposed Gloucestershire light railways, and into the proposal to construct a light railway for the north coast of Cornwall from Padstow to Tregurrian.

Aston.—The Tramways and Electric Light Committee in their last report state that they are of opinion that the overhead trolley system is the most suitable for the tramways in the district when acquired and electrically equipped by the Council, and accordingly recommended that this system be adopted. The agreement for the purchase of the Birmingham and Aston tramways has now been exchanged. Sir Frederick Bramwell has fixed Oct. 16, 17, and 18 next for the hearing of the arbitration. In connection with the application for sanction to the loan of £24,516, part of the tramway works, the following estimate has been prepared: 450 poles, including the necessary bases, finials, brackets, etc., £5,850; 15 miles of trolley wire, £1,360; suspension wire, £220; guard wire, £300; overhead material, insulators, etc., £1,050; section boxes, etc., £440; bonding, etc., £600; safety devices, £500; contingencies, engineering fees, etc., £1,032—total, £11,352.

Private Bills.—In the House of Commons during the last week the Mexborough and Swinton Tramways, the North Staffordshire Tramways, the Great Northern and Strand Railway, and the Birmingham and Midland Tramways and Devonport Corporation (General Powers) Bills were read a third time, as was also, by suspension of Standing Order No. 243, the Great Northern and City Railway Bill. The following Bills were considered and ordered for the third reading: Birmingham and Midland Tramways and Great Northern and City Railway. The consideration of several private Bills, including the Baker-street and Waterloo Railway, the Charing Cross, Euston, and Hampstead Railway, and the North-West London Railway Bills, was postponed to Oct. 16. The Lords' amendments to the Fleetwood Urban District Council Bill and the London United Tramways Bill were agreed to. In the House of Lords the Fleetwood Urban District Council and the London United Tramways Bills were read a third time and passed.

South Africa.—The Durban County Electric Tramway Syndicate, having first secured parliamentary sanction to their scheme for the construction of an electric tramway from the boundary of Durban to the seaside resort of New Brighton, are now actively engaged in arranging preliminaries. It is proposed to make a junction with the Durban borough system on the Umbilo-road. The scheme includes the supply of light and power to private consumers in the districts traversed, and involves considerable orders for the material. The Johannesburg City and Suburban Tramway Company have been officially informed that his Majesty's Government recognises the concession granted by the late Republican Government, but the Transvaal Administration requires them to resume an efficient service at the earliest opportunity, in accordance with the terms of the concession. Recent advices state that the company has since offered to construct and run an electric tramway service, but the offer has been declined. The Town Council has wisely decided to run its own service, and a committee has been nominated to consider the details.—*British South African Export Gazette.*

Glasgow.—A gross surplus of £209,310 is the result of the past year's working of the Corporation tramways, the receipts were £614,413, and the expenditure £405,103. The revenue of the previous year, before the complete installation of electric traction, amounted to £489,469, the balance being £87,629. The last of the horse cars were withdrawn on April 14. There are now 536 electric cars in stock, all of which are new except 69, which are old horse cars electrically equipped. Other 51 cars are in process of conversion, and 42 have been equipped as trailers for salting the track. The remainder will either be sold or broken up. Twenty-four additional electric cars are in course of construction. The number of passengers carried has grown steadily, as the following figures show: 1894-5, 57,104,647; 1901-2, 163,678,190, and the length of rails has increased from 64 miles in 1894-5 to 103½ last year. The financial results of electric traction, as compared with horse traction, have so far been entirely satisfactory. Although the car mileage has been very much increased, the average revenue per mile has been maintained. The extension of the Braehead-street route to Rutherglen Town Hall has been opened.

Liverpool.—The Parks and Gardens Committee have passed a resolution strongly objecting to any proposals to construct tramways through any portion of Sefton Park. It is stated that the proposal of the Tramways Committee to send the general manager, the chairman, deputy chairman, and Councillor Lloyd to the United States and Canada to inspect the various tramway systems there will be strenuously opposed at the next Council meeting. Notices of several amendments have been given. One relates to a proposal to instruct the Tramways Committee that, on the completion of the lines of tramways to Garston already contemplated, the Dingle route should also be extended to Garston. The second amendment is in favour of a new belt route, starting from the present Wavertree terminus to Smithdown-road terminus, thence by the Smithdown-road route to St. James's Church, proceeding to join the Wavertree route *viâ* Great George-street, Berry-street, Lime-street, London-road, and Boundary-place. Another takes exception to the proceedings of the committee with regard to the non-construction of tramway lines between Lodge-lane and Aigburth-road, and it will be moved that the committee take steps to obtain powers to construct the lines.

Blackpool Tramways (South).—The latest outcome of the deadlock between the Blackpool (South) Company, the Electric Tramways Construction and Maintenance Company, and the Blackpool, St. Annes, and Lytham Tramways Company, is a proposal by the debenture trustees that the Construction Company shall hand over to the debenture holders the contracts made for conversion and equipment, but never carried out, together with the profits it would have received, and also practically all its other interest in the Blackpool (South) Company. In return the latter company will control the transformation of the lines and settle with the Blackpool St. Annes Company, the Lawsonian Syndicate assisting in this latter enterprise. The nominees of the Construction Company will retire from the Board of the Blackpool (South) Company. The debenture money would only be applied in meeting the cost of conversion as originally intended, and the holders of the stock are asked to agree to the suspension of the sinking fund pending the completion of the works, and to accept certain deposits and surplus assets in discharge of the obligation of the Construction Company to provide the Blackpool (South) Company with £5,000 working capital.

Ipswich.—Plans for the new power station at Seven-Acre Field have been approved by the Electric Lighting Committee. There will be a large and spacious building of some 50ft. span and 43ft. high up to the wall plate. It will contain two 80-h.p., two 200-h.p., and two 360-h.p. engines, whilst room is left for three more—one of 360 and two of 600—if extension should prove necessary in the future. Between the flue and the chimney shaft are economisers for generating steam from the waste heat, and the shaft itself will be the largest in the town, measuring 177ft. 6in. high, 20ft. 7¾in. outside of brickwork at the bottom, and 12ft. 7in. at the top. Along Portman's-walk there is 252ft. space left for future car-shed extension, and then will come the dust destructor, 120ft. in length. The entrance for the refuse will be in Portman's-walk up an inclined roadway to the tipping shed, where it will eventually go into the destructor to be consumed. Judging from the front elevation plan, the main structure will be plain, but none the less effective, to be built of red brick, relieved with white stone pilasters. Messrs. Kennedy and Jenkin, 12, Victoria-street, London, are the engineers, and Mr. C. Stanley Peach, F.R.I.B.A., 26, Victoria-street, the architect.

Dundee.—The revenue account of the tramways shows that the traffic receipts for the year amounted to £35,408. 0s. 2d., and the other items of income were: advertising, £359. 7s. 6d.; and parcel

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traffic, £106. 13s. 1d.—making a total income of £35,874. 0s. 9d. This sum has been disbursed as follows: working expenses, £23,494. 19s. 8d.; maintenance of lines, £547. 7s. 10d.; interest, £5,076. 7s. 4d.; sinking fund, £3,415; fund for renewal of rails, £300; depreciation on plant, £903. 13s. 3d.; amount paid to the tramway company, £2,100; surplus carried to suspense account, £36. 12s. 8d. The working expenses included, *inter alia*, the following items: salaries and wages, £11,933. 2s. 2d.; electric motive power, £6,029. 1s. 1d.; coal and coke, £844. 8s. 6d.; uniforms, £355. 13s. 2d.; tickets, £143. 1s. 3d.; compensation for injuries, £29; ambulance service, £47. 12s.; sand, £19. 5s. 8d.; salt, £27. 14s. 9d. The total liabilities on capital account amount to £218,819. 18s. 7d. The debt prior to the municipalisation of the system was £46,279. 13s. 9d., and the amount added since then, exclusive of the sinking fund, was £163,390. 6s. 2d. The balance of the total debt is made up by floating liabilities and other items. In the construction of lines there has been expended £117,026. 2s. 5d., car-sheds and workshops cost £12,210. 1s. 3d., cars and equipment £26,213. 1s. 3d, and Acts of Parliament £4,854. 1s. 1d.

Aberdeen.—The Tramways Committee have under consideration the adoption of a universal penny fare on all routes during certain hours of the day—*i.e.*, during the meal hours—and also the adoption of half-penny fares on all routes in the centre of the town. The takings last week on the tramways amounted to £1,113. 5s. 1d. as against £1,081. 18s. 8d. for the corresponding week last year, the increase being £31. 6s. 5d. The annual accounts of the tramways department show a revenue of £37,931, which is an increase of £2,479 as compared with the previous year. The working expenses have been £26,577, or a decrease of £106 as compared with the previous year. The balance of net revenue account is £2,585 more than in the preceeding year. On the other hand, the charges for interest on borrowed money, etc., show an increase of £2,375, leaving a net surplus to be carried to renewal account this year of £1,708, as compared with £1,498 in the previous year. The working expenses per mile for horse traction averaged this year 9·07d. as compared with 8·80d., and for electric traction 8·14d. as compared with 6·03d. last year. Now that the whole system has been electrified, there will be an apparent profit of 7d. for every mile run, and with the increased number of miles the yield will be a free revenue of £26,439, which, after allowing 10 per cent. for capital charges, leaves £2,000 for reserve account. The formation of a line to Ferryhill, which could be laid at £8,000, is advocated, also the utilisation of the tramways for other purposes than carrying passengers—namely, their use for watering and sweeping the streets by means of special vehicles to be constructed for the purpose.

Gravesend.—Electrical energy was for the first time distributed over the tramway system of Gravesend, Northfleet, and Swanscombe last week for testing purposes, and, so far as we can learn, it proved very successful. Among those present were the Mayor (Alderman J. H. Cooper), Alderman E. C. Paine (chairman of the Electrical Committee), Messrs. C. E. Hatten (town clerk), W. H. Trentham (electrical engineer), J. F. Albright (chairman of the Gravesend and Northfleet Tramways Company), F. T. Grant (borough surveyor), F. C. McInnes (resident electrical engineer), A. W. Kipping (manager to the local tramway company), H. J. Holder (who superintended the laying of the mains for the Western Electric Company), E. Wallis (builder), J. Brook (of the firm of Messrs. Brook, Hirst, and Co., Chester, makers of the switchboard, measuring 34ft. long by 7ft. 6in. high), Rogers (of the Alliance Company, Limited), J. Gray (representing Messrs. Alley and Maclellan, of Glasgow, who supplied the engines), F. Black (electrical engineer to the tram company for the overhead wires), and others. The generating station is situated near the canal, close to the gasworks. The buildings, when complete, will include engine, boiler, accumulator, and pumping houses, with storeroom and an office for the resident electrical engineer. There is also to be a refuse destructor, and one or two cottages for the use of workmen. The shaft will be 120ft. high, and the four cells will each consume about 10cwt. of house refuse per hour. The destructor, exclusive of buildings, will cost about £1,500. The total loan amounts to £35,000. There are three Babcock and Wilcox water-tube boilers, one being 400 h.p. and two 320 h.p. each, the larger boiler being so constructed as to work either with the gas from the destructor or from hand stoking. The two smaller boilers are fitted with automatic stokers. Green's patent fuel economiser will be used, and a "Boby" patent detartariser is provided for softening the water before passing into the boilers. The switchboard has been erected by Messrs. Brook, Hirst, and Co., of Chester; and a battery of accumulators will shortly be provided by Messrs. Verity and Co., London. Messrs. Hughes and Stirling, of Liverpool, are the contractors for the destructor. The cables have been laid by the Western Electric Company, under the supervision of Mr. H. J. Holder, A.I.E. The buildings are in the hands of Messrs. Multon and Wallis, with Mr. I. Burrows as their foreman. Mr. E. J. Bennett is acting on behalf of the Corporation in conjunction with Mr. W. H. Trentham, M.I.E.E., who was appointed by the Corporation to devise and carry out the work. The main thoroughfares of the town will be lighted by 27 arc lamps, and other streets by lamps of 50 or 60 c.p., which will be fixed upon the old gas standards. On Wednesday last week Mr. Trotter, Board of Trade inspector, made an official inspection of the overhead wires throughout the entire route. He was accompanied by Mr. F. Black, engineer to the traction company, and the inspection proved satisfactory.

LIGHTING AND GENERAL.

Crook.—Seventeen electric lamps are proposed for Sunniside.

Pacific Cable Bill.—This Bill has been read the second time in the House of Lords.

Barnstaple.—The Town Council are completing a loan of £21,000 for electric lighting.

Colchester.—Sanction has been obtained to a loan of £8,055 for electric light extension.

Redruth.—The principal streets were lit by electric lamps for the first time on Friday last.

Ross.—The Urban District Council propose to erect six electric lamps for street-lighting.

Canterbury.—It is proposed to extend the electric light to the sanatorium at a cost of £1,000.

Bray.—Mr. Wilkins is urging the Urban Council to expedite the installation of the new alternator as much as possible.

Schattner Electricity Meter Co.—The directors recommend a dividend of 6 per cent. for the year ended June 30 last.

Bognor.—The Postmaster-General has under consideration the question of establishing a telephone exchange at Bognor.

Rochdale.—The directors of the Highfield Spinning and Manufacturing Company have decided to light their mill by electricity.

Limerick.—The laying of the cables for the electric lighting works will be commenced immediately under the superintendence of Mr. Enright.

Dover.—The question of the telephones between the fire stations has been referred by the local office of the Telephone Company to London.

Amersham.—The Uxbridge and District Electric Light Company have obtained permission to extend their existing cables to Chalfont St. Giles.

Callender's Cable and Construction Co.—Letters of allotment and regret for the issue of £110,000 4½ per cent. debenture stock have been posted.

Henley.—The United Electric Light and Power Company, London, intend to apply for a provisional order to supply electricity within the Council's area.

Bermondsey.—The Electric Lighting Committee have decided to expend a sum of £4,185 in extending the system of arc lighting in various streets.

Walsall.—The Rural District Council are conferring with the National Telephone Company, who have applied for wayleaves over certain roads in the district.

Grimsby.—The price of electric current to private consumers is to be reduced, from Oct. 1 next, from 5d. to 4½d. per unit for lighting, and from 2½d. to 2¼d. for power.

Carnarvon.—The Electric Lighting Committee reported at the last Town Council meeting that a provisional order had been granted as applied for, and was now in force.

Vickerstown (Walney Island).—The electric supply on the island was commenced on July 31 with 124 consumers. We understand that about 1,000 applications for supply are in hand.

Dorking.—It is proposed to erect a temporary iron chimney at the electricity works on account of the expense. The height will be 70ft., and the permanent chimney will probably be 110ft.

Salford.—At the meeting on Wednesday the report of Judge Parry with reference to the enquiry held by him into the electricity undertaking of the Corporation was received and entered on the minutes.

Durham.—At the last quarterly meeting of the County Council a motion was adopted approving of the appointment of a committee of enquiry as to the practicability of an electric scheme for the county.

Peterborough.—The Council intend to make further application for sanction to borrow £2,000 for the increased cost of the larger generating plant proposed and for the further extension of the station

Hertford.—It has been decided to illuminate the Shire Hall at Hertford by electric light, and after the vacation the Council will probably report satisfactorily in regard to the electric lighting of St. Albans.

United River Plate Telephone Co.—Mr. George Keith (of the Cuba Submarine Telegraph Company and chairman of the Chili Telephone Company) has been elected a director of the United River Plate Telephone Company.

Derby.—Extensions of the mains to Brown's Foundry, Stockbrook-street, and to Mr. Andrews's premises, Forester-street, have been ordered. Mains have been ordered to be laid on the Osmaston-road at a cost of £19. 16s.

Bath.—The Grand-parade will be lighted by means of four electric lamps on ornamental columns at each alternate vase, the annual cost for lighting being £12 per lamp, and £9 for three which are to be extinguished at 11 o'clock.

Awards.—The Glacier Anti-Friction Metal Company, Limited, have been awarded the silver medal for the Glacier anti-friction metal at the Exposition de Lille. We are informed that this was the highest award given for anti-friction metals.

London Electrical Engineer Volunteers.—About 60 of the London Electrical Engineer Volunteers have arrived at Plymouth. On their arrival at Plymouth they marched to Elphinstone Barracks, where they will be quartered for 10 days.

George Heriot's Trust.—Particulars of a three years' course of instruction in mechanical engineering, electrical engineering, and technical chemistry at the Heriot-Watt College, Edinburgh, appear in another column. The session opens Sept. 30, 1902, and closes June 5, 1903.

Manchester.—Dr. Bishop, chairman of the Electricity Committee, in moving the adoption of the committee's annual report on Wednesday, said there had been a steady increase of customers, a very large increase in the output and in new mains, and a pretty large increase in revenue. He was sorry he could not announce any intention as yet to reduce the price of electricity, but that question would engage the committee's attention at the earliest possible opportunity.

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Monk Bretton.—The Council have informed the Postmaster-General, with reference to the proposed telegraph office, that they are willing to give the necessary guarantee.

Guildford.—It has been decided after consultation with Mr. Money-Kent, the engineer of the electricity company, to allow the placing of a number of street boxes for the better supply of current and localisation of faults in various streets.

Londonderry.—The Corporation have received notice from Mr. Vibert Collinson, of 15, Leadenhall-street, London, engineer, of his intention to apply for a provisional order authorising him to supply electricity within the county borough of Londonderry.

Whitby.—The collection of the first complete quarter's charge for the electric light at Whitby has just been made, and general satisfaction has been expressed by the consumers at the amount. The rent charge for the meters, however, gave cause for comment.

Barnsley.—The electricity mains are to be extended at an estimated cost of £120, so that electrical energy may be supplied to the tramcar station and sheds proposed to be erected by the British Electric Traction Company on the road between Barnsley and Worsborough.

Uxbridge.—The Uxbridge and District Electric Supply Company, Limited, have informed the Council of their intention to apply for a provisional order extending their area of supply, to include the parishes of Harefield, Northolt, West Drayton, and Yiewsley.

Amalgamation.—It is reported that Dick, Kerr, and Co., Limited, have taken over the English Electric Manufacturing Company at Preston, which the former practically started through means of an equipment syndicate 2½ years ago. The capital of the new concern is £840,000.

Sandal.—The Provincial Electric Supply and Traction Company intend to apply for a provisional order authorising them to supply electricity for any public or private purposes within the district of the Council. The Council are somewhat inclined to apply themselves for an order.

Heckmondwike.—The District Council have accepted the quotations received for the erection of an ash elevator of Messrs. Bennis and Co., Limited. An enquiry has been held into the application of the Council for sanction to borrow £6,500 for the purpose of electric extensions.

Walton.—The Urban District Council having considered the application of Edmundsons' Electricity Corporation, Limited, for a provisional order and interim leave to lay electric lighting wires, have decided to apply for a provisional order for the supply of electric light in the district.

Morley.—Mr. H. Drewett, borough electrical engineer, in his last report states that the output from the electrical works during the four weeks ending July 12 was 4,031 units, against 2,575 for the same period last year, being an increase of 1,456. The lamps connected to that date was 8,397.

Charing Cross and Strand Electricity Supply Co.—The directors, after providing for debenture and other interest and dividend on preference shares, have declared an interim dividend at the rate of 8 per cent. per annum for the half-year ended June 30, 1902, and carry forward £19,734.

Kingston.—The question of engaging an expert has been postponed until the next Council meeting, the Council having been informed that it is contrary to the by-laws of the Institution of Electrical Engineers for the President to nominate three gentlemen from whom the Council might select one.

Eccles.—The resolution of the Council authorising an application to the Local Government Board for sanction to the borrowing of the sum of £200 for the provision of arc lamps in the borough has been amended by increasing the amount of the proposed loan so as to cover the cost of six additional lamps.

Armstrong-Orling Wireless Telephone Co.—We understand that this Company, which has been formed to purchase the patent rights of the wireless telephone invented by Messrs. Armstrong and Orling, and to sell instruments in this country, will be registered next week with a capital of £175,000. The capital has been obtained privately.

Wood Green.—Having regard to the fact that the District Council's provisional order for the supply of electricity will shortly become law, the Electric Lighting Committee have been empowered to engage an electrical engineer to prepare plans and estimates for laying the mains in the compulsory area, and also in Lordship-lane and Station-road.

Leatherhead.—Messrs. Handcock and Dykes have suggested to the Urban District Council that the reinstatement of the paths should stand over until all the mains in the district were completed. The Council, however, decided that the company be given instructions to lay the main in High-street in the road, and in future to submit plans of what they propose to do.

Chepstow.—A Bill confirming an order granted by the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, to the Chepstow Electric Lighting and Power Company, Limited, in respect of the urban district of Chepstow and part of the rural district of Chepstow has passed the House of Lords Committee, and will be reported in due course for third reading.

Worthing.—The engineer's last report states that 157 applications for current had been received to date, of which 142 had been connected, the equivalent number of 8-c.p. lamps, including public lighting, being 9,415 and 8,260 respectively. The installations connected up to the present are equivalent to 8,410 8-c.p. lamps, or almost the full generating capacity of their existing plant.

Wrexham.—Mr. Sillery in his last report states that 6,960 units had been generated during the month from the destructor boiler. The two Babcock boilers had been overhauled, scaled, cleaned, etc., and were now ready for work. He has obtained authority to procure office furniture at an estimate of £15; also six Nernst lamps and burners for the free library and bookroom, in lieu of the 26 existing lamps.

Bristol.—The Town Council have sanctioned an important extension of the Avonbank electric lighting station, to cost, when equipped, £64,200, and to increase the output by 60,000 lamps. Application is also to be made for sanction to borrow £19,750 for the 365 new arc lamps which the Sanitary Committee have decided to have erected, and £1,500 for transformers, £6,080 for cables, and £840 for a dynamo.

Stock Exchange.—Applications have been made to the committee to allow the following securities to be quoted in the official list: British Insulated Wire Company's further issue of 30,000 ordinary shares of £5 each, fully paid, and 20,000 6 per cent. cumulative preference shares of £5 each, fully paid; and Calcutta Electric Supply Corporation's further issue of 10,000 shares of £5 each, fully paid, Nos. 30,001 to 40,000.

Chesham.—All the clauses of the draft agreement between the Council and the electric lighting company have now been disposed of. It is proposed that the company should set aside ½ per cent. per annum on the capital outlay after the first three years, and should the Council elect to purchase at any period, this reserve money to be in satisfaction of all depreciation; and, in addition, that the company should leave the plant in good working order.

New Steel-Hardening Process.—A Central News Washington telegram states that the U.S.A. War Office announces that the invention of Naval Lieutenant Davis for hardening steel by an electrical process surpasses the results secured by the celebrated Krupp firm, and saves from 20 to 50 per cent. in weight of metal, while offering equivalent resistance. It is claimed that an immense amount of time is saved in manufacture as well as much cost.

Thornaby-on-Tees.—Messrs. Warren, Beattie, and Co. are installing at the works of Messrs. W. Whitwell and Co., Limited, two generating sets of 250 h.p. each for electrical driving. The engines will be of the Belliss quick-revolution type, and they will be coupled direct to Pieper multipolar compound-wound dynamos, working at a pressure of 240 volts. Six cranes will also be converted, and 40 arc and 500 incandescent lamps are to be installed.

Wireless Telegraphy.—On the Cunard mail steamships, which are all fitted with wireless telegraphy, the Marconi Telegraph Company charge a uniform rate of 6d. a word for telegraphing from the ship to a Marconi station or to a passing ship. As an example of the extent to which the system is used by private passengers, it is stated that 2,000 words are sent from a ship in a single passage, while it may be reckoned that nearly an equal number are received.

Glasgow.—The Sub-Committee on Public Lighting have resolved to recommend to the Corporation to have two streets in the city fitted up with the most approved systems of incandescent gas and the Nernst electric incandescent light system respectively. They also advise that the officials of the gas and electricity departments be authorised to visit, if necessary, other towns for the purpose of inspecting and reporting on the lighting of the public streets.

Wallasey.—In consequence of the increasing demand for electrical energy (particularly for traction purposes) in the Wallasey district, the engineer (Mr. W. H. Travers) has suggested to the Gas and Electricity Committee that application be made to the Local Government Board for sanction to borrow the sum of £9,500 for additional works and plant. The committee have instructed the engineer to make a further report as to a larger scheme, to provide for a period of seven years.

Trunk Telephones.—The Post Office authorities are engaged in laying an underground paper cable between Cardiff and Newport on the main road through St. Mellon's. This work was begun last year, and at the present time the workmen are engaged upon the jointing process. The work is under the superintendence of Mr. W. W. Vyle, the superintending engineer of the South Wales district, and under the active supervision of the engineers, Messrs. Robinson and McNicol, of Newport, and Messrs. Price and McMullin, of Cardiff.

Hampstead.—The cost incurred in the boring with a view to obtain an artesian well for the supply of water to the electric lighting station amounts to £975. Tenders had been received at the previous meeting of the Council, and then referred to the committee, for supplying plant and works in connection with the scheme for the arc lighting of the Hampstead side of the High-road, Kilburn, and a portion of Belsize-road. Mains are to be laid for the supply of electric current to private consumers in High-road, Cricklewood, and in Holmdale-road, West Hampstead.

Newark.—A printed form of application for a supply of electric energy within the borough has been sent to residents in the town embodying an agreement with the Derbyshire and Nottinghamshire Electric Power Company, and stating the terms and conditions of supply of electricity within the borough. At the last meeting of the Urban District Council the Mayor said he expected that at the next monthly meeting some gentleman would move that unless the company and the authority had agreed, they must decide at once whether the Corparation put down electrical works or not.

Newcastle.—Notices received from the Potteries Electric Traction Company and from the Provincial Electric Supply and Traction Company of intention to apply for provisional orders for authority to supply electrical energy and electricity respectively have been referred to a sub-committee consisting of the chairman, vice-chairman, and the town clerk, with power to act. Another sub-committee is to consult with the borough surveyor, the gas manager, and the consulting engineer as to preparing plans and specifications and obtaining tenders for the erection of an engine-house and buildings for the Council's scheme for the supply of electricity in the borough.

Blackpool.—At the monthly meeting of the Town Council, it was explained that the electrical engineer had recommended the provision of a tower cooler in connection with a condenser for the electricity

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works, which was to cost £6,000 or £7,000, and stated to be capable of saving £40 a week. Before coming to a decision, the Electricity Committee preferred to see similar works at Bolton and Liverpool. This would cost £3 or £4, but if it were to be the ruling that only the chairman of the committee and the engineer form the deputation, he would not take the responsibility of recommending that cooler for Blackpool. The minutes were eventually passed.

Aberdeen.—At the last meeting of the County and Municipal Buildings Commissioners reports from the Finance Committee and by Mr. F. Kelly, architect, with relative plans, as to the electric lighting of the court house buildings were discussed. The cost of carrying out the work is estimated as follows: probable cost of wiring and fittings for court house, exclusive of the sheriff clerk's department, £220; probable cost of wiring and fittings for sheriff clerk's department, £60—together, £280. The estimate for the county portion of the buildings is £95. The report was approved, and it was agreed to give the committee power to carry out the scheme provided that the sanction of the Government is obtained to pay one-half the cost.

Camberwell.—A conference has been held with the County of London and Brush Provincial Electric Lighting Company with respect to its proposal to sell its undertaking within the Council's area. The sum expended by the company is approximately £158,956. The company have laid about 25 miles of mains in the borough, and if the Council are willing to purchase the undertaking they are now prepared to treat on a basis of many thousands of pounds lower than that provided in the purchase clause under its Act of 1896—namely, the total expenditure chargeable to capital account, plus 33 per cent., together with such a sum as shall make up to 5 per cent. since the date of the order. No action has been taken in the matter by the Council.

London Electrical Contractors' Association.—A general meeting was held on 29th ult. at Anderton's Hotel, Fleet-street, W. R. Woodward, Esq. (president), in the chair. Mr. A. Rashleigh Phipps was elected president for the ensuing year, and Messrs. W. W. Gillard, H. Marryat, and E. T. Tomlinson vice-presidents. Mr. Rawlings was reappointed honorary treasurer, as were also the hon. solicitors, Messrs. Turner and Co., and the hon. auditors, Messrs. Bawden, Smiles, and Co. The honorary secretary was also reappointed. The gentlemen appointed for the ensuing year to act upon the council are: Messrs T. O. Belshaw, E. L. Berry, W. Duncan, H. Foote, F. A. Glover, A. J. Noble, F. Tricket, C. L. Troup, and Harrington Wyman.

Cults.—By way of experiment, a few of the houses in Cults were lit with the electric light last week for the first time since the end of March. The installation, however, is by no means completed, but the work will be gradually overtaken. It will be remembered that in the end of March the liquidator of P. C. Middleton and Co., who owned the installation, decided to discontinue the lighting of the district by electricity. In the interval the electric plant, etc., was acquired from the liquidator of P. C. Middleton and Co. by Messrs. Lowdon Bros. and Co., Dundee, who lost no time in getting the installation into proper order with the view of again putting the electric light at the disposal of the Cults people. New dynamos and extra boiler power have been put in and the mains thoroughly repaired.

Broadstairs and St. Peter's.—At the last meeting of the Urban District Council a letter was read from the Thanet Tramways and Electric Lighting Company expressing regret that there should be any difference between the Council and the Company with regard to the laying of the electric light cables by the footways in various parts of the town. The directors could not admit that their engineer had done anything wrong in placing the cables so near the kerbing as he had; indeed, he could do nothing else. While not prepared to give a written undertaking of the character suggested by the Council, the company were willing to pay, at any time the necessity might arise, a reasonable sum for providing concrete foundation for channelling. The tramway and lighting company have been granted permission to open Harbour-street for the purpose of laying a small cable to Cosy Nook.

Horsham.—A long discussion ensued at the last meeting of the Urban District Council's Electricity Committee upon a statement by Mr. Dewdney that he did not consider it fair to the councillors who were tradesmen that an employé of the Council at the electric lighting station should be allowed to work in his leisure time for private persons and to tender against tradesmen. It was stated that the man was employed for eight hours a day, and that his wages were 35s. per week. It was alleged that he did work at half the cost at which tradesmen in the town could do it. It seemed that the Electric Lighting Committee raised no objection to the man's request to do work when he made it, and this was not brought forward in the committee's report to the Council. It was decided that at the next meeting the committee should reconsider the matter and report to the Council.

Luton.—Messrs. E. Wiseman and Co., Silver-street, propose to hold an exhibition of electric motors driving straw hat and other machinery. Charges for the supply of energy for 12 months from Sept. 30, 1902, have been fixed as follows: light—6d. per unit for the first 70 hours of the maximum demand, after such first 70 hours 3d. per unit, or an uniform rate of 4½d. per unit; power—6d. per unit for the first 70 hours of the maximum demand, after such first 70 hours 1½d. per unit, or an uniform rate of 2d. per unit. The town clerk is to prepare the necessary notice to the consumers, and also the undertakings to be signed by such customers stating how they will take their supply. The Council have decided to purchase 12 Mordey-Fricker meters at £2. 5s. each, and 12 Aron meters at £5. 5s. each. Mr. Frederick John Fleming Dalston has been appointed an assistant at the electricity works.

Earl's Court Exhibition.—At the West London Police Court last week there were summonses against Messrs. Davey, Paxman, and Co., of Colchester, the people responsible for the electric lighting system at Earl's Court Exhibition, for permitting black smoke to issue from their chimney shaft in the grounds. Mr. R. M. H. Humphrey supported the summons for the Fulham Borough Council. Mr. C. E. Jones, who defended, suggested an adjournment for the reason that his clients proposed expending a considerable sum of money in improving the character of the chimney shaft so as to remove the nuisance complained of. As a matter of fact, the work was put in hand the day before, and he maintained that his application was reasonable. After some discussion, the magistrate allowed an adjournment, with power to have the summons reinstated on the list if the Council's advisers thought it prudent and necessary to do so.

Swindon.—The Council have appointed Mr. J. G. Griffin, of Burnley, electrical engineer, the appointment to date from Oct. 6 next. A report on the question of electric wiring, containing the following paragraph, has been referred back to the Lighting and Tramways Committee: "In the opinion of the sub-committee the more satisfactory method seems to be one in which arrangements are made with local firms to wire consumers' premises and supply and erect the fittings—the Corporation paying the contractors in the first instance—and the owners or occupiers entering into an agreement to repay the amount to the Corporation by quarterly, half-yearly, or other instalments spread over a period of from three to five years, with interest at, say, £5 per cent. per annum, and they recommend that arrangements be made on these lines with wiring contractors, and that the Finance Committee be requested to make the necessary financial arrangements to enable this committee to bring the system into operation as early as possible."

Belfast.—The Borough Council have adopted the report of the engineer on the application for additional supplies of current in Alexandra Dock district. In the event of more than 500 h.p. being demanded on Queen's-road mains, the high-tension method of transmission is to be adopted. The statistics as to the electricity rental for the half-year ending June 30 last show that the total units sold amounted to 679,474, against 487,779 for the corresponding period of the previous year, or an increase of 40 per cent., the income for the same periods being £9,239. 3s 2d., against £7,354. 4s. 5d., or an increase of 25 per cent.; the smaller percentage increase in income being accounted for by the reduced price obtained; the average for the last half-year being 3·263d. per unit, against 3·618d. per unit for the corresponding period of the previous year, and the increased proportion of motor units. The increase in units sold for lighting was 22 per cent., while the increase in units sold for power was 103 per cent. The units sold for power purposes formed 30 per cent. of the total units sold.

German Telephones.—According to a statement issued by the German Imperial Post Office, the Berlin telephone network constitutes the largest in the world at the present time, the number of subscribers or connections, including main and branch lines, amounting to 60,683. There has been a rapid development of branch lines as a result of the new law relating to the tariff, there now being 15,000 connections of this kind. The principal exchange has 10,482 subscribers and the smallest has 4,622 connections, and excluding Bavaria and Wurtemberg, the number of exchanges throughout the empire totals 3,303. The longest line, over which an average of 30 conversations takes place daily, is between Berlin and Paris, a distance af 1,186 km. The second position is occupied by the line connecting the German capital with Budapest, which is 980 km., and is used about 26 times daily; the third is from Berlin to Memel, which is 948 km. in length, and serves on an average for 79 conversations per day; and the fourth line forms a connection with Basle, of a length of 923 km., and is used 17 times daily. Among other long-distance connections may be mentioned those between Berlin on the one hand and Vienna, Prague, Munich, Hanover, Cologne, and Frankfort-on-Maine on the other.—*Financial Times.*

Newport (Mon.) Electricity Works.—We have received from Mr. C. W. Copland, the borough electrical engineer of Newport, the financial statement and analysis of accounts for year ended March 31, 1902—the seventh year of working. The capital expenditure to date amounts to £102,882 (last year £97,499); revenue from electricity supply, £10,441 (£8,545); revenue from meter rents and other sources, £616 (£323); total revenue, £11,057 (£8,868); total costs, £4,626 (£6,306); gross profit before setting aside instalments for interest and sinking fund, £6,431 (£2,562); percentage of costs to revenue, 42 per cent. (71 per cent.); percentage of gross profit to capital (outlay during year being averaged), 6·41 per cent. (2·68 per cent.); interest on loans, less credits, £3,181 (£2,946); amount set aside for sinking fund, £2,391 (£2,376); percentage of ditto to capital (outlay during year being averaged), 2·38 per cent. (2·49 per cent.); financial result, after covering all charges, and providing for interest and sinking fund, profit, £859 (deficit, £2,760); capacity of dynamos, March 31, 1,050 kw. (1,050 kw.); maximum load reached 648 kw. (582 kw.); load factor, 10·18 per cent. (9·43 per cent.); number of 8-c.p. lamps connected to March 31 (arcs, incandescents, and motors, equivalent in 8 c.p.), 45,817 (36,451); number of units sold, 578,275 (480,645); price charged, private lighting 6d. to 4d. (6d. to 4d.), power and heat 2d. to 1½d. (2d. to 1½d.); average price obtained, private supply 5·01d. (5·07d.), public lighting 1·76d. (2·03d.); number of customers, 579 (458). The works costs amounted to £3,546, or 1·47d. per unit, as compared with £5,225, or 2·61d. per unit, showing a decrease of 1·14d. per unit. The financial result for the year 1902, therefore, is: gross profits, £6,431; less interest on loan capital, deducting credits, £3,181, and amount transferred to sinking fund, £2,391; leaving a net profit for the year of £859.

Birkdale.—The new generating station which has been erected off Liverpool-road, Birkdale, was opened last Friday, and an extended service of electric lighting inaugurated. The station will also supply the power for an extension of the tramway service when the latter is completed. The station comprises a boiler-house, engine-room, condenser-room, battery-room, cooling tower, store, workshop, and offices, and the cost is estimated at about £30,000. The dimensions are:

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boiler-house, 42ft. by 39ft.; engine-room, 26ft. by 42ft.; battery-room, 22ft. by 50ft. The chimney shaft will be 52ft. high, and the cooling tower 65ft. high. The boilers, of which there are three, are superheaters of the Babcock water-tube type, each capable of evaporating 40,000lb. of water per hour, at a pressure of 160lb. per square inch. Over the boiler-house is a storage tank, which acts as a roof as well. The engines are of the enclosed type, with forced lubrication, being built by Messrs. Browett, Lindley, and Co., Manchester. There are three dynamos directly coupled. They are capable of giving an output of 220 amperes at 500 volts, and they will develop a maximum of 110 kw. each. They can be worked in shunt or compound for either lighting or tramway purposes. The builders are Messrs. Bruce Peebles and Co., Edinburgh. The condenser, which is by Messrs. W. H. Allen and Co., Bedford, is capable of condensing 10,000lb. of steam per hour. The tower, used for the purpose of cooling the circulating water for the condenser, is capable of cooling 48,000 gallons per hour from 120deg. F. to 75deg. or 80deg. The balancers, which are used for balancing the three-wire system, and the two boosters, for the purpose of boosting up the voltage for battery charging, are connected up in one line, the builders being Messrs. Bruce Peebles and Co. The switchboard is 32ft. long by 8ft. high. It has been manufactured by a German firm. The battery consists of 270 cells, giving an output of 480 ampere-hours, the maximum rate of discharge being 162 amperes. The cables, now being laid, are by Messrs. Callender and Co., of Erith. The system will be fed at three points—viz., at the junction of York-road and Aughton-road, junction of Weld-road and Lulworth-road, and the junction of Trafalgar-road and Grosvenor-road. The distributors are three-core—·07 by ·04 by ·075 cables. Fireproof doors have been fitted up between the offices and the engine-room and boiler-house, and a 10-ton travelling crane by Messrs. Morris and Bastert, of Loughborough, has been fixed in the engine-room. The contractors for the steelwork was Messrs. J. Abbott and Co., Gateshead-on-Tyne; for the brickwork, Messrs. Duxfield, Southport; and for the boilers and piping, Messrs. Babcock and Wilcox.

South Africa.—The current issue of the *British and South African Export Gazette* contains a note on special patterns of transformers wanted in that country, as owing to the extraordinary climatic conditions which prevail in the Transvaal in the summer months all the various types of transformers for overhead high-tension mains offered in recent tenders failed under the tests, save those manufactured in Switzerland and Berlin, and it is pointed out that transformers of English pattern are designed entirely for running on underground mains, and for working in a climate where severe lightning is unknown. British manufacturers can inspect the report of the Works Committee of the Johannesburg Town Council which bears upon the subject at the London Chamber of Commerce. We are indebted to the same source for the following items: The directors of Rezende, Limited, contemplate the acquisition of a 10-h.p. motor for erection in their cyanide house in substitution of the existing oil-engine. A 40-h.p. low-tension motor is also to be acquired to replace the existing steam winding engine. The extensive electrical equipment of the Ayrshire Gold Mine and Lomagundi Railway Company includes two enclosed dynamos, two generators for the battery-house, two 350 and 600 volt generators for the three-phase electric light installation, a three-phase motor for the workshops, two motors for the river pumping plant, incandescent and arc lamps, conductors, etc., the total expenditure on power and light plant being set at £14,700. Delivery has recently been made to the North Bonsor Gold Mining Company of a 110-volt electric lighting and power plant, including two 65-kw. generators. A 2-h.p. alternating-current motor, built by Mr. C. Langdon-Davies, London, S.W., has lately been imported by Messrs. Wilson and Platt, Durban. In addition to the three generating machines, each of a capacity of 10,000 8-c.p. lamps, erected at the Durban electric lighting works, it is proposed to acquire another of 16,000 8-c.p. lamps, also two 500-kw. generators; the whole, with accessory plant, to cost £23,000. The general movement observable in industrial circles in South Africa to replace other motive power by that of electricity, is seen at the Indwe Company's collieries, Indwe, Cape Colony. The system adopted is the continuous current, and the material ordered consists of a 400-h.p. plant, including dynamos, engines, coal-cutters, a workshop motor, and hauling machinery. A portion of the current generated is to be allocated to the town water supply and lighting services. On the Rand, where seven or eight years ago none of the mines were able to provide themselves, except at prohibitive cost, with their own power, and were consequently compelled to be tributary to an outside institution like that of the Rand Central Electric Works at Brakpan, large numbers of them now are not only able and do supply themselves, but upon much more economical and favourable terms than from an outside source. The consequence of this is a large increase in the demand for electrical material of all kinds, which is constantly being added to as each mine makes a further extension of its establishment, or a revision of its plant. This transformation of old plants was especially active during the enforced period of idleness after the annexation; some mines, like the May Consolidated, merely limiting their reconstruction works to displacing the numerous small steam-engines used to drive separate items of their plant by electric motors, still drawing their supply of current from the Brakpan Works, while others set up complete generating plants outright. According to latest reports, 10 mines are still tributary for current to the Rand Central Works, which also supplies a number of chemical and industrial establishments and a part of the demands of Johannesburg and the railway, its aggregate contracts totalling 2,400 h.p. With the new mines coming into working, or opening up, and with the prospective municipal tramway and lighting scheme, very large calls for electrical material will be made, and home firms are advised to bestir themselves accordingly. It is asserted that English machinery is built on too heavy a plan, involving increased cost of freights, and enhancing unduly the ultimate price, for which reason reduction in both weight and price are points insisted on. Our manufacturers who are interested would do well to note these facts, especially as the freight item on goods delivered in Johannesburg on the most moderate scale often exceeds the prime cost of goods in the home country.

PROVISIONAL PATENTS, 1902.

JULY 28.

16664. Improvements in or relating to trolley heads or collectors for electrically-propelled vehicles. Maunsell Mercier, 57, Barton-arcade, Manchester.

16680. Improvements in and connected with electric adapters. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.)

16706. Improvements in galvanic cells. William Striekland, 70, Chancery-lane, London.

16711. An improvement in electrical conductors. Siemens Bros. and Co., Limited, and Wilhelm Dieselhorst, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

16727. Improvements in portable or table telephone instruments. Lars Magnus Ericsson, 4, South-street, Finsbury, London. (Complete specification.)

16740. Improvements in electromagnetic motors and generators. Arthur Zehden, 46, Lincoln's-inn-fields, London. (Complete specification.)

16750. Improvements in the ventilation of enclosed electric motors and dynamo-electric machines. Justus Eek, 5, Priory-road, Chiswick, London.

JULY 29.

16755. Lifeguard for electric or motor trams. William Garner and Alfred Roberts, 12, Athol-street, Winton, near Manchester.

16764. Improvements in electric time switches for cutting in or out of circuit at any desired time. Horace L. P. Boot, 12, Limehill-road, Tunbridge Wells.

16776. An electrically-operated safety clutch for hoists. Ughtred Horsfall and Joseph Crowther, 22, Thomson-street, North Stockport-road, Manchester.

16808. Improvements in adjustable pendant fittings for electric lamps. Horace McGowan, 33, Cannon-street, London.

16817. A new or improved electric facia sign. Abraham Goldsmith and William John Boughton, 237, Whitechapel-road, London.

16837. Improvements in the framing of dynamo-electric machines and electromotors. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

16839. Improvements in polyphase induction motors. Siemens Bros. and Co., Limited, and Francis Lydall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16843. Improvements in and relating to clocks and particularly to electric clocks. Joseph Butcher, 6, Lord-street, Liverpool. (Complete specification.)

16850. Improvements in electric igniters for gas-burners Hugo Bergner, 18, Buckingham-street, Strand, London.

16852. Improvements in perforators, more particularly for use with automatic telegraph transmitters. John Gell, 21, Finsbury-pavement, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 21.

1901.

15069. Lead fuse for electrical plant. Krebs.

15467. Wireless telegraphy and other signalling. Bose and Bull.

15579. Electrolytic apparatus. Boult. (American Alkali Company.)

15882. Electric brakes. British Thomsen-Houston Company, Limited. (Case.)

16123. Terminal couplings for electric conductors. Jacob.

16319. Electric rotary speed indicator. Scialpi.

17045. Driving gear for dynamos. Böhm.

17139. Safety lifeguards for electric trams or other motor-driven vehicles. Dean and Instone.

17621. Apparatus for hauling electric cables. Grinnell and Goepel.

19514. Electromagnetic apparatus giving vibratory or oscillating motion. Thompson.

20423. Electrical transformers and the like. Burnand.

23446. Automatic electric circuit breakers. Haddan. (General Incandescent Arc Light Company.)

1902.

5043. Trolley frame or bracket and head combined for use in electric overhead tramcars and the like. Hunt.

11487. Electric cables. Harrison. (Kabelfabrik Actiengesellschaft.)

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12554. **Means and apparatus for telephonic communication.** Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

12706. **Wireless telegraph systems.** Ehret.

12956. **Transmitting apparatus for electric telegraphs.** Justice. (Rowland Telegraphic Company.)

14573. **Switches for electrical glow lamps.** Edison and Swan United Electric Light Company, Limited, Shepherd, and Gover.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	Aug. 2	4,880	4,913	- 33	148,837	137,077
Blackburn Corporation	,, 1	843	637	+ 206	15,528	12,576
Blackpool Corporation	July 24	1,585	1,467	+ 118	14,177	15,017
Blackpool-Fleetwood Tramways	Aug. 2	1,183	1,310	- 127	4,742	5,541
Bolton Corporation	,, 3	1,609	1,585	+ 24	48,551	44,292
Bradford Corporation	,, 3	3,390	1,193	+ 2,197	83,349	27,342
Bristol Tramways Company	,, 1	4,847	3,799	+ 1,048	—	—
Carlisle Tramways Company	,, 2	209	215	- 6	5,274	4,915
Central London Railway	,, 2	5,981	5,679	+ 302	32,572	30,077
City and South London Railway	,, 3	2,697	1,718	+ 979	13,588	9,268
Cork E. T. and L. Company	July 31	788	585	+ 203	15,570	13,965
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	Aug. 2	276	300	- 24	6,383	6,232
Dublin & Lucan Electric Railway	,, 3	128	143	- 15	623	721
Dublin U. T., electric cars	,, 1	4,011	4,117	- 106	—	—
Dublin S. District, Electric	,, 1	1,063	1,246	- 183	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 2	11,167	12,344	- 1,177	—	—
Halifax Corporation	July 16	2,715	2,844	- 129	18,943	—
Huddersfield Corporation	,, 26	1,058	1,013	+ 45	—	—
Hull Corporation, E. S.	Aug. 2	1,681	1,855	- 174	31,118	30,331
Liverpool Corporation	July 26	10,243	9,622	+ 621	285,484	261,697
Liverpool Overhead Railway	Aug. 3	1,694	1,749	- 55	8,067	8,655
Newcastle-on-Tyne Corporation	July 12	2,688	—	—	—	—
Portsmouth Corporation	,, 26	1,796	875	+ 921	—	—
Sheffield Corporation	,, 3	4,180	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Sunderland Corporation	,, 20	1,356	1,351	+ 5	18,756	17,043

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £74 decrease.
Barcelona Ensanche y Gracia, £88 decrease. Barcelona £498 increase.
Brisbane, £437 increase (month of June, £10,187; increase, £1,813).
Buenos Ayres and Belgrano Electric (month of June, receipts £12,229; increase £478), £64 increase.
Calcutta, £246 increase.
Cape Town (month of June), receipts, £14,148; expenditure, £6,689.
Isle of Thanet Electric, £26 decrease
Mexico Electric (month of June), receipts, £20,285; expenditure, £12,275.
Perth Electric, £79 increase.
Port Elizabeth (month of June), receipts, £3,849; expenditure, £1,891.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¼-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-½
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Insulated Wire, Ord., 1-70,000	5 ..	7¼-7⅜
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5⅜
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5⅛-6⅛
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2 ..	1½-2
—— 4½ per cent. 1st Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15½-16½
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	2⅞-3¼
—— 5 per cent. Debentures	100 ..	101-106 p.c.
Edison and Swan United, "A" Shares, 1-98,261	3 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	78-83
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-100
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅞-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20½-21½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15½
Telegraph Construction and Maintenance	12 ..	36-39
—— 5 per cent. Bonds	100 ..	102-105
Electric Railways.—		
Central London, Ordinary	100 ..	105-108
—— 4 per cent. Pref.	100 ..	106-109
—— ,, ,, deferred	100 ..	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	71-73 xd
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '81	100 ..	128-133 xd
—— ,, ,, ,, '96	100 ..	127-130 xd
—— ,, ,, ,, '01	100 ..	121-125 xd
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 —	92-95

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 —	¼-⅜
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 —	103-106
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref.	10 ..	9¾-10¼
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	9¼-9⅜
—— 7 per cent. Preference	5 ..	9¼-9⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9
—— Nos. 20,001-30,000	5 ..	8¼-9¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, £10 Ord.	6 ..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-107
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6½-6⅝
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5½
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11 xd
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104 xd
Kensington and Knightsbridge and Notting Hill	100 ..	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4¼-4⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	94-99
Metropolitan, Ordinary	10 ..	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	13¼-14¼
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7-7¼
—— £4½ Shares, New	4½ ..	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	97-100
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2⅛
—— 4 per cent. Debenture Stock	100 ..	80-90 xd
South London, Ordinary	5 ..	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15¼ xd
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	10¼-11¼ xd
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	5¼-6¼
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13¼-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3⅞-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	102-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	12¼-12½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅛-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅝-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	95-98
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½ xd
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½ xd
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4½-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	Within 10 ..	10⅞-11¼
—— ,, ,, ,, ,,	1-82,500 5 ..	8-8½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	107-109
—— ,, ,, Prov. Crts.	50 ..	81-83
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	14s. ..	¾
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	70 p.c. ..	70 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Preferred, 590,001-790,000	3½ ..	4⅜-4⅝
—— Deferred Stock	100 ..	56-60
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100 —	96-98
—— 4 per cent. Deb. Stock, Red.	100 —	102-106
Oriental Telephone and Electric Company	1 —	15/16-1 1/16

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NOTES.

Indian Cordite Factory.—The Government is now equipping a large cordite factory in India for the manufacture of ammunition in that country. We understand that the whole of the electrical work required in the factory, both for lighting and power purposes, is to be supplied under contract by the General Electric Company, of London. It is not likely that the factory will be in working order before the end of next year, as a vast amount of detail work in connection with the nitric and sulphuric acid plant will have to be perfected before a full working trial can take place.

Armour Technical Institute.—This institute of technology, founded by Philip D. Armour, of Chicago, has just forwarded to us its year-book for 1902-1903. This institute, which started with four year courses in mechanical and electrical engineering, has since added to its curriculum similar courses in civil engineering, while last year a course in chemical engineering was also organised. Architecture is again a new departure, the Chicago School of Architecture being part of the institute. From the names which appear of the professorial list and the yearly programmes for each of the courses, we gather that most thorough instruction is given.

The Chemical Society of South Africa.—We gather from the *Journal* of the Chemical and Metallurgical Society of South Africa that the following officers have been elected for the year ending June, 1903: president—Mr. J. R. Williams; vice-president—Mr. E. H. Johnson; hon. treasurer—Mr. J. Littlejohn. The following members were elected to the council: Messrs. R. G. Bevington, W. A. Caldecott, T. L. Carter, G. A. Darling, R. E. Hall, S. H Pearce, A Whitby, and J. Yates. This society, which has done a vast amount of valuable work in connection with the gold-mining industry of South Africa, is now able to resume its meetings and the regular publication of its *Proceedings*.

"The Electrician's Friend."—We have received from Tokyo No. 132 of vol. xii. of the above publication, which is published at No. 6, Minami Kinroku-cho, Kiobashi-ku, Tokyo, Japan, under the presidency and editorship of Mr. S. N. Katogi. We can read as much as this on the title page. We can also understand a good number of the illustrations and a few of the advertisements, but the rest of the journal is in Japanese, and we are surprised to see illustrations of dry batteries on the ebonised case of which only Japanese characters occur. We presume, therefore, that they are made in Japan. Unfortunately, our want of knowledge of that language as written or spoken renders the information in the editorial articles unavailable.

Flywheel Accidents.—We get it from the interested evidence of an insurance company's engineer of a New York company that during the past year the percentage of engine pulleys and flywheels that exploded exceeded the percentage number of boiler explosions. He adds that sound wheels operating at slow speeds and apparently safe are continually going to pieces, entailing frightful loss of life and property. Our authority's cure for the evil is to insure with his company against the loss due to flywheel accidents. Our idea is that in the States they work their flywheels with insufficient margins of safety, and that, while the insurance is not to be despised, it would be well to avoid the accidents by working the flywheels at slower peripheral speeds.

Street Railway Investments.—In the United States, where the tramways are rightly called street railways, and are really worked as railways, the capital involved is enormous. Mr. Alton D. Adams, in the July issue of the *Street Railway Review*, gives some interesting statistics for the street railways of Massachusetts from the year 1888, when the majority of them were worked by horses, up to last year. The main point, however, of the article which will interest our readers is that while the net income has increased 4·3 times in that period, the total capital stock has increased by five times, so that the percentage of net income to capital stock has fallen from 7·2 to 6·2 per cent. The net income for 1901 was about £680,000, which is a wonderful figure for a single State.

The London Day Training College.—The new day training college established by the London County Council in connection with the University of London is to be opened early in October. The temporary accommodation for the college will at first be provided in the new building of the London School of Economics and Political Science in Claremont-street, near the Strand. The principal appointed by the London County Council to take charge of this college is Prof. John Adams, M.A., B.Sc., who has had most valuable experience both at home and abroad in teaching. Other appointments have also been made, and 45 London County Council teachers' training scholarships have been awarded. We gather that these scholars, with others to be appointed before October, will provide 100 students for the teaching staff the first year.

Trades Unionism.—A rather good, or bad, story has recently been told by *Cassier's Magazine* illustrating the arrogance, ignorance, or whatever it may be called, of the executives of some of the trades unions in dealing with their members. It appears that while a workman was engaged in guiding a cable into a conduit in a building that was being wired, his fingers were caught between the cable and the walls of the conduit. The men at the far end of the conduit, unaware of their comrade's plight, continued to pull upon the cable, seeing which an apprentice lad ran to his assistance and pulled back on the cable. A delegate of the union who had witnessed the affair, and had expressed sympathy for the sufferer, reported him for violation of the rules of the order, and the latter was called to executive headquarters to explain his conduct. Notwithstanding that his fingers bore evidence to the extent of the accident he had undergone, he was fined "for allowing an apprentice to do helper's work, to wit, assisting a journeyman drawing wire into conduits."

The British Association.—The local arrangements for the annual meeting of the British Association in Belfast are now practically completed, and everything points to there being a most successful meeting in that town. The bulk of the sectional meetings will be held in the various rooms of the Queen's College in University-road, but three other educational establishments in the near neighbourhood of Queen's College are to be used for Sections C, E, and L. The presidential address on Wednesday, Sept. 10, will be delivered by Prof. James Dewar, M.A., F.R.S., in the Grosvenor Hall, which is in Grosvenor-street, as will also the Friday evening lecture on Sept. 12, on "Becquerel Rays and Radio Activity." This lecture is in the able hands of Prof. J. J. Thomson, D.Sc., F.R.S. On Monday evening, Sept 15, W. F. R. Weldon, M.A., F.R.S., will lecture on "Inheritance." There will be soirées on Thursday, Sept. 11, and Tuesday, Sept. 16. We shall give full particulars of papers to be read in the various sections in early issues.

Railway Electrification.—It is a sign of the times that no meeting of a railway company nowadays is com-

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plete unless the chairman makes some remark in his speech as to the electrification of the system. Up to the present, in a good number of cases the chairman takes the line that the Board is investigating the subject and is collecting all information as to what can be done, or has been done, by other companies in electric traction. Without a doubt caution is required, but there are lines which, if they wait until they can be guided by the experience gained by others, will find that the experience comes too late to save their traffic We notice that the Liverpool Overhead Railway, which has played a most successful pioneer part in the development of electric traction on heavy lines, is still thinking of extension, and the chairman at the meeting this week alluded to these extensions as being bound to come. He added that he was now certain that all the great suburban lines, such as the Liverpool and Southport and the Garston lines, would have to be worked by electricity.

Colour Photography.—The current number of the *Photogram* contains, besides the usual number of excellently illustrated articles on various phases of photography, a note by Dr. Adolph Miethe, professor of photo-chemistry at the technical college, Charlottenburg, on practical colour photography, the perusal of which will be of considerable help to workers in this direction. An important recommendation is contained in the paragraph referring to the illumination of the dark room, which requires special care, as the perchromo plate is extremely sensitive to red light. Prof. Miethe says that the dark room should be kept as dim as possible during the first development, and advises that a filter be used consisting of two gelatine plates, which should be fixed, washed, and immersed, one in a solution of 10 grm. of brilliant yellows in 300 cubic centimetres and the other in 2 grm. of violet methyl in 200 cubic centimetres of water. After a slight rinsing the two plates are dried and bound film to film together. This filter excludes all injurious light, and after the first minute the plates can be handled freely without any fear of fog.

The Shaw Prize.—The conditions under which this prize is to be awarded were laid down by Mr. Benjamin Shaw as follows: The prize is to be offered "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." We gather from the *Journal* of the Society of Arts that the council have awarded a gold medal, or a prize of £20, to James Tonge, jun., 149, Church-street, Westhoughton, Lancashire, for his hydraulic mining cartridge—an appliance for breaking down coal in mines without the use of explosives. The committee making the award are aware that it has been frequently proposed to use some kind of hydraulic apparatus for this purpose, and they have had brought to their notice instances in which such apparatus has been successfully tried. They are not, however, aware of any hydraulic device similar to that of Mr. Tonge, nor that any hydraulic device has been brought into permanent or regular use for the purpose of coalmining, whereas they have had evidence that Mr. Tonge's hydraulic cartridge has been used with success in several mines where it has been superseded the use of explosives. They have, therefore, awarded the prize to this invention. Forty-three applications for this prize were received.

The Colonial Conference.—The various resolutions which have been passed by the conference of the Colonial Premiers are not to be made public until Parliament meets for its autumn session. The keenness, however, of the daily Press has led to the publication of what is claimed to be the gist of these resolutions. Assuming that the knowledge on which these reports are founded is correct, the results of the conference will please manufacturers in this country, as they are said to be in favour of preferential tariffs between the Colonies and the Mother Country. How far this can be realised in practice in the near future is a question which must be left in the able hands of the Colonial Secretary, as England cannot well give a preferential tariff on articles which are admitted into this country free of duty. The reverse, however, is not the case, and a preferential tariff such as Canada has established will be of great service to the electrical manufacturers of this country. The competition for the supply of electrical goods in Australasia is exceedingly keen, and up to the present has ended rather in favour of the Americans. There are numerous signs, however, that this state of affairs will not continue, even without the preferential tariff, as our English electrical manufacturers are getting a much larger proportion of orders than heretofore. The other resolutions in favour of Imperial defence, etc., will be heartily welcomed by all Imperialists.

Insulators for High-Voltage Lines.—The success or non-success of any system of insulation for overhead wires carrying high-voltage current depends on the climatic conditions, and it will frequently be found that insulators which are quite successful in a certain district are quite unsuitable in others. As an instance of this we might mention the oil insulators for telegraph lines, which have done exceedingly good work in some of our Colonies, and have not proved successful in others. The experience gained on the large power transmission lines on the Pacific coast of the United States will be found of great value to electrical engineers all over the world. We recently have heard of insulation faults on the system of the United Electric, Gas, and Power Company, which has its works at Santa Monica. In this case the trouble was caused by a combination of dust and fog. The insulators stood well in rain, but the sea fog moistened the collection of dust under the petticoats of the glass insulators and caused burn-outs. Curiously enough, the addition of a block of wood with a circular hole in it placed round the base of the base of the insulator, has prevented the burn-outs We presume that the small space between the insulator and edge of the wood surrounding it is sufficient to prevent a great quantity of dust collecting. Also it would seem that the fog is kept out to a certain extent, and hence any dust which does collect does not get moistened. For the same cause—*i.e*, collection of dust, which when moistened produces a conducting path to earth—iron pins for insulators have been almost entirely abandoned in favour of wooden pins for this class of work.

The Iron and Steel Institute.—This institution holds its annual meeting this year at Düsseldorf, commencing on Tuesday, Sept 2. The first meeting of the members, however, takes place the next day. The following is a complete list of the papers which are to be read and discussed at this important meeting: "On Iron and Steel at the Düsseldorf Exhibition," by Prof. H. Wedding, honorary member of the Iron and Steel Institute; "On the Progress in the Manufacture of Pig Iron in Germany since 1880," by W. Brügmann, of Dortmund; "On the Progress in the Manufacture of Steel in Germany since 1880," by R. M. Daelen, of Düsseldorf; "On the Applications of Electricity in the Manufacture of Iron," by D. Selby-Bigge, of Newcastle-on-Tyne; "On the Probable Existence of a New Carbide of Iron," by E. D. Campbell and M. B. Kennedy, of the University of Michigan; "On Results obtained in the Equalisation of the Varying

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Temperatures of Hot Blast," by L. F. Gjers and J. H. Harrison, of Middlesbrough; "On the Compression of Steel in Ingot Moulds," by M Harmet, of St Etienne; "On the Overheating of Mild Steel," by Prof. E. Heyn, of Berlin; "On Electrical Plant in Steelworks," by F. Kylberg, of Benrath, near Düsseldorf. The secretary's office will be in the municipal concert hall at the Tonhalle, which is best approached from Schadow-street entrance Friday, Sept 5, and Saturday, Sept 6, are to be devoted to visits to the works and excursions. Besides these, a special programme of ladies' excursions have been arranged for other days. The usual conversazione will be held on the Wednesday. The attractions of the Düsselford Exhibition should induce a large gathering of members.

Electrical Legislation.—It is a curious thing that while this year the Institution of Electrical Engineers in this country have been looking into the effects of electrical legislation, the Canadian Electrical Association should be doing the same. In presenting the report of the committee of the Canadian Association on this question at the annual meeting, Mr. John Yule, the chairman, commented on the fact that some of the electrical companies who had benefited most by the work of the committee had contributed not a cent to the cause. After referring to the failure of the Toronto City Council to break through the Conmee Act, Mr. Yule says: "The socialistic candidates in the election campaign last month all advocated the policy of the Provincial Government generating electricity at the Falls, transmitting and selling at cost to the different municipalities. Whether this movement will grow or not the future will determine. We point this out for the purpose of showing the different lines of attack made upon our interests and the necessity for continued wakefulness on the part of the companies. In the case of Rat Portage a compromise was arranged that was satisfactory to the company and Council. The question of assessment on the properties of the companies was also before the Municipal Committee, and an amendment passed to assess on their value as going concerns, or on the price at which the properties could be sold to others who would continue the business. The different interests were represented by able counsel, but the strong agitation throughout the province in support of a more oppressive system of taxation than is adopted to other manufacturing concerns appeared to influence the committee in coming to this decision. The whole question of rearrangement of assessment has yet to be dealt with and a modification of assessment on electric companies may be obtained, but the outlook in this direction is not encouraging."

Parliamentary Procedure.—The Select Committee of the House of Commons which has been enquiring into the question as to whether the Standing Orders of the House for the conduct of private business require alteration had another meeting last week, with Mr. A. F. Jeffreys presiding. Sir R. Littler, K.C., thought that business would be expedited if all petitions opposing the more important Bills had to be deposited before a certain date, so that there could be an adequate supply of work earlier in the session. In this way, by commencing the more important Bills before Easter, the work would be more evenly distributed over the session. He deprecated the second reading of Bills in the House of Commons when the details of the same had not been considered, as this contributed to the wasting of time in debates which took place on insufficient information. He thought that the fees should be in some way proportionate to the expense involved in the proposed works, and that a uniform system for both Houses of Parliament should be adopted. He did not believe in the present system of dealing with questions of *locus standi*, and held that a technical point should not decide whether or not a man should be heard before a committee. He was not in favour of joint committees of both Houses, as only a few Bills were opposed before committees of both Houses, and the second hearing, when this was the case, was sometimes valuable. Mr. E. H. Pember, K.C., upheld the Court of Referees for dealing with Standing Orders. He thought that the fees were higher than they should be. If opposition to a Bill was withdrawn at the last moment, he thought that a committee should be able to charge the party so withdrawing with the expenses of meeting their opposition. He also advocated that the report of the inspector of the Local Government Board sent down to hold local enquiries should be made public.

Automatic Tramway Signals.—In view of the great interest which the tramway engineers in England are taking in automatic signalling devices for electric tramways, we think it well to give a few brief notes on the system which the American Electric Switch Company, of Pittsburg, has developed and placed on the market. In this system, which can be used either for blocking or car spacing, as required, three lamps are placed at the beginning and end of each of the line sections. These lamps are coloured respectively green, red, and white, and the colours have the same significance as in railway signalling. The lamps are automatically lighted in turn by means of current drawn from the trolley wire. The individual relay circuits causing the red light to show at one end of a block section on a single line and a green light at the other are momentarily energised by means of a contact near the trolley wire, which is closed when the trolley wheel passes. With this system for a single line, the green light indicates to the driver that there is a car going in the same direction as himself on the section he is entering, and this green light is not replaced by a white light until the last car in the section has left it. The advantage of this system of connection is that there are no trigger or mechanical obstructions in the path of the trolley wheel or pole, and the signals can be operated whether the motorman is using current at the time he passes the entrance to the section or not. Also there are no portions of the trolley wire insulated for signalling purposes. The diagrams of connections for single and double track work on this system will be found in the July issue of the *Street Railway Review*, and they will interest those of our readers who are inventing automatic signalling gear themselves. We may add that the lamps are so enclosed that the signals can be seen equally well in broad sunlight as in the dark.

The Independent Telephone.—If the original inventor of the telephone is to be responsible hereafter for all the bad temper arising from the use of the telephone, he will have a heavy load to bear. We grant that in the ordinary case it is not the use of the telephone which causes bad language so much as the inability to use the instrument in the way desired. We do not propose here to go into the question as to who is to bear this heavy burden, but would suggest that as there is a certain amount of doubt on the point, the man who took the spoils should also take the responsibility. Quite apart from the trouble caused to the private user, which is nowadays usually more than counterbalanced by the great convenience derived at times when the telephone young ladies and the telephones are really doing business, there is the moral effect which the telephone seems to exert on telephone engineers and managers. For instance, in Tunbridge Wells competition has existed for years between two railway companies, and still exists, without making any excitement or vastly improv-

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ing the service. With the telephone, however, it is quite different, as, as soon as the Corporation commenced to give a competing service at about cost price, the National Telephone Company improved their system out of knowledge and reduced their rates to much below cost. The rival partisans have fought week by week in the local Press for the last 15 months, for all of which the telephone is responsible. The Corporation, while fighting in a dignified way, regretted its inability to send the company to warmer climates, but immediately ensured a warm time for its subscribers by ruling that no subscriber to that company should get the benefit of a fire call to the Corporation brigade. We are continually being told that "they do these things better in the States," but here again we see instances that the natural perverseness of the telephone holds sway. There was recently organised a large meeting of the independent telephone men of the New York State. The object of the meeting was to organise an association to control the independent toll line service of the State in opposition, of course, to the Bell Company's lines. Between 90 and 100 men met, fought, and departed in two bodies, each of which incorporated itself at once as "The New York State Independent Telephone Association." The quarrel seems to have been over the selection of officers, commencing with the chairman of the meeting. The result, unless the gentlemen in question are prepared to drop a certain amount of independence, is that there will be as much confusion over the toll line service in the future as there has been in the past. Some of our esteemed engineering contemporaries will succeed without doubt in proving that the confusion is due to municipal action.

Municipal Accounts.—The strongest opponent in practice of municipal trading, who is also the most powerful organiser of private electrical enterprises in this country, claims to be a Socialist and to be in favour of municipal work. We remember once listening to a most able speech of his, in which he laid down as the first principle to guide municipal enterprise that it should be carried on at practically cost price; in other words, that no municipal undertaking should be used to contribute to the relief of the rates. This principle is one which we had laid down in our columns before the speech in question, and which we have often emphasised when Socialists have ranted on the great reduction in rates which will follow the expenditure of large capital sums they require for certain objects. We now find that there are others who agree in the principle, and who promptly find means for evading it. The following extract from our contemporary *Engineering* when criticising the Glasgow tramway report is a case in point: "We are opposed to the relief of rates from such corporate commercial undertakings, but there is no reason why the city should not profit in the same degree as if a company were running the tramways; and this should be in a direct way, and not by the reduction of fares at the expense of sound finance; for even the case of Glasgow affords evidence of injustice. The tramways extend beyond the city boundaries, and thus the residents in other towns profit by the reduction of fares, while Glasgow citizens do not benefit as they would under a company, nor as they should if guarantors of capital outlay not sufficiently safeguard by revenue sufficient for the ultimate refundment of such capital. Thus the Glasgow tramway undertaking pays to the Corporation of the adjoining burgh of Govan a sum for the rental of the streets out of all proportion to the amount paid to Glasgow, while at the same time Govan residents share equally in the facilities. In name of such rental the tramway hands over this year £12,500 to the Glasgow funds; on the Govan basis it ought to be three times this, and would be very much more if a company were at the mercy of the Corporation." In other words, you must not relieve the rates by means of a profit from a tramway undertaking, but there is no reason against paying a large rental out of one pocket of the Corporation into the other in order to prevent any profit being earned. We heard this procedure strongly recommended once as the means of defrauding the income tax department of the Treasury, but we are surprised to see it advocated by the above-mentioned contemporary, whose ideas of finance are peculiar if it supposes that the rental in question does not constitute "a relief of rates from such corporate commercial undertakings."

The Arnold Single-Phase Railway System.—The principal feature of the new system described by Mr. B. J. Arnold before the American Institute of Electrical Engineers, is the use of a single-phase or multiphase motor, which is always connected to the line, and in which either the rotor or stator, or both, are always in motion. The rotor is connected directly to an axle, and both the rotor and stator are connected to compressed-air engines, and in opposite relation to each other. The air compressed by these motors is stored in tanks, and is used to assist in starting the cars, helping over grades, for switching purposes, and for the operation of the brakes. By means of this arrangement the motor operates continually in synchronism, and any excess of power developed not required by the car is taken up by the compressed-air engines, and subsequently utilised anew. When the car is at rest the rotor would be therefore also at rest, and the normal speed of the motor would be attained by the stator in compressing air. To start the car, the engine connected to the stator would be throttled, and the rotor then begins to revolve and propel the car at a speed equal to the diminution of speed of the stator, as the synchronous relations between the two must be maintained. When the stator is brought to rest the motor has attained normal speed, and if a higher speed is desired the stator is revolved in the same direction as the rotor by means of the compressed air in the storage tank. The engine of the rotor can also be put in operation to assist the latter, in case a higher than normal torque is required. The use of single-phase current permits this system to conform to the overhead construction of to-day, except that a much higher working voltage can be used, and in case this voltage is too high for direct use upon the motor, a static transformer can be placed upon each car to reduce the line voltage to the pressure desired for the motors. Other features of the system involve a multiple-unit and simple system of control, and the use of electromagnetic clutches, by means of which either the rotor or stator may be disconnected from the car wheels when it is desired to compress air only. It is also to be noticed that the system of control is entirely mechanical, and that there is no manipulation of the electrical circuits; the operations are all effected automatically by a controller lever. The pneumatic auxiliary of this system makes the single-phase alternating motor, which has been inflexible in regard to speed, even more flexible than the present direct-current railway motor; and the fact that in this system the motors run continually at their normal output, and store energy for use in emergency, which is under ordinary circumstances dissipated as heat, points to a good efficiency for the system. The air storage feature will also be found of great value in a number of circumstances. As pointed out by Mr. Arnold, it will allow the active conductor to be stopped where the private right of way ceases, and the car to proceed through the city or town on any tracks, whether electrically equipped or not, until it reaches the point where it can take up the working conductor again. This feature is also valuable in

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switching work, and eliminates the necessity for electrical conductors except on the main line of track.

Washington Navy Yard Equipment.—The U.S.A. Congress has this year voted £20,000 more for additional land and plant for the above yard, in which the use of electricity for power is steadily gaining ground. It is safe to say that in no very long time it will drive all the machinery there, as well as do all the lighting. In the latter particular it is now employed for about 400 arc lamps and 4,000 incandescents. The wires in the yard are in underground conduits, and the system is in a most satisfactory condition. Within the last two years about £20,000 has been spent on the electrical plant, and the change thus brought about has met with general approval. Motors are now employed in nearly all the shops, and in some they have completely supplanted steam power. The shops in which motors are exclusively used are secondary mount, tool, gunners' workshop, breech mechanism, cartridge case, seaman gunners', erecting, miscellaneous shop, and driving galleries of gunshop. In the shops where the motors operate shafting the former are high above the galleries, and so are out of the way of all other machinery. In one shop—the seamen gunners'—the motors are directly connected, which method in some respects is better than operating a series of machines by one shaft, which, to operate even a single machine, must be kept in motion The direct-connected motors are employed principally for small lathes, shapers, and milling machines, and in some cases are mounted on the machines; in others they are attached lower down, and belting is used. These motors run from 1 h.p. to 4 h.p. each. All excepting one of the travelling cranes in these shops are run by electricity, there being four motors to each. The single exception is the 110-ton crane in the big gunshop. There are 15 of these cranes which vary in motor lifting power from 10 h.p. to 25 h.p The electricity is obtained from a central station in the yard. Among the features of the electric plant of the big war material factory is its oiling system. This is partly located in a room on the second floor of the building, where are a number of oil-tanks equipped with filters. The oil is strained and filtered through water, then passes by gravity to the engines, the overflow pumped back to the tanks of the storage room. By this method there is no unnecessary waste, and since its installation the consumption of oil has been reduced from four to five barrels a month to about four barrels in seven months. Another interesting feature of the navy yard's electrical equipment is the fire-alarm system. The apparatus is of the latest improved Gamewell pattern, and is mainly located in the office of the chief electrician. The yard is divided into fire stations, with an alarm box at each. In each shop there is a 6in. gong, and at the central station an automatic electric signal box, having face-slots for exhibiting the number of any station of the system. The testing tank for trying models of ships is also supplied with power from the central station. The equipment of this tank with its heavy towing traveller has previously been described in our columns. The above information is from an article by "J. E. P." in the *Electrical Review* of New York.

An Australian Electrical Swingbridge.—The new Pyrmont Bridge over an arm of Sydney Harbour was opened last June. It was required owing to the old bridge purchased by the Government being unable to cope with the traffic. After obtaining competitive designs, the best of which was estimated to cost £295,700, it was decided that the new bridge should be constructed from designs prepared by Mr. Percy Allan, M.I.C.E, one of the engineers in the State Department of Public Works. A commencement was made with the actual work in September, 1899, and the structure was formally opened on June 28, 1902, by Sir Harry Rawson, the State Governor, assisted by the Hon. E. W. O'Sullivan, State Minister for Public Works. The total length of the Pyrmont Bridge and its approaches is 1,758ft., the bridge occupying 1,200ft., of which 223ft. represents the length of the swing span. The area of the latter (12,000 superficial) feet compares favourably with the 10,600ft. of the Newcastle-on-Tyne bridge swing. The operating machinery both for turning the span and for lifting the ends, as well as for operating the gates on side spans, consists of electric motors driven by power derived from the power-house at Ultimo, and controlled from an office situated over the southern footpaths at the centre of span. The two 50-h.p. motors provided for slewing are capable of opening or closing the span in 44 seconds. Both motors are for economy worked together; but even in a heavy wind the swing span can be easily handled with one motor. The motors are carried on a platform inside the drum, and work through a train of cut gears two vertical shafts, on the lower ends of which are cast-steel pinions meshing with a cast-steel rack secured to top of pivot piers. To take up the jar caused by the sudden stoppage of such a large moving mass, buffers, consisting of heavy coil springs, are fixed over each rest pier, being so adjusted that should the span when closing be travelling too quickly it will jump the catch in a similar manner to a swinging gate, thus avoiding damage, and necessitating only the reversing of the controller to bring the span back to its correct position. The swing span is, however, so easily controlled by means of the mechanical hand brake that these buffers have so far shown themselves not to be required. The ends of the span when free of supports have a deflection of 3½in, but when closed, to prevent chattering due to heavy loads, the ends are raised 1¼in. by means of a 35-h.p. motor gearing on to a longitudinal shaft running the whole length of the span, and working two horizontal shafts carrying cams under each main girder. This operation takes 15 seconds, an automatic electric device being provided for stopping the same in their correct position. Each of the four gates on the side spans is operated by a 5-h p. electric motor, capable of opening or closing the gate in 15 seconds. Automatic gear for locking the gates is provided, and an automatic electric device stops the gate in its correct position, the operating of the gates being controlled by the man in the controlling-house at the centre of the swing span. Mechanical tell-tales are placed in the controlling-house, by which the operator can see on a dial the position of the end lifts, and the position of the ends of the span when opening and closing. To ensure duplicate parts being always available in the colony, the motors and controllers are of the standard pattern adopted by the New South Wales Railway Commissioners for tramway purposes The whole of the electrical apparatus was from the establishment of the General Electric Company of America, and has been supplied and installed by the Australian General Electric Company, Mr. R. C. Jeffcott having personally supervised the installation of the equipment, which is considered to be the most up-to-date in the world, the estimated cost of the power for opening or closing the swing, including the raising and lowering of the ends and the working of gates, being a little under 1d. per trip. The estimated cost of the structure, which possesses a substantial, yet not ungraceful, appearance, is £112,000, against £295,700, the estimated cost of the design obtaining the first premium in the competition open to the world, although the necessary works were on a more extended scale.

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NOTES ON THE TESTING OF TRAMWAY MOTORS, AND AN INVESTIGATION INTO THEIR CHARACTERISTIC PROPERTIES.*

BY MICHAEL B. FIELD, MEMBER, A.M.I.C.E.

Synopsis of Paper.

Introductory remarks—Definition of "rating of tramway motors"—Testing frame—Disadvantage of the Hopkinson method—Connections employed—Description of test—Reduction to standard voltage and standard temperature—Example—Results tabulated, Tables I.-VIII., plotted Figs. 3, 4—Leading features of motors under consideration—Connections for testing with less than 500 volts—Separation of losses, Note 1—Starting current—Test for similarity of two motors used—Examples, Tables IX., X.—Effect of temperature on full load efficiency—Prony brake—Determination of thermal characteristic—Correction for cooling—Flashing of motors—Reversal of direction of rotation—Volt-ampere characteristic, and determination of ampere $-\frac{R}{n}$ curve—Latter very nearly straight line—Deduction therefrom, Note 2—Determination of retarding torque, motors acting as electric brakes—Coefficients of adhesion in practice—Particular case as example—Change of velocity and distance traversed under varying accelerations, Note 3—Tractive effort diagrams—Allowance for angular acceleration of rotating parts—Best shape of efficiency curve—Diagram of controller positions for different routes—Average current over route—Current for minimum loss—Graphical methods of studying acceleration and retardation periods—Importance in connection with tube railways—Possible economies to be effected by studying manipulation of controller—Examples, Tables XI., XII.—Approximate formulæ—Comparison with graphical methods, Table XIII.

Very little attention is paid as a rule by British tramway engineers to the determination of the characteristic properties of the motors they purchase. The author has known cases where important contracts have been decided in favour of one firm or another because the particular motors offered have been rated higher than those of other competitors, when in all probability a full-load test would have shown the accepted motor to be not one bit superior to those rejected. It is often considered sufficient by the tramway engineer to have one sample equipment of the new type proposed, mounted on a car and tried on the street. If the speed be about right, the motors show no signs of violent sparking, and do not become excessively hot towards the end of the day's working, the test will often be considered as satisfactory. Engineers sometimes specify that the equipment shall be capable of propelling a car of given weight over a given route with a stated number of stops for not more than a stated energy consumption expressed in kilowatt-hours, the supply voltage being 500. Any one who has made such tests will appreciate how entirely the results lie in the hands of the motorman.

The author is of the opinion that the most satisfactory manner of arriving at the merits of the individual types is to supplement the above tests, taken on the road, by others carried out on the same motors mounted on a testing frame specially arranged for this purpose.

It is generally recognised now that it does not pay to put in motors which, although capable of doing all the work required of them without undue sparking, nevertheless heat more than 60deg. C. in so doing. There is consequently a liability with different manufacturers to rate their motors unequally. One, for instance, may call a motor a 40-h.p. motor because it is capable of delivering up to 40 h.p. intermittently, while another would call the same motor a 20-h.p. motor because it was not capable of giving out more power for any length of time without seriously heating the insulation. In order to avoid vagueness of this description, American firms have adopted the following convention for rating tramway motors. The rating of a motor is that horse-power which it will give out continuously for one hour under working conditions with a rise of temperature measured with a thermometer nowhere exceeding 75deg. C., provided the atmosphere is not more than 25deg. C.

When testing such motors stationary—*i.e.*, not mounted on a car—the ventilation and cooling facilities are manifestly less than would be the case on the road. To counterbalance this the lid above the commutator is usually left open, which has been found by experience to give a fairly correct compensation for the altered conditions.

* Paper read before the Glasgow Local Section of the Institution of Electrical Engineers.

The author has adopted this as a basis of comparison of a number of different types of tramway motors in the past, and proposes to illustrate in this article how readily such motors may be quickly tested, and all their characteristic properties ascertained in a practical workshop manner.

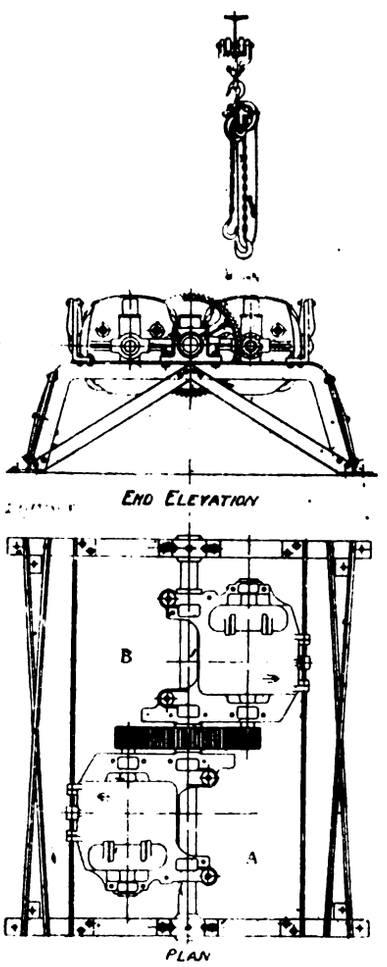

FIG. 1.—Testing Frame for Tramway Motors.

The motors under test are erected on the testing frame (shown in Fig. 1), one of the gear wheels supplied with the equipment being used for the purpose. M works as motor, driving G, which works as generator, and is loaded on a water resistance. The current, after traversing the armature and field of M, passes also round the field of G. M and G being exactly similar, having the same ampere-turns on the field, and running at the same speed, it may be assumed that the iron and friction loss in each is the same. This is very important, as it enables us to arrive at the efficiency of M, and at the same time to separate out the losses far more accurately than can be done with the Hopkinson method.

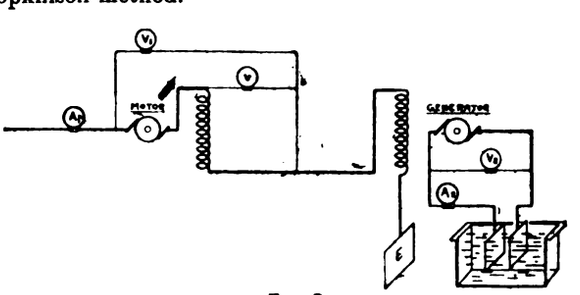

FIG. 2.

For example, if we wished to determine the efficiency at 500 volts, 50 amperes, by means of the Hopkinson method, we could either supply the losses mechanically by driving the combination by means of a belt, or electrically by including in the circuit an additional E.M.F. Suppose at 50 amperes the C^2 R loss amounts to 9 per cent., and the gear and iron loss to 8 per cent.—*i.e.*, efficiency of the motor = 83 per cent.—then in the first case it would be

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necessary to weaken the field of one motor by 18 per cent., and in the second case by 16 per cent. Under these circumstances it would be manifestly incorrect to take the square root of the combined efficiency as the efficiency of each motor.

Fig. 2 shows the diagram of connections for the method above described, and illustrated in Fig. 1.

If $_mR_a$ = resistance of motor armature;
$_gR_a$ = resistance of generator armature;
$_mR_f$ = resistance of motor field;

then $A_1 V_1$ = input;
$A_2 V_2$ = output;
$A_1 V_1 - A_2 V_2$ = total loss in motor and generator (but exclusive of generator field).

Subtracting from this the loss $A_1^2 (_mR_a + _mR_f) + A_2^2 {}_gR_a$, or the known ohmic losses, we have as a remainder the total loss in motor and generator covered by hysteresis, eddies, friction, windage, etc. But for reasons already given, we may with very great accuracy apportion this loss half to the motor and half to the generator. The efficiency of the motor is then easily calculated. The voltmeter, *v*, allows of the resistance of the motor field being taken with each reading of input, output, etc. The resistance of the armature is best taken at the beginning and end of each series of tests, when, if time readings be also taken, the actual resistance of the armatures for any particular reading may be easily found by interpolation. By taking simultaneous readings of supply voltage, current input, speed, etc., we can construct curves for kilowatt input, efficiency, hence horse-power output. Then by aid of the speed curve we obtain tractive effort and the volt-ampere characteristic for any desired speed.

With the exception of the last named, all other results should be reduced to a standard voltage, say 500, and a standard temperature, say 20deg. C. This may be readily done, as the following example will show:

Take A_1 = 50 amperes;
V_1 = 490 volts;
$_mR_a$ = ·457 ohm determined by interpolation from initial and final readings being approximately at 47deg. C.;
($_mR_a$ = ·414 ohm at 20deg. C.);
$_gR_a$ = ·446 ohm determined by interpolation from initial and final readings, being approximately at 40deg. C;
($_gR_a$ = ·414 ohm at 20deg. C.);
$_mR_f$ = ·541 ohm determined by interpolation from initial and final readings, being approximately at 74deg C.;
($_mR_f$ = ·448 ohm at 20deg. C.);
A_2 = 40 amperes;
V_2 = 421 volts;
Speed = 422 revolutions per minute.

In this case the input = 24·5 kw.;
" " output = 16·84 kw.

The actual total ohmic loss in armature and field of motor = $50^2 \times (·457 + ·541) = 2·5$ kw., and in generator armature = $40^2 \times ·446 = ·714$ kw., hence the total iron, friction, and windage loss = 4·45 kw.

Now, of the 490 volts supplied to the motor, 50 volts are required to overcome ohmic resistance, leaving a back E.M.F. of 440 volts. If, however, the supply had been 50 amperes at 500 volts and the temperature 20deg. C., the back E.M.F. would have been 457 volts—*i.e.*, the speed would have been 439 revolutions per minute instead of 422. We may then with great accuracy increase the iron and friction losses found above in this proportion, and dividing by 2 we obtain 2·31 kw. as the motor iron and friction loss at 50 amperes, 500 volts, 20deg. C. Using now the true values of the armature and field resistances at 20deg. C., we obtain, as the corrected efficiency of the motor at 500 volts 50 amperes and 20deg. C., the result of 82 per cent.

Following this up, we should get with a 4·86 gear reduction (14 : 68) and 30in. wheels, a speed of 8·1 miles per hour, an output of 27·5 h.p., and a tractive effort at the tread of the wheel of 1,275lb., making no deduction for journal and rolling friction of the car truck. Tables I.-VIII. give the readings taken recently during tests on two different types (say P and Q), together with calculations thereon, while Figs. 3 and 4 show the various properties of the motors represented as curves, reduced to 500 volts and to 250 volts respectively, and to 20deg. C. In plotting the tractive effort curves, no allowances are made for journal and rolling friction. In making calculations, it is therefore necessary to deduct 15lb. to 20lb. per

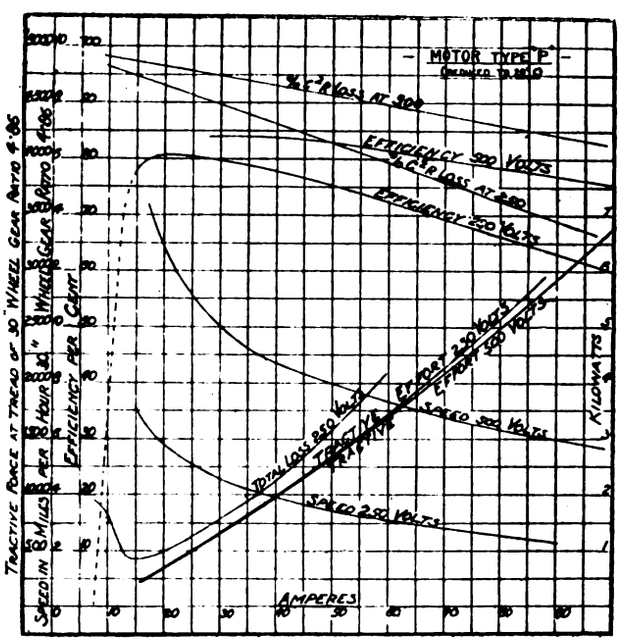

Fig. 3.

ton dead-weight from the total tractive effort of the two motors, as given by these curves. This gives the effective tractive effort, producing acceleration, or available for overcoming a grade, as the case may be. The leading features of the motors, P and Q, are as follows:

	P.		Q.
Diameter of armature	346mm.	...	345mm.
Length of iron of armature	190mm.	...	180mm.
Number of slots	37	...	53
" commutator bars	111	...	105
" armature coils	37 × 3	...	105
" poles	4	...	4
Gear ratio	4·86	...	4·86
Weight of motor (without gear and gear case).	1,856lb.	...	1,924lb.
" armature and pinion	476lb.	...	478lb.

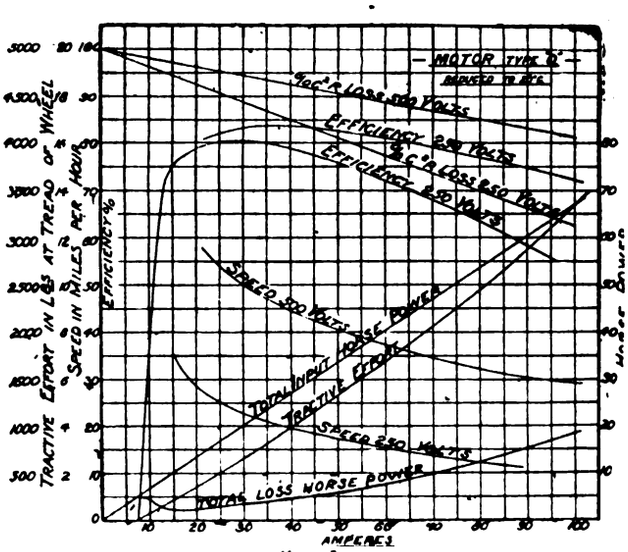

Fig. 4.

Fig. 5 shows the connections for carrying out the 250-volt test, current being taken from the 500-volt supply. By adjusting the three plates in the water-tub suitably, 250 volts may be maintained at the terminals of the motor with any desired current strength.

With the arrangement shown in Fig. 5 a whole series of tests may be carried out at different voltages. If the iron

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losses be separated for each reading and plotted, a set of curves can be obtained showing the variation of iron and friction losses with speed for each field strength. Then adopting Kapp's method—viz., plotting loss divided by speed, or back torque with speed—it should be possible to separate out the Foucault current losses from the total iron and friction loss.

[*Note* 1.—For a given field strength we may take the total iron and friction loss as $(H + f)\ n + F\ n^2$, where H, f, and F represent the losses at the speed $n = 1$ due to hysteresis, friction, and windage, and Foucault currents respectively. Dividing this loss by n, we should then obtain a linear relation between speed and $\frac{\text{loss}}{n}$, from which the value of $(H + f)$ and F can be easily determined. The writer has, however, not carried out this refinement in the case in question.]

For determining the starting current of a motor (this being the starting point of the efficiency curve) one motor

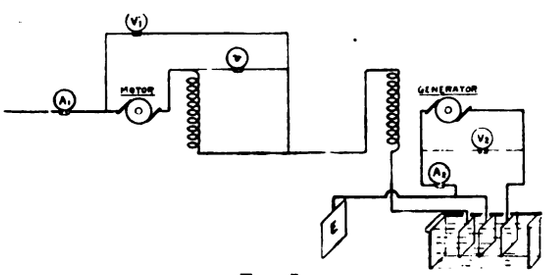

FIG. 5.

is removed entirely from the frame, and sufficient resistance introduced into the circuit of the other as to bring it just to the point of starting. It will be shown later that the determination of this starting current is of considerable importance.

It is to be noted that the method of testing already described depends entirely on the assumption that the motors M and G are sufficiently similar, that with equal field currents and the same speed the E.M.F. generated in each armature is the same. A very slight difference in the length of the air-gap of the two motors would make this an unwarrantable assumption; but the author has found that with motors manufactured by good firms the assumption is well founded In any case it is easily tested. The supply voltage to motor M and the drop in volts in the

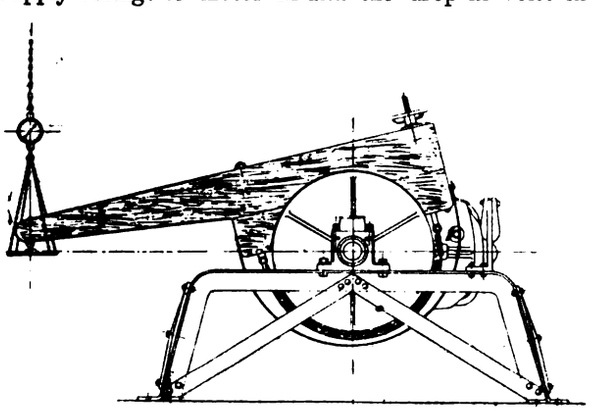

FIG. 6.

motor itself are known, hence the back E.M.F. Similarly the terminal volts of G and lost volts in armature of G are known, hence the "generated volts" of G can be determined. Since in both machines the brushes are exactly in the neutral position, the back E.M.F. of M should be the same as the "generated" E.M F. of G if the above assumption be correct.

Tables IX. and X., which have been worked out for the two types of motor, P and Q, show how nearly the E.M.F.'s of the two motors of similar type are in agreement with one another.

In this connection it will be well to point out that a difference of 5 per cent. in these E.M.F.'s will not produce an error in the total efficiency, calculated, as already explained, of more than 0·2 per cent.

In specifying efficiencies it is important to specify the temperature at which the test is to be taken; at the end of the hour's heat run, for example, the resistance will often be 30 per cent. higher than at the beginning, which may mean a diminution in the efficiency of fully 3 per cent.

Fig. 6 shows an independent method of obtaining the torque curve that I have occasionally used. The cast-iron pulley of the Prony brake is hollow, and partly filled with water, which effectively keeps down the temperature of the brake blocks within reasonable limits. I have used such a brake up to 100 h.p. The length of the arm in this case is

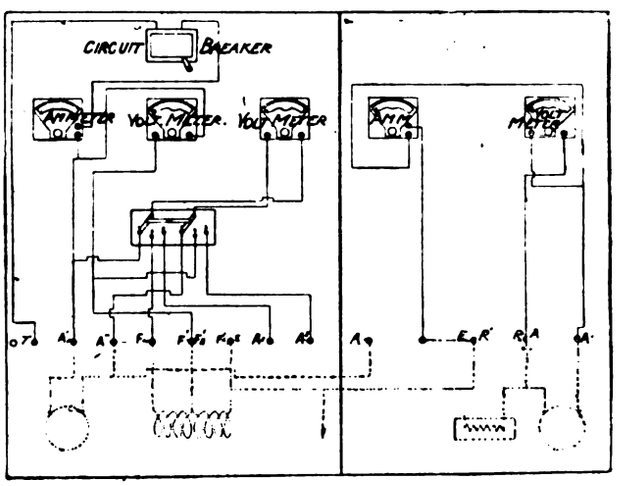

FIG. 7.

5ft. 3in., this being so chosen in order that the pounds pull × revolutions per minute ÷ 1,000 = horse-power. The diameter of the cast-iron pulley is 30in., so that it exactly corresponds to a car wheel, the force at the tread being that indicated in the spring balance multiplied by 4·2 and corrected for the weight of the lever arm. It is sometimes convenient to arrange a balance weight to counterbalance the weight of the lever arm, so that no correction is needed for this.

Returning now to the purely electrical method, I have found that for carrying out the one-hour heat run it is most convenient to employ a special switchboard (Fig. 7), in which all the necessary connections are made once for all, the measuring instruments, after being standardised, being dropped into pockets and connected in circuit.

Before the commencement of the test (which we will suppose is being made to determine the rise of temperature after one hour at 50 amperes), the connections between the terminals marked $A^2{}_m$ and $F^1{}_m$ and between C and E R^1

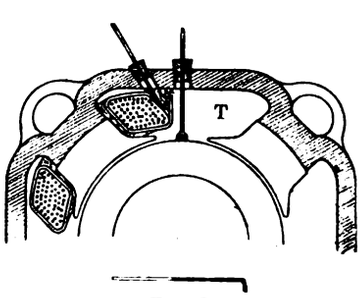

FIG. 8.

are removed, and between C and $A^2{}_m$ established. The current is now adjusted to 50 amperes, and readings are taken with the three-way switch in positions 1 and 3. This gives the initial resistance of the two armatures, including carbon brushes and brush contacts (care having previously been taken that brushes are well bedded and not canted). A similar test is taken after the hour's run to determine the final resistance. If the rise of temperature as determined by rise of resistance be desired, it is best to have a copper brush that may be slid in in place of the carbon brush, as better contact will then be obtained.

To obtain the correct temperatures at the end of the heat run, the author has found it best to employ bent thermometers, as shown in Fig. 8. Two holes are drilled

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through the motor case, through one of which a thermometer can, immediately after the test is finished, be dropped down on to the surface of the armature. The bulb of the thermometer is protected by a cork hood to thermally insulate it. The second thermometer is packed into a pocket formed in the side of the field coil, so that its bulb is lying up against the winding, as shown in Fig. 8.

With this arrangement the two thermometers are gradually rising towards their final temperature throughout the test, upon the conclusion of which no time need be lost in bringing T down on to the surface of the armature. A short interval of time must, however, elapse before the final temperature can be recorded, especially if a cold thermometer be laid upon the commutator to determine the rise of temperature of same.

If, however, time readings be taken from the finish of the test until the maximum temperatures are recorded, and then for an equal length of time further (during which the motors are cooling), a correction for the cooling off during the first interval can readily be arrived at.

If the motors have to be opened up before the thermometers can be applied to the surfaces, it will be found that usually 15 minutes elapse, and often a considerably longer period, before the final temperatures are recorded, during which time the motors will have cooled to a considerable extent.

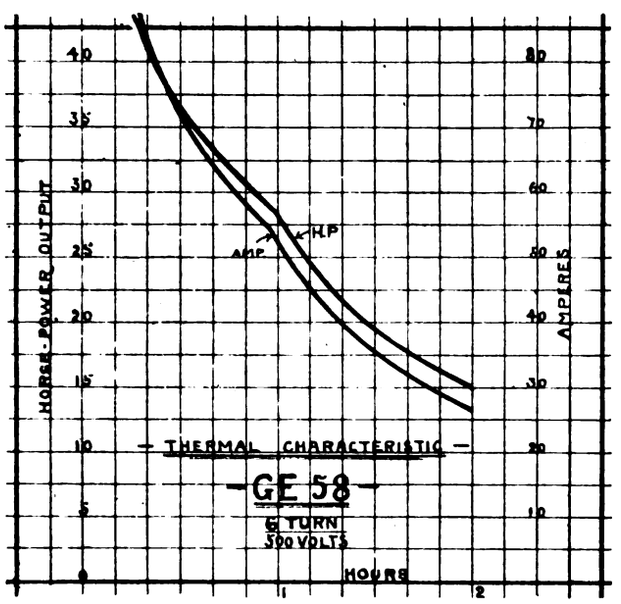

FIG. 9.

In making this test care should be taken that there is no excessive pressure between brushes and commutator, also that there is no sparking which can be avoided—that is, which is not inherent in the motor—*e.g.*, such as due to unfair vibration of the frame; for an abnormal commutator temperature will naturally heat the air inside the motor case to a greater extent, and cause both armature and field coils to show a higher final temperature than otherwise.*

By making a series of such tests at different current inputs, in each case allowing the test to continue till 75deg. C. rise is reached at some part of the motor, the thermal characteristic can be obtained. It often happens that at the upper part of the curve the temperature is governed by the armature and at the lower part by the field coil. As an example, Fig. 9 shows the thermal characteristic for the well-known, though somewhat old-fashioned, G.E. 58 motor.

Before removing the motors from the testing frame it will be found a good plan to try them for flashing by connecting them up to a rheostatic brake controller, running them at a high speed, and then applying the brake—*i.e.*, short-circuiting the motors after reversing the field connections, under which circumstances they act as generators

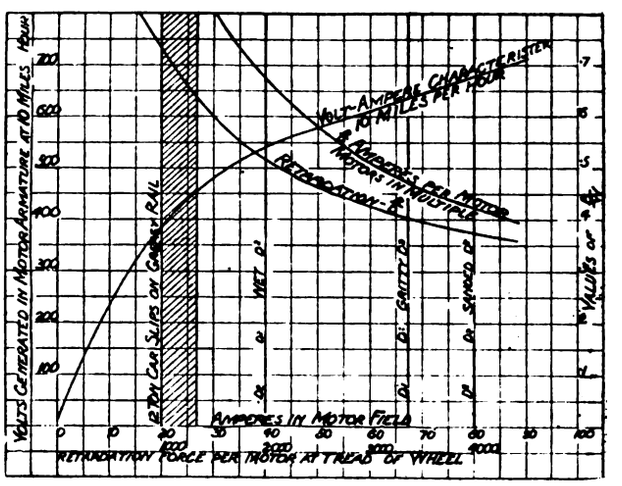
VOLT-AMPERE CHARACTERISTIC
AMPERES PER MOTOR
RETROGRESSION - %
AMPERES IN MOTOR FIELD
RETROGRESSIVE FORCE PER MOTOR AT TREAD OF WHEEL

FIG. 10.

generating current in the closed circuit. A comparison of different motors from this point of view is of great importance.

In carrying out this test an interesting phenomenon will be noticed—viz., that if the brake be suddenly applied to the motors while running at a high speed they will quickly stop, and then run round in the reverse direction for a few revolutions. The reason of this most probably is that, owing to the large self-induction and small resistance of the short-circuited motors, the current generated has not died away by the time the motors have been brought to a standstill. This current still circulates then round the circuit as if supplied from an outside source, and the field magnets being reversed the direction of rotation is reversed. There is, however, no further tendency to reversal of rotation, for the motors running in the reversed direction will not at any speed whatever generate current as generators unless their fields be again reversed.

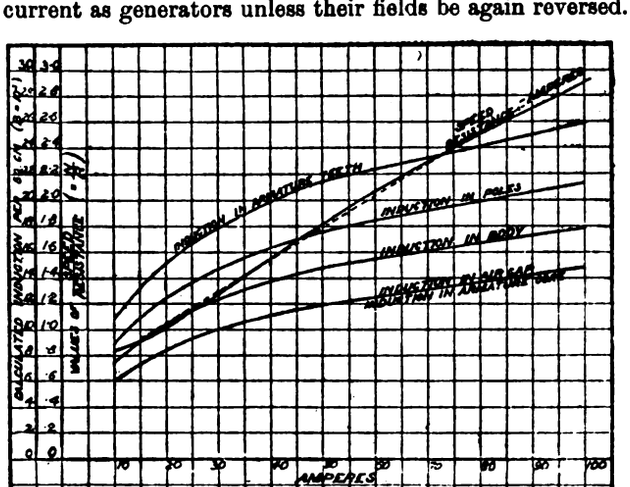

FIG. 10A.

Before leaving the subject of rheostatic braking the following considerations will be found of interest and importance:

The E.M.F. generated in the armature of the motor working as a generator will be proportional to the speed n multiplied by some function of the current representing magnetic flux. We have, in fact,

$$V = C R = n f(C) \text{ or } \frac{n}{R} = \frac{C}{f(C)} = \phi(C).$$

Now, from the volt-ampere characteristic, which is easily

* The following figures are interesting as bearing on the subject. The same motor was tested twice at exactly the same load. In the first case the brushes were sparking badly and the friction was excessive. The increased rise of temperature at all parts could therefore only have been due to the great temperature rise of the commutator.

TEST I.—One hour's run.

Final temperature of armature	68deg. C.	Rise	49deg. C.
,, ,, field coils	70deg. C.	,,	51deg. C.
,, ,, commutator	110deg. C.	,,	92deg. C.
,, ,, atmosphere	19deg. C.	,,	—

TEST II.—Same motor, same load, one hour's run.

Final temperature of armature	68deg. C.	Rise	43deg. C.
,, ,, field coils	67·5deg. C.	,,	47·5deg. C.
,, ,, commutator	63deg. C.	,,	43deg. C.
,, ,, atmosphere	20deg. C.	,,	—

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constructed for any given speed from the figures tabulated, it is a simple matter to obtain the value of $\frac{n}{R}$ corresponding to any current strength.

Fig. 10 shows the volt-ampere characteristic for motor P and the ampere – $\frac{n}{R}$ curve for two motors connected in parallel, as in Fig. 11.

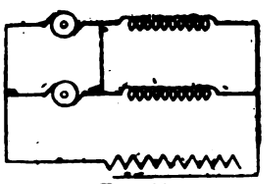

Fig. 11

[*Note* 2.—It is interesting to note that the $\frac{n}{R}$ and current curve is very nearly a straight line throughout the range shown. If we write

$$\frac{n}{R} = \alpha + \beta C, \text{ and } \frac{n}{R} = \zeta \frac{C}{F},$$

F being the total armature flux, or if we assume ζ includes a certain coefficient of magnetic leakage, we may say F = mean flux throughout the magnetic circuit. Now F is of the nature of an induction × an area or B × A. Let B stand for a mean effective induction, such that we can say total field-magnet ampere-turns $\propto \frac{B}{\mu}$, μ being of the nature of a mean effective permeability for the circuit. A will be an area equal to $\frac{F}{B}$. We have then $C \propto \frac{B}{\mu}$, which leads to the expression $\mu = \frac{\lambda - B}{\rho}$; α, β, ζ, λ, ρ being unknown constants. This form of expression for μ for iron circuits is well known; Dr. S. P. Thompson gives in his short article on dynamos in "Munro and Jameson's Pocket-Book," $\mu = \frac{17{,}000 - B}{3{\cdot}5}$ as being approximately correct between 6,000 and 16,000 lines per square centimetre. The linear relation of $\frac{n}{R}$ to C in motors of the type in question, is of such interest that the author has shown in Fig. 10A the ampere – $\frac{n}{R}$ curve for motor Q, together with the mean calculated values of induction per square centimetre in different portions of the magnetic circuit, plotted with reference to current. It will be observed that inductions as high as 26,000 are indicated, while the maximum induction in the teeth under the leading horns probably reaches over 30,000 lines per square centimetre. The values of α and β for motor P are ·554 and ·0237, and for motor Q ·56 and ·0244 respectively.]

(To be continued.)

THE DISSIPATION OF ENERGY BY ELECTRIC CURRENTS INDUCED IN AN IRON CYLINDER WHEN ROTATED IN A MAGNETIC FIELD.*

BY ERNEST WILSON.

The effect which induced electric currents have upon the distribution of magnetism in an iron cylinder, when rotated in a magnetic field, has formed the subject of a communication, and it is the object of this paper to deal with the energy dissipated by these electric currents. A comparison will be made between the results of experiment and theory. In connection with the latter, I have to thank J. B. Dale, Esq., M.A., assistant lecturer in mathematics, King's College, London, for a contribution which at his wish I append to this paper. The cylinder used in the experiments has diameter and length each 10in. (25·4cm). Since the previous experiments were made additional holes have been drilled in a plane containing the longitudinal axis of the cylinder, and its present section is shown in Fig. 1. Insulated copper conductors have been threaded through these holes, and enclose areas indicated by the thick lines in Fig. 1. The coils are numbered 1, 2′, and 4, and enclose areas of 25·8, 232, and 654 square centimetres respectively.

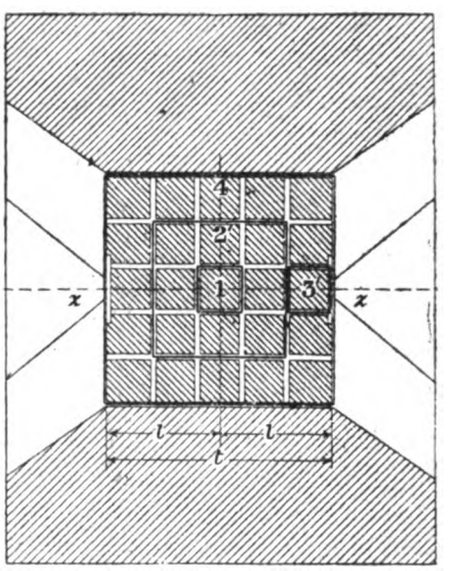

Fig. 1

As in the previous experiments, the E.M.F. in each coil has been calculated from the observed deflection of the needle of a d'Arsonval galvanometer placed in each circuit. The deflections were observed simultaneously, thus enabling the relative phase displacements to be determined.

Specific Resistance.

The specific resistance of the material of the cylinder has not been directly determined. The late Dr. John Hopkinson gives $10{\cdot}5 \times 10^{-6}$ ohms for mild steel, and I have used 10×10^{-6} ohms in connection with the cylinder. A remarkable case of high specific resistance, combined with high

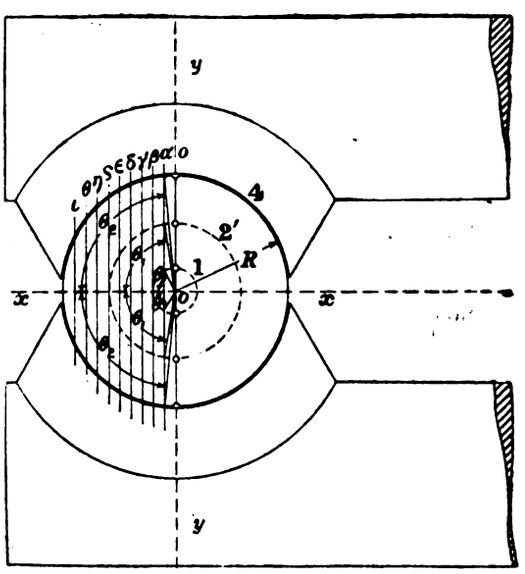

Fig. 2.

magnetic permeability and relatively small dissipation of energy by magnetic hysteresis under alternating magnetic force, is an alloy of iron and aluminium, in which the specific resistance is 39×10^{-6} ohms. Provided it keeps its good qualities after prolonged use, this alloy should prove of great value.

Experiment.

The rate at which energy is being dissipated by electric currents induced in the cylinder has been obtained in the following manner: The horizontal radius in Fig. 2 has been divided into 10 equal parts, and the cylinder is supposed to

* Paper read before the Royal Society.

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TABLE I.

Periodic time in seconds.	Frequency for a cylinder having diameter and length = 0·1cm.	Maximum average induction per square centimetre B.				Phase difference between E.M.F. curves. 360° = 1 period.			Watts dissipated by induced currents in half volume of the cylinder.			
		Coil 1.	Coil 2′.	Coil 3′.	Coil 4.	Nos. 1 and 3′.	Nos. 4 and 1.	Nos. 4 and 2′.	Calculated from $2{\cdot}08\ \frac{\pi B^2 f^2 l^2}{10^{16}\rho}$ No. 4 coil E.M.F., rectangular.	Obtained from experiment.	Calculated from $3{\cdot}95\ \frac{\pi B^2 f^2 l^2}{10^{16}\rho}$	Ratio A/B.
										B.	A.	
45	1,434	429	541	1,546	1,090	65°·6	73°·7	28°·8	0·0127	0·0137	0·0240	1·75
,,	,,	908	3,070	7,860	5,900	121°	108°	59°·4	0·373	0·224	0·705	3·15
,,	,,	12,980	12,400	12,000	12,600	28°	17°·6	8°	1·70	2·280	3·22	1·41
,,	,,	18,200	20,000	—	20,000	—	0	0	4·28	5·8	8·10	1·40
90	717	730	895	1,400	1,060	44°·8	39°·2	16	0·0030	0·0036	0·0057	1·58
,,	,,	2,660	5,100	8,100	6,700	96°	82°·5	36°·8	0·119	0·138	0·227	1·64
,,	,,	13,100	13,400	13,800	13,300	5°·8	4°·8	0	0·472	0·708	0·895	1·26
,,	,,	17,900	19,300	17,000	19,300	0	0	0	0·993	1·141	1·88	1·33
360	179	1,520	1,320	—	1,040	—	8°	0	0·00018	0·00027	0·00034	1·27
,,	,,	8,400	8,330	—	7,300	—	0	0	0·0088	0·0135	0·0168	1·24
,,	,,	13,740	14,100	13,400	14,400	1°·6	0	0	0·0346	0·045	0·0655	1·45
,,	,,	20,000	20,600	—	19,900	—	0	0	0·0662	0·0974	0·125	1·26

be cut by vertical planes 0, α, β, γ . . . passing through the points of intersection, the plane 0 containing the axis of the cylinder. The circles, 1, 2′, 4, show the paths traversed by the longitudinal sides of the exploring coils during rotation of the cylinder. In the plane α let θ, θ_1, θ_2 be the angles which the plane of the exploring coils makes with the horizontal when the coils 1, 2′, 4 have respectively one of their longitudinal sides in the plane α. Three paths of induced electric currents in the plane α are now assumed. No. 1 is taken to be the rectangle having its two sides which are parallel to the longitudinal axis equal to and coinciding with the sides of the coil, and its two other sides the straight lines necessary to complete the rectangle in the plane α. Similarly with regard to coils 2′ and 4. Each path is assumed to have a cross-sectional area of one square centimetre throughout its longitudinal length, and this area multiplied by the sine of the angle which the plane of the coil makes with the horizontal, throughout the remaining portion of its length. The electric resistance of each path has been calculated in ohms. Fig. 3

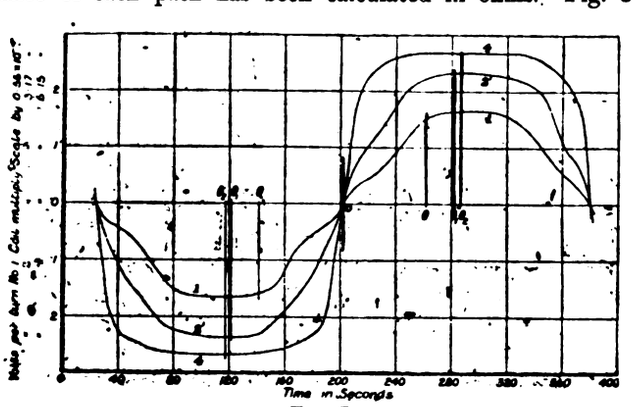

FIG. 3.

gives a set of curves obtained with 360 seconds periodic time, and maximum average induction 19,900 C.G.S. units per square centimetre for No. 4 coil. The curves give the E.M.F.'s in volts per turn for coils 1, 2′, and 4 respectively. The E.M.F. of No. 1 coil at angles θ on each side of the point 0, where the curve cuts the axis of time, has been halved, and the sum of the values thus obtained is taken to be the effective E.M.F. in volts acting around the assumed path of the induced electric current. Similarly, for coils 2′, 4, at angles θ_1, θ_2 respectively in Fig. 3. The rate of dissipation of energy in watts is taken to be the square of this E.M.F. in volts divided by the resistance of the path in ohms. These watts have been plotted on squared paper, and the total watts in the plane α have been obtained by integration with respect to the vertical distance from the horizontal axis. Finally, by integrating with respect to the horizontal axis, $o\,x$, the total watts dissipated in the half cylinder have been found. The figures thus obtained at periodic times, 45, 90, and 360 seconds, for different values of the total flux of induction between the pole-pieces, are set forth in Table I. Strictly, this method is only applicable when the E.M.F.'s of coils 1, 2′, and 4 are in phase. With a periodic time of 360 seconds the curves are nearly in phase for all values of the external magnetising force, but this is not the case for the other periodic times, except at the high forces. The E.M.F. curves are assumed to be in phase in each experiment when applying the above process of integration.

Influence of Wave-Form.

If reference be made to Fig. 3, it will be seen that No. 4 coil gives an E.M.F. whose wave-form lies between a sine curve and a rectangle. Suppose that the E.M.F. curve of No. 4 coil were a rectangle having the same area as a sine curve about the same base line. Since the maximum ordinate of the sine curve is $\pi/2$ of the ordinate of the rectangle, it follows that the minimum induction density in the case of the rectangle will be $2/\pi$ of the average induction density. Since also with the rectangle the E.M.F. is constant for the No. 4 coil, the induction density will increase inversely as sin θ_2 (Fig. 2). The value of the intensity of magnetic induction in each of the planes α, β, γ . . . has been calculated, and the graphical treatment described in connection with the experiments has been applied. It gives as a result $2{\cdot}08\ \frac{B^2 f^2 l^2}{10^{16}\rho}$ for the watts per cubic centimetre dissipated by induced currents, the symbols having the definition given in the next section of this paper. The graphical treatment has also been applied when the intensity of magnetic induction is constant, and gives $3{\cdot}93\ \frac{B^2 f^2 l^2}{10^{16}\rho}$ for the watts per cubic centimetre. This formula is in close agreement with the result of theory. We should expect, therefore, that the experimental result would give a less rate of dissipation of energy than dictated by the consideration of constant intensity of induction, and this is found to be the case. It may be mentioned that as the above graphical methods rest upon calculation, the paths of the respective curves were determined by many more points than were possible in connection with the experimental results.

Theoretical Considerations.

Let B = average induction per square centimetre in C.G.S. units;
f = frequency in complete periods per second;
ρ = specific resistance of the material of the cylinder in ohms;
$t = 2\,l$ = length of cylinder in centimetres along its longitudinal axis;
$2\,n\,l$ = diameter of cylinder in centimetres;
R = maximum radius of cylinder in centimetres;
x, y, z be axes as shown in Figs. 1 and 2.

In any plane section, such as α (Fig. 2), one can consider three distributions of the currents induced in the cylinder

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by rotation in a magnetic field, the lines of force being parallel to the planes α, β, γ . . . and at right angles to the longitudinal axis of the cylinder.

1. There is the distribution assumed by Baily in which the electric currents flow in rectangular paths similar to the boundary of the plane of section $\alpha\,\beta\,\gamma$ . . . On the assumption that the rate of cutting lines of force is proportional to the distance from the centre of a plate, and that the distribution of magnetism is such that any point in the plate is cutting lines of force during two-thirds of a revolution, and that for the remaining one-third revolution the point is travelling along the lines of force, Baily has shown that, when R is great compared with l, the average rate of dissipation of energy per cubic centimetre of the plate is given in watts by the formula $3\,\frac{B^2 f^2 l^2}{10^{16}\rho}$. Assume that the cylinder rotates about its longitudinal axis in a truly uniform magnetic field. Assume also with Baily that the length of the path of the induced current

$$= 4z + 4nz\sin\theta_2 = 4z\left\{1 + n\frac{\sqrt{(n^2 l^2 - x^2)}}{nl}\right\} \text{ centimetres,}$$

and that the electric resistance of the path

$$= \frac{4z\rho}{dx\,dz}\left\{\frac{1}{n} + n\frac{\sqrt{(n^2 l^2 - x^2)}}{nl}\right\} \text{ ohms.}$$

The E.M.F. in volts $= 8z^2\pi f n B\,10^{-8}$. Then the total rate of dissipation of energy in watts

$$= \frac{16\pi^2 B^2 f^2 n^3 l}{10^{16}\rho}\int_0^{nl}\frac{lx}{l + n\sqrt{(n^2 l^2 - x^2)}}\int_0^{l} z^3\,dz,$$

and this reduces to

$$\frac{8\,B^2 f^2 l^5 \pi^2}{10^{16}\rho}\left(\frac{\pi}{2} - 1\right), \text{ when } N = 1;$$

$$\frac{8\,B^2 f^2 l^5 n^3 \pi^2}{10^{16}\rho}\left(\frac{\pi}{2n} - \frac{1}{n\sqrt{(n^4-1)}}\log\frac{\sqrt{(n^2+1)} + \sqrt{(n^2-1)}}{\sqrt{(n^2+1)} - \sqrt{(n^2-1)}}\right)$$

when n is greater than unity;

$$\frac{8\,B^2 f^2 l^5 n^3 \pi^2}{10^{16}\rho}\left\{\frac{\pi}{2n} - \frac{2}{n\sqrt{(1-n^4)}}\left(\tan^{-1}\sqrt{\frac{(1-n^2)}{(1+n^2)}}\right)\right\}$$

when n is less than unity.

The average watts per cubic centimetre of the cylinder as given by the above formula are:

$$7{\cdot}16\,\frac{B^2 f^2 l^2}{10^{16}\rho} = 1{\cdot}79\,\frac{B^2 f^2 l^2}{10^{16}\rho}, \text{ when } n = 1$$

$$19{\cdot}7\,\frac{B^2 f^2 l^2}{10^{16}\rho} = 4{\cdot}9\,\frac{B^2 f^2 l^2}{10^{16}\rho}, \text{ when } n = 200.$$

When $n = \frac{1}{200}$, the value of

$$\frac{\pi}{2n} - \frac{2}{n\sqrt{(1-n^4)}}\left(\tan^{-1}\sqrt{\frac{1-n^2}{1+n^2}}\right)$$

is very small indeed.

By modifying the expression for the resistance of the rectangular path, Mr. Dale shows that the watts per cubic centimetre $= 4{\cdot}69\,\frac{B^2 f^2 l^2}{10^{16}\rho}$ when $n = 1$, and $12{\cdot}6\,\frac{B^2 f^2 l^2}{10^{16}\rho}$ when n is much greater than unity.

2. There is the distribution assumed in connection with the experiments—that is, the induced currents distribute themselves on the surfaces of cylinders similar to and concentric with the cylinder experimented upon. Mr. Dale has dealt with this case theoretically for a uniform magnetic field, and shows that the watts per cubic centimetre of the cylinder $= 3{\cdot}95\,\frac{B^2 f^2 l^2}{10^{16}\rho}$ when $n = 1$, and $7{\cdot}9\,\frac{B^2 f^2 l^2}{10^{16}\rho}$ when n is much greater than unity. The former coefficient is in very good agreement with the graphical result, which is 3·93.

3. There is the case in which the current density in any path is constant throughout the whole length of the path. Mr. Dale has also dealt with this case theoretically, and shows that the watts per cubic centimetre $= 4{\cdot}09\,\frac{B^2 f^2 l^2}{10^{16}\rho}$ when $n = 1$, and $11{\cdot}1\,\frac{B^2 f^2 l^2}{10^{16}\rho}$ when n is much greater than unity.

Comparison of Experiment with Theory.

In Table I. the formula $3{\cdot}95\,\frac{B^2 f^2 l^2}{10^{16}\rho}$, multiplied by the volume of the half cylinder, is used, in which B is the maximum average value of the intensity of magnetic induction given by coil No. 4. It will be seen that experiment gives a lower value for the total watts in the half cylinder than the formula, and this is to be expected from the wave-form.

At 45 seconds periodic time and maximum average induction density for No. 4 coil 5,900, the ratio of the watts given by theory and experiment is 3·15, which is much larger than the average. The explanation is that the magnetic induction is crowded to the surface of the cylinder, and as the wave-form for this portion is more nearly rectangular the result is to make the watts given by experiment relatively smaller. At periodic time 90 seconds we see the same influence at work when maximum average induction density given by coil 4 is 6,700. On the other hand, there is no great difference between the results at 360 and 45 seconds periodic time with approximately uniform distribution of the intensity of magnetic induction.

Alternating Magnetic Force.

Fleming gives the expression $0{\cdot}616\,\frac{B^2 f^2 d^2}{10^{16}\rho}$ in a uniform magnetic field for the watts dissipated by induced currents per cubic centimetre of a cylinder to which an alternating magnetic force is applied whose direction is parallel to the longitudinal axis of the cylinder. The diameter of the cylinder is d centimetres, and the other symbols represent the same quantities as before. This formula for frequency 129 and $\rho = 13 \times 10^{-6}$ ohms is approximately verified by experiment. The following results were obtained with a cylinder of mild steel 4in. (10·16cm.) diameter, and have been extended to the case of a cylinder 0·1cm. diameter on the assumption that similar electric and magnetic events happen in cylinders of different diameters at times varying inversely as the square of their diameters:

Maximum average B at centre of cylinder.	Maximum average B over whole cylinder.	Frequency with the cylinder 10·16cm. diameter.	Ergs per cycle per cubic centimetre.	Frequency with a cylinder 0·1cm. diameter.	Watts per cubic centimetre of a cylinder 0·1cm. diameter.	Fleming's formula $d = 0{\cdot}1$cm.
7,690	6,888	1/80	3,820	129	0·049	0·037
15,000	17,050	,,	26,200	,,	0·338	0·222
1,630	4,710	1/20	2,750	516	0·142	0·282
15,500	20,000	,,	54,500	,,	2·810	5·07

Turning from round wires to plates, in which the cross-section normal to the lines of force has a length great as compared with its thickness, Fleming, Steinmetz, and Thomson agree in giving $1{\cdot}66\,\frac{B^2 f^2 t^2}{10^{16}\rho}$ for the watts per cubic centimetre. A plate would, therefore, dissipate nearly 2·7 times as much energy in a given time as a wire having a diameter equal to the thickness of the plate.

(To be continued.)

LIGHTING AND DRIVING TEXTILE MILLS BY ELECTRICITY.*

BY MARSHALL OSBORNE, ASSOCIATE.

The application of electricity to the majority of the manufacturing industries has long passed the experimental stage, and is an established commercial success. This applies equally well to the textile industry, although very little progress has

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers.

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been made in this direction in this country. While this may appear to indicate lack of enterprise on the part of our textile manufacturers, and, to some extent, this is undoubtedly the case, it should be borne in mind that in most countries where the greatest progress has been made in this connection, the conditions obtaining are more favourable to such progress than with us. There are in this country a large number of new mills being erected which are arranged for a mechanical drive, although they are, for the most part, if not always lighted electrically. I propose to bring to your attention to-night some facts and figures showing what has been done in other countries, both in lighting and driving textile mills by electricity.

Lighting.

Until the advent of the enclosed arc lamp, illumination by means of arc lamps was not satisfactory for many of the fine operations demanded in weaving and spinning, and incandescent lamps placed in close proximity to the work were generally used. The enclosed arc lamp, however, where it has been tried, has proved both satisfactory and efficient. Its use has been most general in the textile mills in the States, where many large plants have been installed, which are operating to the entire satisfaction of the millowners. The following information in reference to some of these installations, I trust, will prove of interest. In the Lynchburg Cotton Mills, a new weaving mill, 125ft. by 400ft., of two storeys, has its lower floor most effectively illuminated by 45 five-ampere double-reflector direct-current enclosed arc lamps. Although the columns that support the upper floor are in two rows, 8ft. apart, and there is overhead shafting, connected to the looms by belts, yet the lighting is most satisfactory, each lamp illuminating 1,100 square feet. Work is carried on here equally well night and day, and the millowners are most enthusiastic as regards the advantages of the enclosed arc lamp. In the Berkshire Cotton Mills the weaving-rooms, containing 2,404 cotton looms, belted from below, and 5ft. 6in. high, are lighted by 128 five-ampere enclosed arc lamps. A spinning-room in the same mill, 135ft. by 500ft., with machines 6ft. high, is also effectively illuminated by 58 enclosed lamps. Numerous other examples follow which show the extensive use made of enclosed arc lamps. Thus, the Olympia Mills use 375 alternating-current constant-potential six-ampere enclosed arc lamps, the Buffalo cotton mills use 250 of the same type, the Amory Mills use 260 direct constant-current 6·6-ampere enclosed arc lamps, the Manchester Mills use 262 direct constant-potential five-ampere enclosed arc lamps. Satisfactory results could not have been obtained in these mills with open arc lamps, and the cost of installing and operating incandescent lamps would have been much higher.

The principal advantages which the enclosed lamp offers over the open type are: (*a*) the fire risk is reduced to a minimum, if not entirely eliminated, by the introduction of the inner globe; (*b*) improved diffusion of light, reducing the highly-illuminated zones and increasing the effective illumination over an extended area; (*c*) the light of the enclosed lamp is more constant and less subject to sudden fluctuations due to feeding, etc., than the open type; (*d*) the enclosed lamp is practically free from shadows, a frequent source of trouble with lamps of the open type; (*e*) the light of the enclosed arc more nearly approaches daylight, thereby permitting delicate colours to be matched, and ensuring a uniform product during the entire year.

The principal advantage gained by the use of the enclosed arc lamp over the incandescent lamp is less capital outlay and lower cost of operation, the efficiency of the arc lamp being much higher. These points should receive careful consideration at the hands of those engaged in the lighting of mills or factories, although there are undoubtedly many operations in spinning the finer numbers of yarn and weaving fine damasks where it is absolutely necessary for the light to be immediately over the work. In these cases incandescent lamps are invariably used in a modern mill, two or more, as may be required, being fixed over each loom or frame. In general, it may be said that arc lamps are most suited for work of a comparatively coarse nature, and in connection with which there is undoubtedly a very large field for them. As an indication of the superior efficiency of arc lighting, it may be noted that it has been found by experience that one enclosed arc lamp absorbing 480 watts, fixed at a suitable height, efficiently illuminated an area of 1,100 square feet where the materials dealt with were of a light colour. With materials of dark shades, however, this area is reduced to 600 square feet, but a number of incandescent lamps absorbing the same power would only illuminate half the above-mentioned areas to the same extent.

Power.

The application of electric power to the operation of textile machinery has not, up to the present, made much progress in this country, and, although many striking advantages can be demonstrated in favour of the electric drive, it has not received that consideration on the part of our millowners which in their own interests would seem advisable. The most important of these advantages is undoubtedly the fact that, with the electric system, it is possible to concentrate the whole of the power required for operating an extensive mill, or collection of mills, which are scattered over a comparatively wide area, *into one central power plant*. By this system great economy in working costs, maintenance, and staff is obtained, as by the use of large steam-engines and generators of an efficient type, the generating costs for power are reduced to a minimum; also, one staff only is required, instead of several independent staffs, as in the case of isolated steam plants. But even in the case of a single mill, very material advantage can be demonstrated in favour of the electric drive over the mechanical system by means of belt or rope transmission, as a large amount of shafting and belting can be entirely dispensed with by the use of the former operated from one centrally-situated generating station by the application of motors at the points where power is required. The transmission can be so arranged as to give a very high efficiency, although the question of commercial economy, particularly in the first cost, limits the over-all efficiency between the engine shaft and frames or looms to 70 or 75 per cent., which is a decided advance on the average efficiency obtained with the mechanical system. The usual practice is to divide the shafting on the various floors into small sections, each section of which is operated by a separate motor. This renders the various sections and floors entirely independent of any other section or floor, which is not the case with the mechanical system, where each floor is driven separately by means of ropes or belts through one continuous shaft. Further, the mechanical system necessitates the introduction of a large number of what may be properly called *power-wasting devices*, such as extra belts, cross belts, bevel wheels, and gears of all descriptions, in order that power may be applied exactly where required, in many cases in positions which necessitate drives at right angles to the main drive of the mill. This difficulty is entirely obviated in the electric system. In many mechanically-driven mills the power is transmitted through various countershafts to the final point of application. In some cases as many as six line shafts are belted together, so that all the power required on the sixth shaft is transmitted through the remaining five. This necessarily results in an excessive waste of power and increase of slip. The slip on the first belt is transmitted in an increasing ratio to all the others, until it finally reaches the sixth in a much more magnified degree than where it started at the first.

Some of the principal advantages of electric driving, briefly stated, are: (*a*) sub-division of the various points of application of the power, thus reducing the liability to breakdown and stoppage; (*b*) sub-division of the various floors and sections, so that any floor, section, or group of machines can be operated independent of any other floor, section, or group for overtime or night work; (*c*) short lengths of shafting, ensuring perfect alignment, and thus saving in friction losses; (*d*) improvement in the general lighting by the removal of a large percentage of belting; (*e*) saving in first cost of the equipment of the mill, both in the cost of buildings and shafting; (*f*) extreme flexibility of the system, enabling a mill to be erected in any position relatively to the power operating it, thus ensuring that the mill is erected in the most suitable position from the production standpoint only, the electrical system not introducing any limiting factors, as would probably be the case with the mechanically-operated mill; (*g*) any extensions or alterations required can be made without interfering with production; (*h*) the depreciation and maintenance charges are very much less in the electrical system than in the mechanical.

In order to demonstrate the actual results obtained in practice, the following examples indicating the progress in various countries of electricity applied to textile mill-driving may be of general interest. It will be observed that almost every country engaged in textile manufactures is represented, whereas the largest textile manufacturing country is conspicuous by its absence. The history of the development of the electric drive in the Olympia Mills, at Columbia, S.C., U.S.A., is of striking interest in this connection, and is briefly as follows. Some five or six years ago Messrs. W. B. Smith, Whalley, and Co. erected two cotton mills at Columbia, each for about 12,000 spindles, one being driven by the usual steam-engines belted to lines of shafting, and the other by electric motors, the generating plant for the latter being at a distance from the main building. According to Mr. Smith Whalley, the cost of repairs in the electrically-driven mill is 50 per cent. less than in that of the mechanically-driven mill. It was found in the electrically-driven mill, owing to the speed being maintained at much higher average, that the production was greater in a given time than in the mechanically-operated mill, the actual increase being about 4 per cent. per machine, the quality of the product also being much improved. When the large new Olympia Mills were to be built by the same people, it was decided to put down steam-driven electric generators and drive the machines by motors. The main building measures 553ft. by 151ft., with a couple of towers for stairs and tanks for the sprinklers. Attached to the middle of the rear wall is the machine shop. Close to it, and

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at the rear, is the engine-room and boiler-house, each being 120ft. by 140ft. by 40ft. On the first floor are the weaving looms, and here the bales are unpacked. On the second floor weaving, spooling, warping, and slashing are carried on. On the third floor is drawing, carding, and lapping. On the fourth floor are the spinning frames. For this mill, of about 100,000 spindles, two sets of plans and estimates were prepared. One embodied electric transmission of power, the other mechanical. The estimates for the electrically-driven mill were found to be the cheaper, in that it was possible to (*a*) reduce the cost of the building 10 per cent.; (*b*) reduce the cost of shafting 61 per cent. (the largest size being 3in. in diameter for some few lengths of 12ft., the majority being 2⅞in. diameter); (*c*) reduce the cost of belting and ropes 66 per cent. The above saving more than compensated for the first cost of the electrical plant.

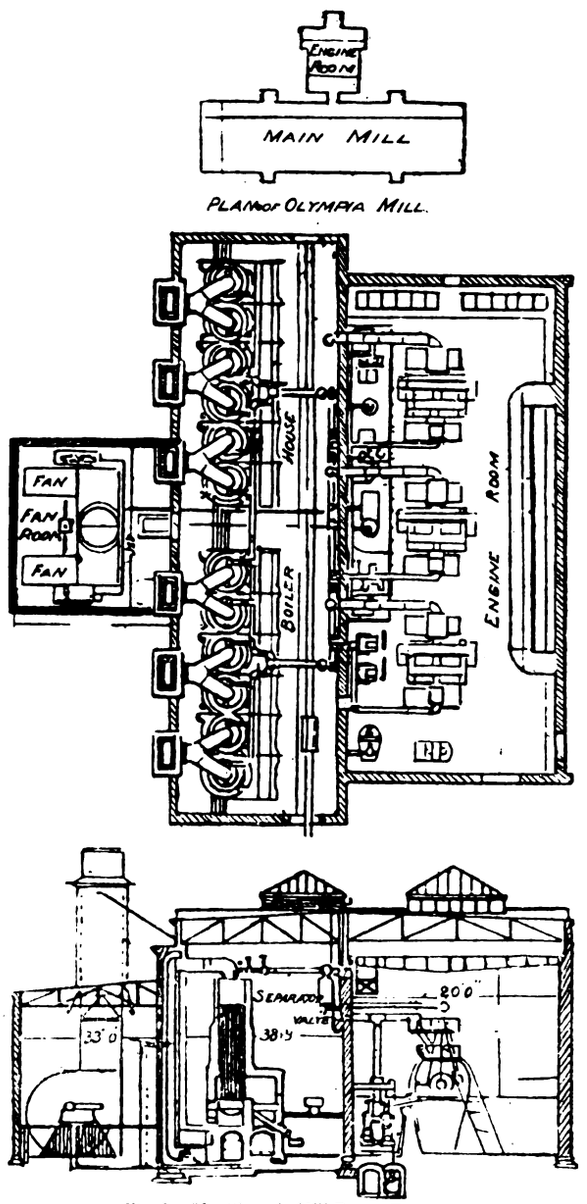

FIG. 1.—The Olympia Mill Power House.

The illustration (Fig. 1) shows the plan and elevation of the power-house, which is designed for a maximum capacity at full load of 4,800 i.h.p., divided into three units of 1,600 i.h.p. each, at a speed of 123 revolutions per minute. The engines are of the compound type, having cylinders 20in. and 48in. diameter, with a stroke of 42in., and a steam pressure of 168lb. per square inch. These engines have a guaranteed steam consumption of 12·7lb. per indicated horse-power per hour. The generators are of the three-phase type, having 36 poles, of 1,300 kw. capacity at 600 volts, and are direct connected to the above engines. The exciting current is obtained from a vertical marine-type direct-connected steam set of 75 kw. capacity, which is also utilised for lighting purposes when the main engines are shut down. As a stand-by to the above, a direct-current generator of 75 kw. capacity, driven by an induction motor at 600 revolutions per minute, is provided. The motors driving the mill are 22 induction motors, each of 150 h.p., 550 volts, and 588 revolutions per minute at full load. They are suspended from the roof, and generally are direct connected in the centre of a 12ft. shaft. Where the machines require very slow speed, counter-shafts are used, as in the case of looms and carding engines. Six induction motors of 20 h.p., at 800 revolutions per minute, operate four pumps and two hoists. Another motor of the same size is used in the opener room, and still another in the machine shop. For driving the cloth looms a 50-h.p. motor is installed. The maximum requirements of the mill will be 3,600 h.p., leaving the balance available for other purposes, one of which is the driving of the Capital City Mills in the city of Colombia. A point of mechanical interest is the low stack, 10ft. in diameter, the draught being obtained from two 14ft. fans driven by electric motors. This mill is taking 3,000 h.p. from electric generating plant three miles distant. The illustration (Fig. 2) is a good example of the use of motors suspended from the roof beams. In the Anderson Cotton Mills the

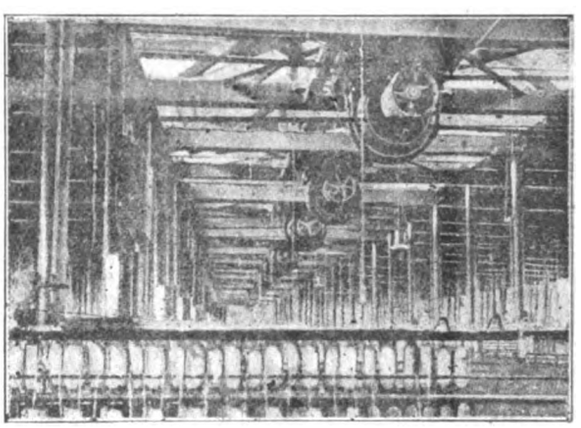

FIG. 2.—View of the Spinning Room of the Pelzer Manufacturing Company, South Carolina, U.S.A.

motors and generators are 10 miles apart. The point to be noted is that no belt or auxilary shaft comes between the spinning frame and water-wheel.

Another good example of electricity driving a textile mill is at Montreal. Two mills—Hochelaga and St. Anne's—in the autumn of 1898 were driven by steam-engines. The Hochelaga had three engines. Of two of these one was 28 years old, and the other in a quite good condition. The St. Anne's mill was being extended, and instead of having new

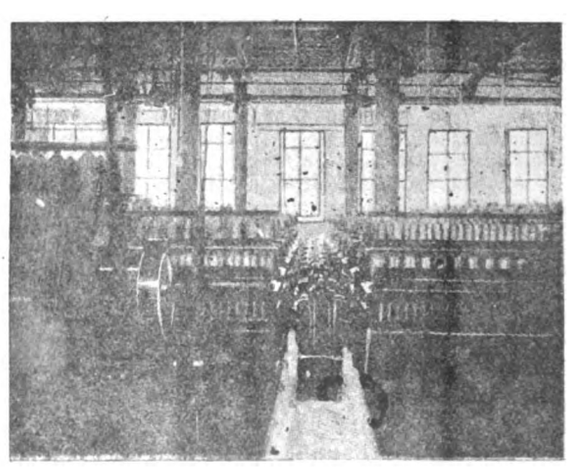

FIG. 3.—Spinning Room, Anderson Cotton Mills, South Carolina, U.S.A.

steam-engine power, the owners decided upon electric motors for driving the mills. They obtain power from the Montreal Royal Electric Company, involving transmission from Chambly, 17 miles distant. The question of using induction or synchronous motors was discussed, and the supply company strongly advocated the synchronous type of motor to ensure the company having a good power factor. However, owing to the difficulty of starting these on load, and troubles with the clutch heating, so as to cause sparks, they were not used. Ultimately induction three-phase motors were installed, which overcame these difficulties. Four floors are driven by them. The weaving-room has 300 h.p., the carding-room has 200 h.p., the spinning-room has 300 h.p., and the mule spinning-room has 150 h.p. The motors and the stairway are contained in a tower built for them, and a belt connects each motor with its mill shaft. On the fourth floor there are four 60-kw. transformers (one as a stand-by) for reducing the pressure from 2,200 volts to 50 volts, or 100 volts, as required for about 100 h.p. in small motors.

To show the development of the electric drive in Belgium the following is a brief description of the Spinning Company's

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Mills, La Louisiane, at Ghent. From the plan (Fig. 4), it will be noted that the mill consists of several separate adjacent buildings. These are the outcome of gradual extensions. Four buildings made up the mill La Louisiane, each of which was a complete unit with one or more steam engines. The engines were small and old, and the power transmission losses were great. The many engines were costly, complicated, and inconvenient to maintain, and involved much supervision. Owing to recent developments, the mill had to be extended, and a fifth building added. Thus a new steam-engine of 1,500 h.p. was put down in a central power-house. It drives a three-phase generator at 400 volts, and a frequency of 40 cycles per second. As soon as this was working, three engines were shut down in three buildings, and the machines operated by electric motors. The power-house is arranged for two three-phase generators of 500 h.p. each, at 200 revolutions per minute. All the motors are of the three-phase induction type. There are installed either on ordinary foundations or suspended from the roof, as the conditions of each case demanded. For lighting purposes, when the engine is shut down, a storage battery was installed. Two belt-driven direct-current generators are necessary for charging the battery, and are arranged so that they can be driven by direct-coupled induction motors at some future date.

A good example of a weaving factory completely driven by small motors is that of Messrs. Gavazzi, in Milan; 336 looms are driven by ¼-h.p. three-phase motors. In such a case a very high power factor is not to be expected. In their older factory at Desio a two-phase plant was installed six years ago for lighting, as they then feared bad regulation with three-phase generators. Messrs. Gavazzi have found great uniformity in the motion of motor-driven looms, especially when gearing is used, compared to the older belt driving, which allows during a turning or cycle of the loom a series of variations in the speed. They use both incandescent and arc lamps for lighting, and consider that the three-phase system gives very satisfactory results.

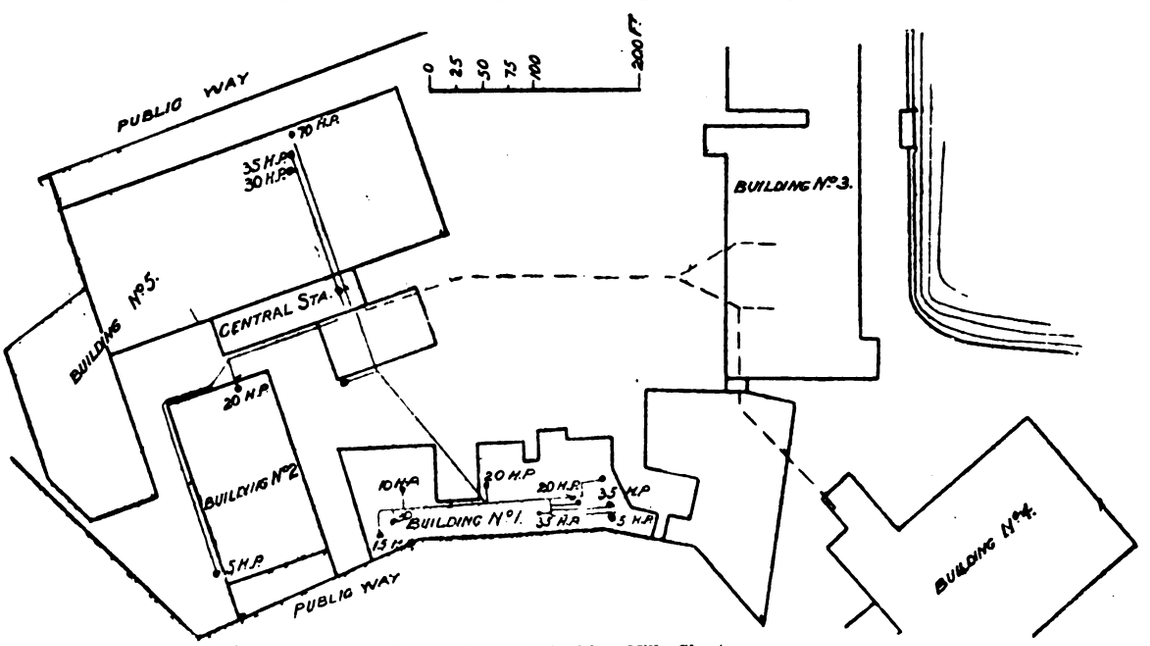

FIG. 4.—Plan of La Louisiane Mills, Ghent.

The following indicates recent developments in Russia: the Prescheroff Factory, at Moscow, is a large mill, driven by motors and steam-driven generators. The central station is about 1,000ft. from the buildings requiring the power, and bare overhead conductors are used to carry three-phase current at 350 volts. Two large generators driven by steam-engines were installed for power, and one small set for lighting. The two larger machines were 1,574 kw. and 970 kw., with 1,800-h.p. and 1,200-h.p. engines respectively, and run at 75 revolutions per minute. There are about 265 motors in the factory, varying in capacity from ½ h.p. to 200 h.p. Separate motors are used for each frame in the spinning mill, which has a capacity of about 48,000 spindles, in the weaving-rooms with about 800 looms, and in the chintz factory with about 21 machines printing from one to twelve colours. The total power generated is about 2,000 kw., with a power factor of ·8. The spinning mill takes 850 kw., the weaving-rooms 200 kw., and the chintz factory 950 kw.

The Voslauer Kammgarn Factory, at Voslau, in Austria, use electricity for both lighting and driving their mills. Their lighting equipment is so arranged that each steam-engine drives one or several generators, so that all rooms can receive both light and power from the same source. The cellars are lighted by a separate dynamo. Light for the offices, after the regular working hours, is supplied by a storage battery, which also supplies light for different places in the factory. Light can also be had from this battery in case of a breakdown, and for repairing work executed during the night. Arc and incandescent lamps are used, which are distributed according to the nature of the work. For lighting purposes direct current of 110 volts is used. The electric transmission installation supplies the newly-erected and more distant parts of the manufactory with power, and also serves to drive elevators. The transmission is by belt, driven by 50-h.p. and 100-h.p. motors. Three-phase current of 350 volts pressure is used for power work.

In May, 1900, before the Southern Cotton Spinners' Association, Mr. S. Paine, of Boston, U.S.A., pointed out that only a year previously about 13,000 h.p. of electric motors were used in textile mills in the States, whilst at that date about 30,000 h.p. were in actual service and on order. This very clearly indicates the enormous development of electric driving of textile mills in America. On the same occasion Mr. Paine pointed out that nine large textile mills had electric generators driven by steam-engines to furnish electric power for motors. The horse-powers in each mill varied from 600 to 5,100. At the present time one electrical manufacturing company alone has installed 40,000 h.p. of electric motors in textile mills in the U.S.A. On the Continent, Russia and Italy have the largest and most numerous electrically-driven textile factories. Those in Italy total, roughly, about 9,000 h.p., and vary from 120 h.p. to 2,000 h.p. each. Some of the Italian mills are driven by a few large motors, and others by numerous small ones. The same is true of Russia, with, roughly, 8,000 h.p., varying from 300 h.p. to 2,600 h.p. per mill. In France the mills vary from 100 h.p. to 250 h.p.; in Germany, from 250 h.p. to 450 h.p.; and Austria, 500 h.p.

From the above it will be noted that the electrical operation of textile mills is most highly developed in America. Although on the Continent a few examples are found in nearly every country, the United Kingdom alone has not shown any great tendency to adopt this power for textile work, though signs are not wanting that our textile manufacturers are becoming alive to the needs of adopting electricity in driving their textile mills if they are to maintain their supremacy in the textile field.

LECTURE ON ELECTRIC CAR DRIVING.—II.*

BY E. W. ELSLEY.

We will now turn to the equipment proper, but in doing so do not let it strike you as a fifteen puzzle kind of thing which you have before you, or that obstacles of any magnitude are to be surmounted; if you do, you will inflict upon yourselves an injustice quite uncalled for. But so that you shall not be entirely at a loss what to do if anything goes wrong, we will show you the path of the current to and from the car. To simplify matters, we will call it the inlet and the outlet. You need not bother yourselves as to what this new power—the current—is; suffice to say it must have a road or pathway laid for it, if we will have it do its work properly; and the outlet is as important as the inlet, if we are to attain this end.

* A lecture to be delivered to horsemen, enginemen, and the novice on their first attendance for tuition in electric car driving.

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Starting at the top of a trolley car, we find the trolley head (Fig. 1)—this is a contrivance which may appear to you as part whip socket or pump ram—and a grooved or fluted pulley wheel. The latter is generally shielded at the sides, so that it can the better clear itself should it jump the wire. This wheel gathers the current by running on the underside of the trolley wire; the path then is to the pivot pin (Fig. 2), which holds it to the socket: this is slipped over the end of the pole or boom, which is in reality a pipe, and contains the cable, the end of which is brought through the small hole nearest the trolley wheel, and is held in position by a washer and nut being put upon the threaded terminal (Fig. 2), so that you see when the wheel is on the wire the cable is also in contact, and the current

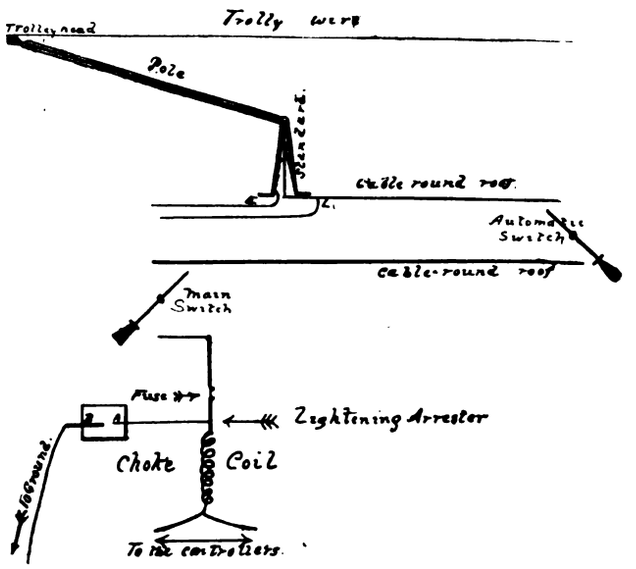

FIG. 1.

can only get off the head at the terminal in consequence of a rubber sleeve being placed between the socket and the pole proper. In some cases the terminal does not come through the socket of the trolley head, but is held at the end of the pole by washer and nut just through a second sleeve, in which case the head is placed over all, and is merely held on by the bolt which goes through on the underside of the socket (Fig. 2). (This I think a capital idea, for if the head should get foul in the overhead work it is more easily pulled off, and without damage to the latter.)

The cable then comes down through the pole, standard, and along between the ceiling of the lower saloon and the floor of the upper, or roof, to the automatic switch at No. 2 end of the car, back along the other side to the switch at the other end, then on down a corner pillar of the car body to the main fuse (Fig. 1). These overhead switches are generally placed under

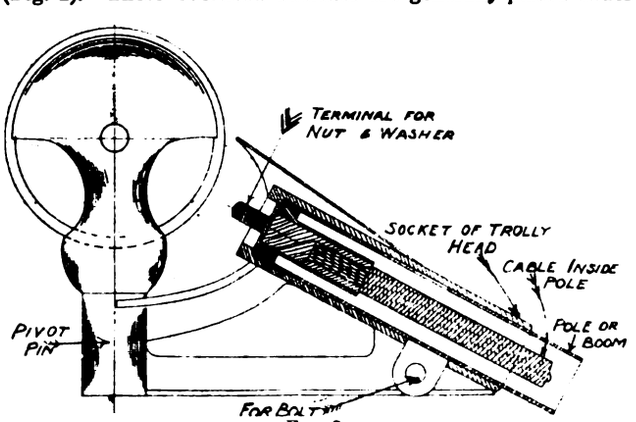

FIG. 2.

the canopy, and are sometimes spoken of as hood or canopy switches. They are placed in that position so that "there shall be an emergency switch within convenient reach of the driver that he may cut off the current in case of any failure of the controller switch," so that if, when running along, you cannot knock off in the usual way, you must knock out the overhead switch. There is a difference between these two switches, for while that at No. 1 end will remain where we put it, that at the other—being a safety device—will give out or blow off should the current be too much for it to carry; somewhat similar to the safety valve on a steam-boiler—hence automatic. The driver, if foolish enough, can also cause it to blow out by his rough handling of the controller, or what we call feeding up too quickly, so that there is really nothing gained in this case by flogging any more than if you had your horses, or the locomotive. But, quite apart from this flogging, if the switch has been properly set, and yet should blow out, it is a sure sign that there is something wrong with the car equipment, and under such conditions the best plan is to try on each motor separately, and when the car travels with one cut out, you may rest assured that you have found the defective one, and the sooner the exact wrong is found out the better. It may be only the brush hammers left up, and which you can put down, and the car may go all right, but do not attempt to remedy or meddle with any particular thing unless you know what to do and how to do it. The best thing is to get the car out of the way of the others, as there is not

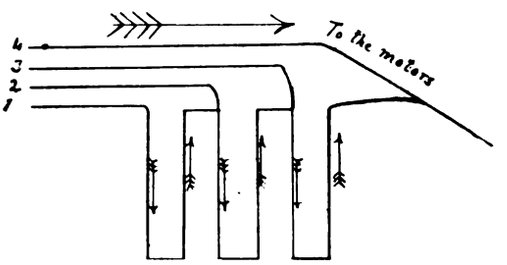

FIG. 3.—Resistance.

much time for experiment in these large towns, for the service cannot be played with. The chief thing is to keep them going, and not give a chance to the ratepayer whose real grievance, perhaps, is that the wrong man got into the Council-chamber last November.

From the automatic to the switch at the other end of the car, and on to the fuse. This also is a safety device, but is arranged to carry more current than the automatic before it gives out, yet it is likely to give out from similar causes. The path is then on through the choke coil to the controllers at each end of the car. The choke coil is somewhat related to the lightning arrester, shown just above it, for as the man who zig-zags across the field is longer in getting to the goal than he who goes straight, so also is the flow of current steadied and held back by the coil, which will only allow it to pass at a certain rate. The lightning arrester is, briefly, two terminals within a certain distance of each other. One is connected to the ground or earth wire (the outlet), the other to the main cable (or inlet). Now, should the lightning strike the trolley,

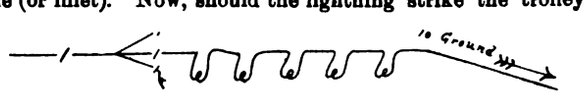

FIG. 4.

or the wire near the trolley, and make a rush down our cable, and if it should pass the automatic switch and fuse without either of them giving out, the additional pressure may damage or injure parts beneath, but on its reaching the choke coil it is held back, like a lot of us tram men making a rush through a narrow passage to the pay table, with just this difference, that while we should have to wait our turn, the current, being a bit impatient, chokes back, and leaps across from A to B, and so to ground, its outlet (Fig. 1). My object in telling you this is not with any idea that you can do anything to it on the road, but there is now sufficient false knowledge getting abroad, that an electric car is a dangerous thing to be in or near during a thunderstorm. I think I have shown that it is as safe or better protected than the steeples and chimney stacks which are furnished with lightning conductors, and if this is clear, then, at such times you are in a

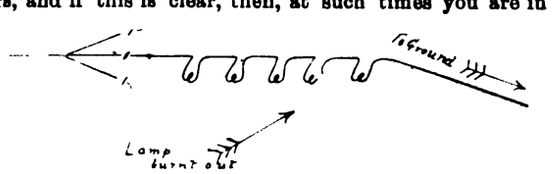

FIG. 5.

position to allay any fears or alarm which may arise among your passengers.

From this point to the controller, which is *the* piece of mechanism of the whole equipment, delicate in a sense, but *safe* in *safe hands*, any rough usage or carelessness very soon means a lot of expense, and it is one of those many things which speaks for itself. It is useless one saying "I did this," or "I did not do that," for very likely it will contradict you, as anyone "in the know" can sit as a passenger in your car with his back toward you, and yet tell at once if you bring the power handle from one point to the other too quickly. One can be half a mile away and yet tell if you bring the motors into parallel sooner than you ought to have done; can be even a mile away and see if you run through a circuit

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breaker in the overhead work without knocking the power off at the controller; so that you see it is little use saying "I didn't," for, as the Yorkshire saying goes, "that which cannot speak, cannot lie." There's a bit of a paradox somewhere around this, but I will leave it for you to sort out at your leisure. The moral however is plain: "speak the truth, even if it expose a fault"; for if "to deny a fault doubles it," it appears to me that to admit it, must half undo it again. I know I ought not to attempt to cram you, as it were, and for that reason we will just explain the locking arrangements of the controller and pass on. The front cover is off, and under the top plate or dial you may see a small bolt, which is actuated by the small reverse handle, while in the sprocket plate or wheel is the hole which the bolt fits into; this in turn is moved by the large or power handle, and when in the off position the hole is opposite to and receives the bolt, if the small handle is also put to the off; so that the one locks the other, and not until this is done can the handle be taken away. To the engine driver "off" on the reverse switch is about on a par to "out of gear" on the locomotive reversing lever—in fact, I often catch myself using those words instead of the "off."

On the other side of this switch we see a small roller bolt, which is pulled in between the segments of the sprocket by a wire spring, and this is all we have to pull against in striking the notches on the dial above, so that it is clearly not a strong pull that is required, but care and attention—in fact, if you will but *allow* this spring to do its work, you cannot miss making a proper connection with the switch; but if you do not, then the fingers cannot properly meet the contacts on the barrel or drum, and arcing takes place by the current leaping across from one to the other. Arcing is flashing or sparking—in short, it is fire, and, as you are aware, fire means heat, and heat means the melting or fusing away of the contacts. Through such carelessness I have known them to melt away like toffee in a summer sun, so to avoid this we give you practice on the handle of a car

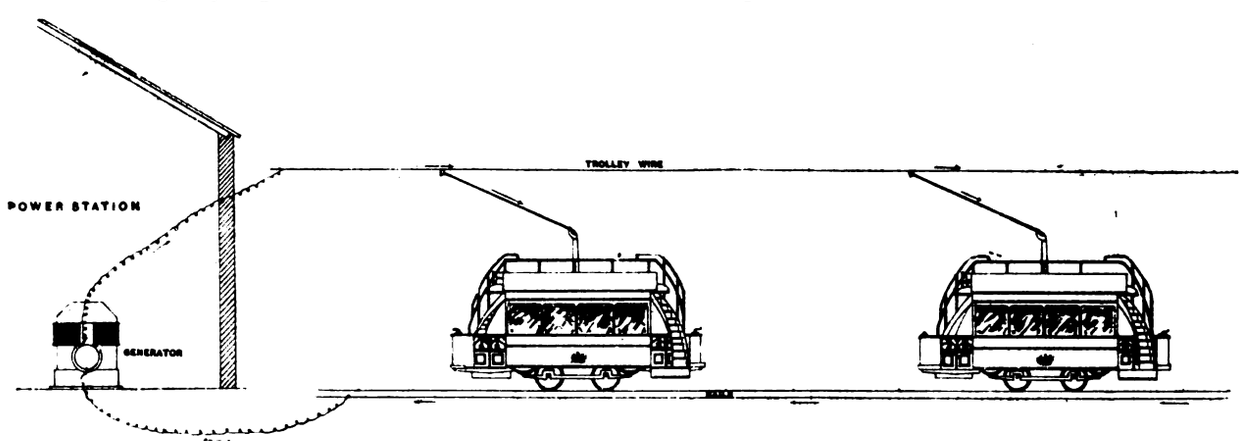

Fig. 6.

standing in the shed with the pole off the wire. The motor cut-outs are for you to prevent the current going to a motor should anything be wrong with them. The solenoid, or magnetic blow-out, is provided to put out the arc made when breaking the connection—*i.e.*, knocking off; but for this contrivance a controller would last some drivers about an hour, as the arc and heat are very injurious indeed.

The resistance (Fig. 3) is put into the circuit to hold back or steady the flow of the current when on its way to the motors. The sketch does not give you the actual amount of resistance, but just sufficient for our purpose—*i.e.*, to show you what takes place in first starting the car. When the controller is put upon the first notch, the current takes the cable marked 1, on the second it commences at 2, and on the third at that marked 3, and when the fourth is reached the current goes straight to the motors, without going up and down those side streets, as it were. So you see that by gradually bringing the controller round notch by notch, you shorten the distance the current has to travel, and it gets to its work the sooner. The resistance is composed (in our case) of sheet asbestos and very thin sheet soft iron, built into walls or panels, and the current is taken to them by the cables which you see leaving the back end of the fingers in the controller, and this enables us to start the car gently and without a jerk.

Running along under one of the seats inside the car, from one controller to the other, is the ground or earth wire (the outlet). This is connected by T joints to both the motor cases, and these are hung on to the suspension bars, which are supported by the truck sides. These span the axle boxes which contain the axles, and in addition to playing their respective parts mechanically, they also conduct the return current to the wheels, and these to the rails; and the rails you see by Fig. 6 are connected to the machine at the power-house. Now, every conductor—that is, everything about the car which uses or which may be called upon to use current—is branched into or joined to this earth wire, so that when it has done its work in either motors, lamps, trolley leakage, etc., pass through it on its way out.

We must turn back for a moment to the main cable (the inlet, Fig. 1), as just below the trolley standard is a small lighting cable, marked E. This is tapped into the standard proper, so that it may convey any leakage of current from the head or main cable to two lamps, one at each end of the car, which in our case are placed just above the guard's bell-push; and if these lamps light up it denotes the leakage, and the car is then said to be "alive," and must be taken to the shed, as it is not safe to carry passengers on the outside for fear they get a shock. On the right of the cable just spoken of is one marked L. This, you see, is tapped into the main cable, and conveys current to the lamps which light the car. Our sketch (Fig. 4) shows a main light switch feeding a crowsfoot-like junction, and each of these cables take the current through a switch (when on) to their respective five lamps and passes on through them one after the other (series) to the ground, or outlet. Should a lamp burn out, the whole five of that series will go out, and the real offender has to be sought. Most frequently the filament inside the lamp is broken, and something like Fig. 5 is the result. The reason the whole five of them go out is simply because the first four have no outlet for the current, and the other has no inlet.

In closing, we think it well, for a few days at least, to sandwich this discourse in with your practice on the handles, and after a little repetition I think we may reasonably expect that you will be able to tell us something about it. You are at liberty to copy anything, either writing, the printed matter, or the rough sketches, hanging about the room. There are no trade secrets in car driving here. Our management is inclined to the belief that the more we can teach you here about it the less we shall have to do for you when on the road, so do not be afraid to ask questions.

We next take you for a look around the car proper, explaining everything we have spoken of, together with things we have not spoken of, which include the hand brake, ratchet and pawl, and when it requires adjusting, the pedal gong, sanding arrangements, and show you how to use them; also the cable when the car is off the road, or on dirty rails. When we feel that you understand what we have been talking about, and when you can strike the notches on the controller, you are taken then upon the school cars in the street, when you will be shown how the electric brake is operated, how to tell when the current is taken from you, or the pole off the wire; and when you convince us that you can, and will, do as you are told, and at the very moment you *are* told, then we trust you on a service car with some of the best and most obedient of our drivers, men who realise that their part (although considerably smaller) is almost as important as that of the engineer or manager, if this new system is to be a success.

Greater authorities than I have, very justly, admitted that it lies very much with the drivers and guards whether this thing is to be a success or not. How say *you*, gentlemen of the whip, and gentlemen of the waste, "Aye" or "Nay"?

APPOINTMENTS VACANT.

Switchboard Attendant, Carlisle Corporation, 25s., Aug. 18. See advertisement.

Assistant Engineer, Edinburgh Corporation Electricity Supply Department, £100 per annum, Aug. 22. See advertisement.

Ticket Inspectors (4), Huddersfield Corporation Tramways, 30s. per week, Aug. 18. See advertisement.

Cable Jointers (2), Poplar Borough Electricity Works, 9½d. per hour. See advertisement.

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CONTENTS.

Notes	217	Field-Magnet Construction	236
Notes on the Testing of Tramway Motors, and an Investigation into their Characteristic Properties	222	Electricity Supply Stations in South Africa	236
The Dissipation of Energy by Electric Currents Induced in an Iron Cylinder when Rotated in a Magnetic Field	226	Bristol Accounts	237
Lighting and Driving Textile Mills by Electricity	228	Nottingham Accounts	238
Lecture on Electric Car Driving.—II.	231	Croydon Accounts	238
Appointments Vacant	233	Glasgow Telephones	238
Infantile Insurance	234	Questions and Answers	239
Correspondence	235	Legal Intelligence	242
Sparkless Commutation: How to Obtain It	235	Companies' Meetings and Reports	242
		Contracts for Electrical Supplies	244
		Traction Notes	245
		Lighting Notes	247
		Provisional Patents, 1902	250
		Traffic Returns	252
		Companies' Stock and Share List	252

TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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INFANTILE INSURANCE.

It has been clearly shown by the evidence brought before the assizes and police courts in the United Kingdom that only too frequently insurances effected on the lives of infants are wrongly termed life insurances, and really become, in far too many cases, assurances of death. The process of securing the insurance money is exceedingly simple, and it is not difficult to so lengthen out the period of starvation that culpable negligence can only with difficulty be proved against the parents or guardians of the ill-fated youngsters. Recognising the fact that it is much easier to kill an infant than a grown man, Sir George Livesey, the chairman of the South Metropolitan Gas Company, has this year effected what he hopes will be a death assurance on two municipal electric light undertakings who wish to supply electricity within the area of the above-mentioned gas company. It is true that the starvation period may be survived in each case, but the object is equally clear. As explained to the meeting of the above company on Wednesday, through the efforts of their chairman clauses were inserted by the House of Lords Committee this year in the Bermondsey and Woolwich Electric Lighting Acts which are meant to prevent the rates being used to make up any deficiency in the electric lighting accounts. The clause provides that after the first year an estimate is to be made of the probable total expenditure for the ensuing year. The charge for electrical energy is then to be such that, as far as is reasonably practical, the revenue of the year shall not be less than the expenditure of that year. This would seem to be at first sight a most reasonable procedure. It is even now the custom in the great bulk of municipal electric light stations for the electrical engineer to present to his committee a report on the prospects for the ensuing year and on the alterations, if any, he recommends in the rate of charging for electric energy. When, however, a reduction in the cost of the electrical energy to the private consumer is recommended, the effect of this reduction on the balance-sheet can only be a matter of estimate. The increase in consumption due to the decrease in price does not follow fixed laws capable of accurate calculation, and with the rapid growth of electrical undertakings, the estimated revenue at the lower rate becomes of the nature of a prophecy. Obviously, with new undertakings, it is to the advantage of all concerned that the reductions in price should be promptly made, in order that as large a number as possible of the ratepayers may be induced to share in the advantages of the electric light for which they are financially responsible. It also follows that the total expenditure as worked out in cost per unit is bound to be high in the first few years of an undertaking, owing to the undue proportion of stand-by charges on a system only partially loaded. It follows, therefore, that a liberal policy is to be recommended in fixing the charges in new work, and it is absurd to suppose, as the House of Lords Committee evidently did, that the undertaking will in all cases reach a stable state after the first year's working. If the scheme has been properly engineered, enough mains will have been laid down to meet the demand in the principal streets for ten or fifteen years at least, and the interest and repayment charges on these come abnormally heavy in the first few years' working. In this respect the private company has an enormous advantage, as it is under no obligation to pay interest, nor as a rule, does it do so during the first years of its commercial work. A municipal corporation has no such option, and usually has to commence the payment of interest and the repayment of capital before its machinery has turned round. In consequence the undertaking accumulates a deficit for the first year, which only in

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exceptional cases can be wiped out by the revenue. If the history of the most successful municipal electric light undertakings is looked up, it would be found that the charges for electricity were reduced before these deficits were cleared up, and that as the undertakings grew there was no difficulty in wiping off the arrears. If the Lords Committee clause is rigidly enforced it will hinder progress, but it seems to us that the words "reasonably practical" will do much to prevent the obstruction to a liberal business policy. Sir George Livesey in his speech instanced two electric light undertakings owned by municipal authorities as requiring and taking aid from the rates. The first of these commenced work in June, 1901, and the other in the autumn of 1899. They are therefore infants still, although they are older than the two undertakings whose feeding-bottles have been obstructed by the above clauses. We should still be prepared, however, to guarantee that they will reach the successful age which will make them formidable opponents of their gas rival.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE STANDARDS IN EWING'S HYSTERESIS TESTER.

SIR,—In the testing of iron or steel stampings for hysteresis by means of my hysteresis tester, the hysteresis of the sample is found by comparison with two or more standards whose hysteresis is known. Experiments which have recently been made here lead me to doubt whether in all cases the standards maintain their quality so well as I have hitherto supposed, and it now appears desirable that users of the instrument should see that the values of the hysteresis which they assume in their standards are checked from time to time. If this precaution is taken, the apparatus may be relied upon to give consistent and accurate results. I would advise users of the instrument, if they have not recently had their standards re-tested, to do so.—Yours, etc.,

J. A. EWING.

Engineering Laboratory, Cambridge, Aug. 11, 1902.

SPARKLESS COMMUTATION: HOW TO OBTAIN IT.

BY F. W. DAVIES.

In earlier days a dynamo or continuous-current motor that would give its specified output without actually breaking down was regarded as a satisfactory machine. Some of the machines made in those times no doubt possessed excellent commutating properties, but some did not. Certain it is that the causes of sparking at the brushes were not as clearly and fully understood as they are to-day. At the present time, the attention of dynamo and motor designers appears to be largely centred upon the problem of sparkless commutation In fact, no other point in the design of continuous-current machines has received of late years such close attention. This is as it should be, for the theory of dynamo design has been for some time fairly complete, excepting in this particular. Many interesting and instructive articles have been written on this subject, which, indeed, is one that well repays study. It is a subject possessing the intensest interest for every thoughtful electrical engineer, and it may now almost be said to be a science in itself, involving, as it does, the theory of armature reaction. When the theory of commutation is thoroughly understood, it is as easy to design a machine that will be absolutely sparkless up to a given limit of output as it is to design one to run at a given speed when working at its specified pressure. The importance of this will be at once evident to anyone who is at all conversant with the designing and manufacture of continuous-current machinery.

An immense amount of ingenuity has been brought to bear on the problem of sparkless commutation, a fact which is evidenced by the records of the Patent Office, if by nothing else. Designers and inventors in working on this problem have followed two different methods. The designer has endeavoured, after a careful study of the conditions which tend to cause sparking, to eliminate—or, at least, to minimise—those conditions. He has trusted mainly to modifying the design of the machine in accordance with the results of his past experience; and in doing this he is perfectly right. The inventor's method, on the other hand, has been to devise new methods of construction. Special armature windings, special windings on the magnet poles, and special-shaped magnet poles have been brought out galore. It is, of course, preferable, as far as is practicable, to trust to suitable designing—that is, to use suitable proportions of armature, field magnet, etc.—rather than to use these special commutating devices, as the adoption of the said devices complicates the machine, besides rendering it more expensive in manufacture; and, as already mentioned, it is quite possible to attain sparklessness without the use of these special methods of construction.

It is purposed to deal here with those points in ordinary designing by attention to which it is possible to obtain good collection, rather than with any special methods of construction invented for the purpose. A good idea of these latter can best be obtained by a perusal of some of the recent patent specifications. It is not the intention of the writer to enter upon a discussion of the theory of commutation, as this has already received a large share of attention from electrical engineers, and it were redundant to traverse this ground again at the present time. However, there are some who, having neither the time nor the inclination to study the question of sparkless commutation in all its bearings, may yet be sufficiently interested in the subject to read a short digest of the principal points which must be attended to in designing a machine for sparkless running. This article will be of an essentially practical nature, being intended, as it is, for practical men. It is purposed to give a simple and dogmatic statement of the leading features in a dynamo or motor which tend to sparklessness.

There are several points which must be attended to in order to design a machine that will run sparklessly at all loads. It is of importance that each of these points should be seen in its true proportion, and treated accordingly. It will not do to attend to some of them and ignore the rest, for this will result in an unbalanced design. The parts of a machine which either directly or indirectly influence its commutating properties will be dealt with as far as possible in the order that they have to be considered in ordinary designing. They are: the armature core, the armature winding, the air gaps, the pole-pieces, the magnet winding, and the brush gear.

The next thing to do is to consider the way in which these affect the commutation. Practically, the first thing that a designer has to attend to in getting out the design for a new machine is the armature core. In the first place, it may be stated that a machine with a drum armature is less liable to give trouble than one with a ring armature, other things being the same. Then, again, it has long been recognised that a toothed core does not, generally speaking, give such good results at the commutator as a plain core; and an iron-clad core is worse still. Notwithstanding this, toothed cores, especially toothed *drum* cores, are largely used at the present time, as they give a shorter air-gap, and offer better mechanical construction; also the loss due to eddy currents in the active armature conductors is considerably less. When the field magnet has four or more poles, a toothed armature core may safely be used. An iron-clad core should never be used for a continuous-current machine, its true use being for certain types of alternators; also for alternate and polyphase current motors.

That it is well to have as few conductors on the armature as possible, is a fact that is well known to electrical engineers. To design a machine, however, with a weak armature winding and a strong field-magnet winding—although good as far as a sparkless design is concerned—increases the cost of the machine, and therefore cannot be

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done to any great extent. Another point in the armature winding affecting commutation is the number of coils or sections into which the winding is divided. The greater the number of coils, and consequently the less the number of turns per coil, the better will be the machine in this respect.

One of the most important points for consideration in connection with the present subject is the air-gap. Upon the length and area of the air-gap depend many of the other points which affect commutation, and its importance should not be under-estimated. Briefly stated, it may be said that the longer the air-gap and the smaller its cross-sectional area, the better will be the commutating properties of the machine. A reduction in the area of the air-gap is obtained by reducing the arc subtended by the pole-piece, not, of course, by reducing the length of the pole-piece parallel to the shaft. Not only does this reduction of the polar arc tend to sparklessness for a given fixed position of the brushes, but the angle through which the brushes may be moved without causing sparking is increased, an advantage which should not be lost sight of. It is well, however, for other reasons not to reduce the polar arc indefinitely. Here, as in everything else treated of in this article, a study of the proportions used by present-day designers of good repute will serve as a safe and useful guide. It is a good plan to make the pole-pieces of cast iron, as the armature reaction, and consequently the tendency to sparking, is lessened thereby. A simple and inexpensive device which is often resorted to nowadays with the object of weakening the armature reaction is to have one or more slots (running parallel to the shaft) cast in the pole-piece and core of the field magnet. Whether or not this expedient is worth adopting in any particular design, is a question that the individual designer must decide for himself.

It is hardly necessary to emphasise the necessity for having as many ampere-turns on the field magnet and, as already recommended, as few on the armature as possible consistent with a high electrical efficiency and a not excessive cost of manufacture. In fact, if the armature has but a few turns of active wire on it, and the air-gap is as long and as small in area as possible, the field magnet *will*, necessarily, have a relatively large number of ampere-turns. As regards the material for the field magnet (cast steel, wrought iron, or cast iron), this is not a matter of much moment; although cast steel is to be preferred on account of the economy in excitation and (what is of importance in traction motors) the reduction of weight obtained thereby.

To an ignorant engineer the brush gear appears to be the seat of all sparking troubles. This, however, is a mistake, for although a well-designed brush gear is essential to a really good machine, yet it is by no means the only or the most important factor in the case. A badly-designed brush gear may mar an otherwise good machine, but a well-designed brush gear will not in itself make a machine a good one. Certainly the brush gear does affect the sparking of a dynamo or motor, but not to the extent it is often supposed to. Much has been said in favour of carbon brushes of late years, and there are many points in which they surpass brushes made of copper gauze. They are generally to be preferred to copper-gauze brushes, though a well-designed machine will run sparklessly whichever type of brush is used. The chief drawback against their general adoption is their low current-carrying capacity, it being possible to run copper-gauze brushes at about four times the current density that is advisable with carbon brushes.

There are three points which are essential to a satisfactory brush-holder. They are as follows: (1) The brush-holder should be constructed so as to ensure a parallel movement of the brush; or, in other words, it should be constructed so that the brush remains inclined to the commutator at the same angle as it wears away. (2) The pressure of the brush on the commutator should, as far as possible, be constant, no matter how much the brush may wear away. (3) The cross-sectional area of the brush should be sufficiently great to avoid over-heating.

In the foregoing remarks nothing has been said as to the exact proportions to be observed between armature, air-gaps, pole-pieces, field magnet, etc., in order to produce a sparkless machine. It is possible for one knowing the principal characteristics of a machine which tend to cause sparking, to make such modifications in a "sparky" dynamo or motor as shall materially improve the commutation, if not eliminate the sparking altogether. The best proportions to give to the component parts of a machine of a new design, however, are best learned from a study of the theory of commutation, combined with practical experience—in fact, such knowledge can only be gained in this way.

FIELD-MAGNET CONSTRUCTION.

Mr. S. E. Huenerfauth recently read a paper before the Ohio Society of Mechanical, Electrical, and Steam Engineers, which was entitled "Recent Refinements in Field-Magnet Construction." In the course of his remarks he described the field-magnet design now being used by the Phœnix Electrical Manufacturing Company, of Mansfield. We gather that in this design the great aim is to reduce the sparking limit, which is done by casting large cavities in the length of the poles, after the manner which is now fairly common. In this machine, however, the poles are divided by the cavities into three parts instead of two, as is usually the case. Also the cavities are much wider than the long slots which are as a rule employed for keeping down armature reaction. It appears that the frames are of cast steel. We should imagine that the machines are rather expensive to build, as the copper for excitation is bound to be heavier than is usual, owing to the increase in the mean length of turn caused by these large recesses. In fact, the magnet poles are as large in perimeter as the pole-pieces of an ordinary dynamo. The field coils can hence be slipped on over the poles, and there is no removable pole-piece required. Mr. Huenerfauth states that in machines having solid poles, it is necessary to limit the reactive voltage of the armature coil under commutation to about six volts in order to avoid sparking, and that many designers adopt a limit of from four to five volts. With the slotted poles, as above described, he has found a 150-kw. dynamo will run without a sign of sparking with a reactive voltage of 11½ volts. This, he claims, allows of fewer armature coils and commutator panels being employed. This saves in cost, but it is the total cost of the machine which needs to be compared with that of the ordinary type.

ELECTRICITY SUPPLY STATIONS IN SOUTH AFRICA.

The information which we reproduce below from the *British and South African Export Gazette*, should be of value to home manufacturers interested in South African orders for electrical plant. Particulars are given of a number of generating plants erected in South Africa, or contemplated, though the list does not profess to be complete. We would call special attention to the amount of work in prospect:

BARBERTON (Moodie's Gold M. and E. Company, Limited).—Alternating-current, two-phase. Power and light supplied to mines on the company's estate, generated by water-driven 250-h.p. plant at Queen's River Fall, six miles transmission.

BLOEMFONTEIN (Municipal).—Alternating-current, three-phase; voltage, 110. Price per unit, 1s. Population, 10,000. Private and public lighting. Generator capacity, 2,000 volts, high tension. Contemplated expenditure of £25,000 on extensions.

BULAWAYO (Bulawayo Waterworks Company, Limited).—Alternating current; voltage, 104. Price per unit, 2s. and 1s. 10d. Population, 8,000. Lighting and power. Working voltage, 2,080; periodicity, 125. Steam generation. Price for lighting is first 100 units, 2s. per unit; power, 1s. 10d.; 300 to 600 units, 1s. 8d.; over 600, 1s. 7d.

CAPETOWN (Municipal).—Direct-current, three-wire (formerly five-wire); voltages, 220 and 440. Price per unit, 1s. 2d.; power, 7d. Population, 84,000. Private and public lighting. Monthly rebates, two-rate system for day load. Gas, 10s. per 1,000 cubic feet. Network to be extended and improved at a cost of £100,000.

Cape Peninsula Lighting Company, Limited, Wynberg.—Direct-current, three-wire; voltages, 120 and 240; and Rondebosch—Alternating-current, single-phase; voltage, 110. Public and private

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lighting and tramways. New central station under construction at Claremont to supply the two districts, five miles apart, with power at high tension. Plant being entirely renewed.

Camp's Bay Electric Tramways Company, Limited.—Tramways and lighting. Output of generators, consisting of two direct-coupled 400-kw. sets, is 400 kw. each at 550 volts.

Cape Electric Tramways Company, Limited.—Tramways.

DUNDEE.—Population, 2,000. A private installation under negotiation.

DURBAN (Municipal).—Alternating-current, single-phase; voltage, 100. Price per unit, 8d. Population, 57,000. Lighting and tramways. Tramways, overhead trolley system. Network 25 miles in extent. Installation only partly completed. Lighting network to be extended at a cost of £30,000, with a combined lighting and power central station at a cost of £45,000.

EAST LONDON (Municipal).—Alternating and direct current, single-phase; voltage, 110. Price per unit, 1s. Population, 13,000. Lighting and tramways. Alternators and transformers used for lighting, continuous-current machines for traction, dynamos and alternators in all cases being direct coupled to engines. Current generated at 2,200 volts. Central station.

GERMISTON (General Electric Power Company).—Power and light transmission plant, with 800-h.p. engines. Supplies mines and lights the Germiston and Elandsfontein railway stations. Steam generating power.

JOHANNESBURG (Municipal).—Alternating-current, single and three phase and series arc; voltages, 300 and 500. Price per unit, 1s. and 10d. Population, 80,000. Municipal plant. Overhead wiring for part of town and for the suburbs; cable for small portion of town, including Government buildings. Steam generation.

JOHANNESBURG (Rand Central Electric Works, Limited).—Alternating-current, single-phase; voltages, 120 and 240. Power and light transmission plant at Brakpan, 25 miles from Johannesburg. Supplies mines with power and light to railway stations; 1,000-h.p. engines. Generating power, steam.

JOHANNESBURG (Suburbs).—Several private plants partially supply the suburbs of Johannesburg with electric light. The Braamfontein Estates Company supply Parktown and the streets in the district; the Standard Theatre supplies some surrounding buildings; the Empire Theatre supplies some of the shops in the block; the Rand Club supplies the Permanent-buildings, the *Leader* and the *Star* offices, Exploration-buildings, and Messrs. E. W. Tarry and Co.'s premises.

KIMBERLEY (Municipal).—Direct-current; voltage, 200. Price per unit, 1s. Population, 50,000. Lighting. Corporation just obtained power to borrow £10,000 for extensions.

De Beers Company.—Alternating-current, three-phase. Price per unit—power, 6d. New central power station and equipment scheme. Plant, 2,000 kw., equalling 2,665 h.p., increasing to 3,000 h.p. Power generated at 5,000 volts and transmitted at that pressure. For supply of mines and Kimberley, if desired.

KINGSWILLIAMSTOWN.—Alternating and direct current. Population, 7,193. Private company just formed, but installation not yet completed. Steam generating power.

KROONSTAD (Municipal).—Population, 2,000. Town authorities purpose installing an electric light service at a cost of £10,000.

LADYSMITH (Municipal).—Continuous-current, low-tension. Population, 5,000. Municipal lighting installation under construction. Plant, two 440-volt belt-driven dynamos. Steam generator.

NEWCASTLE.—Population, 2,500. Private installation under construction. Service equal to 1,600 16-c.p. incandescent lamps. Right to supply power. Meter system.

PAARL ELECTRIC POWER SYNDICATE.—New company just formed to erect a lighting and power installation, generating power from neighbouring stream.

PIETERMARITZBURG (Municipal).—Alternating-current, single-phase; voltage, 100. Price per unit, 1s. Population, 25,000. Lighting and tramways. The latter under construction, and the former system to be extended at a cost of £150,000.

PORT ELIZABETH (Municipal).—Direct-current. Tramways.

PRETORIA (Municipal).—Corporation contemplating erecting its own lighting, power, and traction service.

PRETORIA (Pretoria Lighting Company, Limited).—Population, 12,000. Original plant, output equal to 6,000 8-c.p. lamps, with underground and overhead conductors. Plant subsequently increased by addition of 2,000 amperes per hour, storage battery, and three 126-kw. direct-driven dynamos. Highest output in 1899, 477,000 units. Central station. Meter system.

SALISBURY (Municipal).—Population, 1,000. Town Council intend to construct own installation, but a beginning not yet made.

UMTALI AND MASSIKESSI.—Private company just received lighting and power concessions from Mozambique Company, generating power from Massikessi Falls.

VICTORIA FALLS (African Concessions Syndicate, Limited).—This company has concession from British South Africa Company to develop energy from Zambesi Falls and River for supplying towns and mines in Rhodesia, etc.

BRISTOL ELECTRICITY ACCOUNTS.

From the accounts of the Bristol electricity department for the year ended March 25, 1902, it appears that the total expenditure on capital account amounts to £384,776. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£10,475	10	2			
Oil, waste, water, and stores	714	9	4			
Wages at generating station	3,200	4	5			
Repairs and maintenance	1,790	8	6			
				16,180	12	5
Distribution of Electricity.						
Wages and other remuneration	820	8	7			
Repairs, maintenance, etc., of mains	267	10	11			
Repairs, etc., of transformers, etc.	95	14	6			
Repairs, etc., of apparatus	415	14	2			
Sundries	30	15	10			
				1,630	4	0
Public Lamps.						
Attending and repairs	1,075	13	7			
Carbons and renewals of lamps	500	1	1			
Sundries	45	15	6			
				1,621	10	2
Rents, Rates, and Taxes.						
Rents payable	450	4	6			
Rates and taxes	1,781	19	11			
				2,232	4	5
Management Expenses.						
Salaries—Engineer's department	1,689	10	7			
Secretary and clerical staff	1,085	10	2			
Stationery and printing	312	9	1			
General establishment charges	537	14	5			
Auditors' fees	35	0	0			
Stock management expenses	111	0	11			
Repairs of offices, fittings, etc.	58	13	3			
				3,829	18	5
Law expenses				170	18	1
Special Charges.						
Insurance and guarantee premiums	137	7	11			
Costs of canvassing	9	4	3			
Interest on deposits as security	14	0	6			
Testing machinery, mains, etc.	19	3	8			
Gratuity	5	10	0			
Salary of electric inspector	70	0	0			
Surveyor's fees	100	0	0			
Advertising	154	8	0			
Expenses of reconstructing rain-water pipes of property at Temple Back	162	19	0			
				672	13	4
Avonbank—cleaning after contractors	90	6	11			
Machinery testing and up-keep	360	1	6			
Insurance and premiums	59	18	8			
				510	7	1
				26,848	7	11
Amount carried to net revenue account				18,034	4	4
				£44,882	12	3

Cr.	£	s.	d.
Sale of current for lighting and motors	35,866	4	10
Rental of meters	1,643	19	1
Rental of motors, less bad debts	39	13	11
Electricity supplied to public lamps	5,542	4	0
Attendance, repairs, and carbons for same	1,621	10	2
Incidents	5	8	0
Improvers' premiums	110	0	0
Fees for insulation tests	3	3	0
Surplus lands—rents receivable	19	13	6
Charging batteries	8	14	5
Work on consumers' premises	13	11	7
Profit on sundry accommodation sales	15	12	11
Electric inspector—fees for testing meter	6	2	6
	£44,882	12	3

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	418,576	10	5
Temporary loan awaiting repayment	1,900	0	0
Sundry creditors	7,826	8	0
Deposits by customers as security	426	10	0
Balance at credit of stock and loan account	7,022	13	6
Balance at credit of reserve fund account	4,509	2	6
Balance at credit of depreciation account	1,236	16	3
Balance at credit of suspense account	350	0	0
	£442,028	0	8

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	403,433	5	8
Stores on hand	1,272	19	3
Sundry debtors for current and other debtors	13,905	8	10
Stock investment account	7,022	13	6
Cash at bankers and in hand	16,313	13	5
	£442,028	0	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		3,443,270
Quantity sold { Public lamps	480,776	2,756,624
Quantity sold { Private consumers by meters	2,275,848	
Quantity used on works		686,646
Total quantity accounted for		3,443,270
Total maximum supply demanded (kilowatts)		2,535

Number of public lamps: arc, 310; incandescent, 9.

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NOTTINGHAM ELECTRICITY ACCOUNTS.

In the accounts of the Nottingham Corporation electricity department for the year ended March 31, 1902, the total expenditure on capital account is given as £316,143. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.

Generation of Electricity.	£	s.	d.
Coal	7,841	12	2
Oil, waste, and water	1,711	14	1
Wages at generating station	2,770	7	8
Repairs and maintenance	1,332	4	4
Distribution of Electricity.			
Wages	85	16	11
Repairs, etc., of mains, meters, etc.	138	12	1
Public lamps—attending and repairs	160	9	5
Rents	59	0	0
Rates	286	14	5
Salaries	2,103	17	10
Stationery and printing	114	10	0
Establishment and other charges	650	11	4
Law charges and insurance	99	0	9
Consolidated stock management charges, etc.	44	4	4
	17,398	15	4
Bad debts	36	5	11
	17,435	1	3
Balance carried to net revenue account	26,840	3	6
	£44,275	4	9

Cr. Income.

	£	s.	d.
Sale of current per meter	42,235	9	9
Public lighting	947	9	8
Rental of meters	702	7	3
Public lamps—attending and repairs	176	9	10
Connections to consumers' premises—net	166	4	1
Stores	1	12	4
Discounts	45	11	10
	£44,275	4	9

BALANCE SHEET.

Dr. Liabilities.

	£	s.	d.
Capital account—amount received	213,291	4	1
Consolidated stock (redeemable)	74,016	7	9
Sundry creditors	8,696	12	5
General district rate account	6,500	0	0
Sinking fund	6,617	1	5
Repayment of loans account	14,438	4	0
Reserve fund account	12,602	7	0
Cash due to treasurer and in hand	3,650	9	10
	£339,812	6	6

Cr. Assets.

	£	s.	d.
Capital account—amount expended for works	240,181	17	11
Electric tramway purposes	75,961	12	8
Stores in hand	1,273	15	1
Sundry debtors for current supplied	16,541	18	2
Proportion of sinking fund investments	5,853	2	8
	£339,812	6	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			4,463,636
Quantity sold	Public lamps	92,197	4,094,897
	Private consumers by meter	4,002,700	
Quantity used on works			33,966
Total quantity accounted for			4,128,863
Quantity not accounted for			334,773
Total maximum supply demanded (kilowatts)			3,603

Number of public lamps, 104.

CROYDON ELECTRICITY ACCOUNTS.

The accounts of the county borough of Croydon electric lighting department for the year ended March 25, 1902, show a total expenditure on capital account to date of £212,388. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith.

REVENUE ACCOUNT.

Dr.

Generation of Electricity.		£	s.	d.
Coal or other fuel	£6,953 17 9			
Oil, waste, water, and stores	860 4 7			
Wages at generating station	1,123 9 10			
Repairs and maintenance	738 2 4			
		9,675	14	6
Distribution of Electricity.				
Wages to linesmen, etc.	248 9 7			
Repairs, etc., of mains, etc.	204 8 1			
		452	17	8
Attending to public lamps		895	16	2
Rents, rates, and taxes		416	0	0
Management Expenses.				
Salaries—engineer's department	1,968 6 8			
Stationery, printing, and stamps	193 1 0			
General establishment charges	317 10 11			
	2,478 18 7			
Proportion to general district rate	500 0 0			
		2,978	18	7
Special charges—insurances		157	19	1
Interest on deposits		4	15	9
Total expenditure		14,582	1	9
Amount carried to net revenue account		12,850	0	0
Balance to provide for bad debts		51	8	0
		£27,483	9	9

Cr.

	£	s.	d.
Electricity sales—balance from last account	31	2	8
Sale of current per meter—less discounts, etc.	20,902	5	5
Additional amounts received	3	0	5
Guarantee charges	2	6	9
Public lighting	5,873	1	3
Rental of meters and other apparatus	614	19	2
Sundry receipts for retesting, etc.	51	14	1
Rents—National Telephone Company	5	0	0
	£27,483	9	9

GENERAL BALANCE-SHEET.

Dr. Liabilities.

	£	s.	d.
3 per cent. redeemable stock (1900)	153,285	19	3
Suspense account	2,379	18	6
General district rate—establishment charges and suspense account	2,500	0	0
Sundry creditors	15,509	15	10
Consumers' deposit account	251	17	7
Balance at credit of revenue account	51	8	0
Balance at credit of net revenue account	4,118	7	8
Union Bank of London overdraft	47,773	8	5
Surplus account	8,664	0	9
	£234,534	16	0

Cr. Assets.

	£	s.	d.
Capital account—amount expended for works	212,388	15	9
Costs of issue, etc., capitalised	9,216	0	0
Stores, etc., on hand	1,145	14	2
Debtors for current supplied	11,357	14	4
Sundry debtors	422	17	11
Electrical engineer—petty cash in hand	3	13	10
	£234,534	16	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			2,310,876
Quantity sold	Public lamps	480,962	1,810,587
	Tramways	343,053	
	Private consumers by meter	986,372	
Quantity used on works			175,968
Total quantity accounted for			1,986,355
Quantity not accounted for			324,521
Total maximum supply demanded (kilowatts)			1,683

Number of public lamps: 386 arcs, 24 incandescents.

GLASGOW TELEPHONES.

The following is the first annual report by the Committee on Telephone Service to the Corporation of the city of Glasgow:

The Telephone Committee beg to submit to the Corporation the accounts of the telephone department for the year 1901-2. The system was formally inaugurated on Sept. 1 last, consequently the portion of the accounts dealing with revenue is only for a period of nine months:

Revenue and Expenditure.

	£	s.	d.
Gross revenue from rentals for the period from Sept. 1, 1901, to May 31, 1902	25,854	2	4
Terminal fees received from National Telephone Company, per Postmaster-General	121	15	3
Sundry receipts	2,195	14	10
Total revenue	£28,171	13	5
Working expenditure	9,869	9	10½
Net revenue	£18,302	3	6½
out of which the following requirements had to be met: interest on loans, £2,680. 5s. 2d.; sinking fund, £1,960; terminal fees paid to National Telephone Company, per Postmaster-General, £846. 9s. 1d.	5,486	14	3
leaving a balance of	£12,815	9	3½

which is dealt with as follows: proportion of prepaid rentals, applicable to year 1902-3, carried to suspense account, £12,417. 1s. 5d.; surplus for the year 1901-2 carried forward, £398. 7s. 10½d. It will

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be seen from this that the amount of terminal fees received from the National Telephone Company is £121. 16s. 3d., as against £846. 9s. 1d. paid by the department to the company.

Borrowing Powers.—Borrowing powers authorised under Section 2 (2) of the Telegraph Act, 1899 :

1. On April 12, 1900	£120,000
2. On Feb. 19, 1902	100,000
Total borrowing powers authorised	220,000
Deduct amount of sinking fund for year to May 31, 1902	1,960
Net amount of borrowing powers as at May 31, 1902	218,040
Amount borrowed and not repaid as at May 31, 1902	172,240
Amount of unexhausted borrowing powers as at May 31, 1902	£45,800

Capital Expenditure and Work Executed.—The capital expenditure during the year just ended has amounted to £126,302. 17s. 6d. Adding the capital expenditure of £66,390. 16s. 9d. for the previous year ending May 31, 1901, there is a total capital expenditure of £192,693. 14s. 3d. The capital expenditure for the past year has been incurred not only in providing accommodation for working lines, but in making ample provision of underground ducts for future use, so as to avoid the necessity of an early reopening of streets. Further, in order to facilitate distribution and to provide for connecting subscribers economically later on, as well as to minimise jointing, cables have been laid containing a much larger number of pairs of wires than are required at present. Other works have also been extended. In the following statement the first column gives the work that was originally estimated for, and the second column the work which, at May 31, had actually been executed :

	Original scheme.	Actually executed.
Completed instruments to be provided	5,250.	5,479.
Partially completed lines	1,200.	8,787.
Switchboard accommodation	6,050 lines.	7,060 lines.
Number of pairs of cable wires	6,450.	14,572.
Mileage of pairs of wires in cables	4,938 miles.	11,061 miles.
Length of trenching	22 miles.	94 miles.
Number of pipes going out of exchanges	32.	126.
Capacity of pipes going out of exchanges	6,900 pairs of wires.	27,000 pairs of wires.
Length of pipes	32 miles.	104½ miles.
Length of underground cable	31 miles.	113¾ miles.
Number of ground poles	2,326.	691.
,, roof standards	456.	228.

The original scheme, involving an estimated expenditure of £121,000, provided for overhead distribution everywhere, but in the centre of Glasgow subscribers have been served by taking branches of cable underground into their buildings in the same way as gas and water pipes. It was originally intended to serve the suburbs by means of overhead routes, but, in view of the large number of subscribers offering in all directions, it was decided that these routes should be put underground, consequently underground routes have been laid to Clydebank, Rutherglen, Shettleston, Bishopbriggs, Cathcart, Pollokshaws, Langside, Crosshill, and between Lenzie and Kirkintilloch. This has led to a considerably increased outlay, but full benefit will be reaped hereafter in the shape of reduced maintenance charges. As the greater and more expensive part of the work has now been executed, construction expenditure will soon be on a reduced scale, and new subscribers will be joined up at a considerably lower average cost. The main underground routes yet to be completed are those to Bearsden, Milngavie, Giffnock, Clarkston, Busby, and Cambuslang. The contract with the British Insulated Wire Company for underground work has been practically completed, and the whole of the outside work is now being performed by the department's own staff. The following switch-rooms have been opened : Central ; Western, Hillhead ; Clydebank ; Maryhill ; Springburn ; Shettleston ; Bridgeton ; Queen's Park ; Kinning Park ; Govan. As soon as wayleave and engineering arrangements are completed, the following switch-rooms will be opened : Milngavie and Bearsden ; Kirkintilloch and Lenzie ; Cambuslang ; Rutherglen ; Clarkston, Giffnock, and Busby.

Service and Traffic.—The service generally has proved acceptable to subscribers. This is apparent from the rapidity with which new orders have been received. There are, however, certain improvements to be effected, which, when completed, will increase the efficiency of the service. The rapid development of the system, due to the great increase in orders and the eagerness for early connection exhibited by subscribers, have created certain conditions which would not have obtained had the execution of the work been extended over a longer period of time. Traffic through the Corporation exchange has been brisk from the commencement, and has lately become very heavy, especially at the Central, Bridgeton, and Kinning Park switch-rooms. The number of local messages (counting a connection as one message only) is now at the rate of 10,000,000 per annum. As the annual exchange rentals revenue, plus the local tolls and public telephone receipts, amount to £25,668, the average cost of each connection to the subscriber is ·62d. If each connection were counted as two messages (which is the more usual practice), the cost per message would be only ·31d. The Corporation exchange is also largely used for trunk connections, there being in use 36 junctions to the Post Office, as well as one line for the transmission and receipt of telegrams by telephone.

Call Offices.—Call offices for the general public and subscribers have been opened at various places throughout the city, including the principal post offices. The committee intend to further extend the number of these call offices, so as to afford the greatest benefit to the general public.

General Remarks.—It may be interesting to refer to the fact that all the plant employed by the telephone department is manufactured in Great Britain, except the subscribers' instruments and a certain portion of the overhead wire. The switchboards are entirely British, and that at the central exchange is the largest multiple switchboard ever manufactured in this country. The 5,494 instruments connected are subscribed for by 4,697 persons and firms ; of these, 2,059 have never been telephone subscribers before. About 1,700 orders still remain to be executed.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work ; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

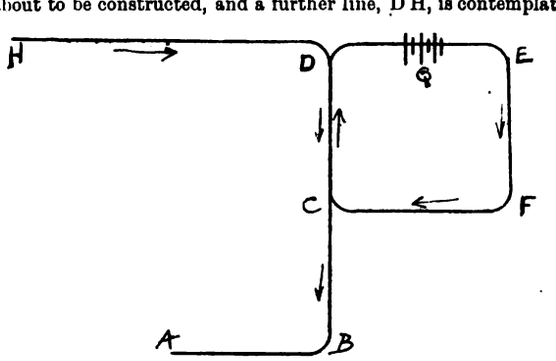
QUESTIONS.

507. By using a three-wire system of supply it is generally stated that a saving of about 20 per cent. of the copper required in the mains is effected. Does this saving more than cover the increased cost of the balancers, etc., required, and the extra complication involved in the working ?—J. C. R.

508. An armature is former-wound, having the coils so arranged that by having a loop from the centre of the coil it can be connected up to either 400 or 200 volts. The two halves of each coil in this instance are connected in parallel for 200 volts. When the armature was being tested, it heated considerably without apparent cause. Would this undue temperature rise be attributable to any induction between the two halves of each coil, seeing that the outer half encircles the inner half ?—W. F. S.

ANSWERS.

Question No. 501.—The diagram represents the rail-return system of an existing electric tramway, A B C D. A new tramway, D E F C, is about to be constructed, and a further line, D H, is contemplated.



The fall of potential is measured at A, and from D to A the drop is found to be six volts. The distances A–B, B–C, C–D are each one mile. The distance from D to H is two miles. It is desired to avoid the cost of a return feeder, but if D H be added to A B C D, the total fall of potential in the return will probably be 10 volts, which is three volts in excess of the Board of Trade limit measured over the greatest length of continuous line, commencing at the measuring point, A. How can the desired end be attained ? If the tramway D E F C be fed independently of the other tramways from a battery sub-station at Q in such a manner that the return current flows in a direction opposite and against the return current in the rails, A B C D, in the portion marked C D, would the result be to reduce the fall of potential between D and A ? If not, why not ?

Answer to No. 501 (*awarded* 7*s.* 6*d.*).—The method suggested for reducing the drop would certainly act in the desired direction, but since the load on the circuit, A B C D H, would not bear any constant relation to that on the circuit, D E F C, the compensating effect would necessarily vary considerably. When the currents used in

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the two circuits were equal, the current, and consequently the drop, in the part D C would be zero, and then the drop from A to H would probably be under the necessary seven volts, but should the current in D E F C fall considerably whilst that in A B C D H remained the same, the drop in D C would be considerable, and the total drop from A to H might exceed seven volts.

Another way of reducing the drop without the use of return feeders consists in inserting one or more series-wound boosters in the rail circuit itself, as suggested by Mr. Kapp (*Elektrotechnische Zeitschrift*, Jan. 2, 1902), and shown diagrammatically in Fig. 1. For each such booster the rail must be cut at two points, A and B, which must be separated by a greater distance than that between the first and last wheels of the longest car. The blank piece of rail, thus (electrically) cut out, is connected to the two poles of the booster through resistances, R and R_1, sufficient to prevent the machine becoming short-circuited during the passage of a car. Supposing one such booster were employed, it would have to be wound for a voltage equal to the excess of the maximum actual drop in the rails above the permissible seven volts—*i.e.*, it should give three or four volts in the case under consideration, and should be placed about mid-way between A and H. The booster would be driven by a small motor connected between the trolley line and the rail. Such a booster has the effect of raising the voltage of the rail at the point where it is inserted to approximately the value it has at the far end of the line, and the drop for the rest of the return circuit then commences once more at that value, the total difference in voltage between the two ends of the line being thus reduced by the amount of the

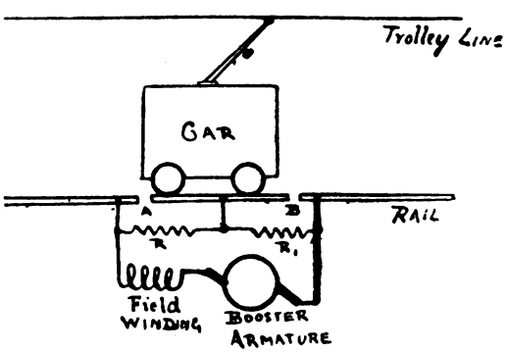
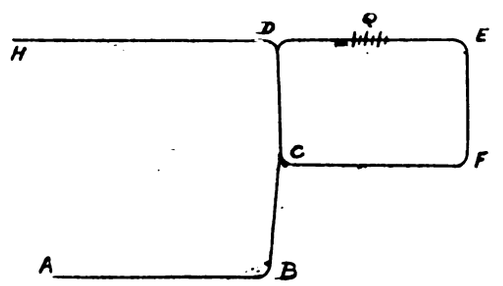


Fig. 1.

booster volts. The motor-booster would be quite a small affair, and would require little, if any, attention. The only serious objection to this method is the possibility of somewhat powerful earth currents being set up at the points where the booster is connected to the rail, for a difference of several volts exists there within a distance of a few yards. If, however, the line passes through open country, where the ground is free from gas or water pipes, this would be of little importance. This method has hardly been put to a practical test as yet, and, failing that, it would probably be safer to use the well-tried method of return feeders, with or without boosters, in spite of its expense.—Q.

Answer to No. 501 (*awarded 7s. 6d.*).—As stated in the question, the Board of Trade requirement is that the total fall of potential measured along the greatest length of continuous line shall not exceed seven volts. The length of line is immaterial. It is therefore evident that with the advent of long-distance tramways the difficulty raised in the question must continually be experienced. To comply with the requirements of the Board of Trade, the usual expedient adopted is to employ a negative booster. This piece of apparatus was fully described in these columns in 1899, and it will therefore be unnecessary to do more than briefly state the function of this booster now. As all electrical engineers are aware, the object of a booster is to raise the E.M.F. of a current; generally this is done for the purposes of battery charging, or other kindred reasons, but the same method may be used with the return current of a tramway installation. Taking the same diagram, supposing it is found that with usual working conditions there is a drop of six volts between H and C, the return current might be passed through a booster at C and the E.M.F. raised six volts; if then there was another six-volt drop between C and the station, the requirements of the Board of Trade would be fully met, for, measured from A to H, the drop is only six volts. Actually there may be a 12-volt drop, but as the potential is raised six volts at C the drop measured from C to H is only six. This system is perfectly legitimate, and is not a way of dodging the Act. This is evident if we consider the lines as belonging to two distinct companies, and connected at C: one company might have its generating station situated at C, and would then clearly be entitled to a seven-volt drop between H and C; then if the second company had its power-house at A, it would also be justified in having a seven-volt drop between C and A. These are the conditions which would obtain if a negative booster were placed at C, and therefore its use is perfectly legitimate. This is the method of overcoming the excess drop which would probably be found to be the cheapest both as regards first cost, maintenance, and working expenses.

The method proposed of having a sub-station at Q is practical, but would be very expensive in every way. In the first place, the equipment of the station would be very great; the cost of the battery is a serious item. Then to charge this, either a separate pair of mains, carrying a current of a higher E.M.F., would have to be run from the power-house, or, if the charging current be taken from the overhead wires, a positive booster would have to be put down in the sub-station, as it is impossible to charge the battery at 500 volts and then to get 500 volts from it afterwards. This positive booster would cost as much as the negative booster before referred to. The expenses of running and upkeep would also be heavy, as a battery is is not an easy thing to keep in order, especially when, as is the case in tramway work, the demands upon it are very varied, and at times it may be subjected to heavy over-



loading, while the inevitable loss in charging must also be taken into account.

Assuming, however, that this battery sub-station is adopted, the currents from A and Q will assimilate at D and C—that is, if there is no demand for current between D and C, and there is, say, 40 amperes flowing in the rail between H and D due to the station at A, and at the same time there is a current of 40 amperes flowing in the rails between Q and C due to the sub-station Q, no current will flow between D and C, but that from the H D rail will flow into the battery, and that from the E C rail will flow into the A station, and so tend to reduce the drop from H to A. If the two currents are not equal in amounts, then the whole of the smaller current will be assimilated, and the balance of the larger one will take its true path. The question is complicated by the fact that there may be trams on all parts of the system, then those between D and C will be fed partly from A and partly from Q; the currents will still assimilate at C and D in proportion to the values. For the theory of assimilation of currents, the student cannot do better than refer to Chapters 17 and 18 of Weymouth's "Drum Armatures and Commutators."

It must also be borne in mind that the case might arise when no cars were running on section D E F C, while section A B C D H was fully loaded; this might be caused by a breakdown on the first-named section, or from other cause. Should such a case arise, there would be a 10-volt drop between H and A; with a negative booster, unless the booster itself broke down, there could never be a drop of more than six volts. From the points of view, then, of lower first cost, cheaper working, lower maintenance charges, higher efficiency, and greater reliability, it would

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be far more advisable to insert a negative booster than to erect a battery sub-station at Q.—M.

Question No. 502.—A dynamo may be considered as a machine for creating a difference of potential. Assume that the dynamo under consideration is completely insulated from earth. Is it correct to assume that the negative pole is at earth potential?

Answer to No. 502 (*awarded* 7*s.* 6*d.*).—Under these circumstances the potential taken up by each pole relatively to the earth depends simply on the electrostatic capacities of the two poles with respect to earth. The actual metallic terminal piece connected to each dynamo pole may be considered as forming one coating of a condenser of which the earth (the walls of the room, etc.) forms the other coating and the air or other insulation between forms the dielectric (Fig. 1). The capacity of the condenser thus formed at each pole depends simply on the superficial area of the terminal, and inversely on its distance from the surrounding objects connected to earth. The potential difference, V, existing between the two coatings of a condenser is given by the expression $V = \frac{Q}{K}$, where K is the capacity of the condenser and Q is the quantity of electricity (coulombs) which has passed into it.

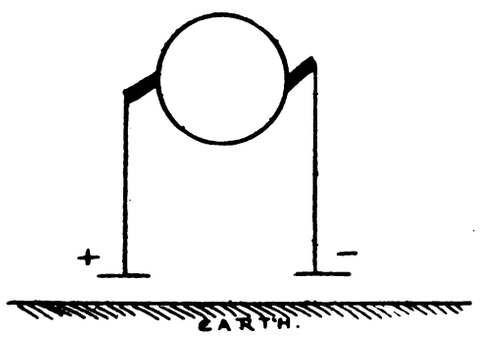

FIG. 1.

Now, in the case given the quantity of electricity flowing out of the dynamo positive pole to charge the + condenser must equal that flowing in at the negative pole to charge the − condenser, so that Q has the same value for both the terminal condensers.

If V_1 = the P.D. existing between the + pole and earth.
V_2 = " " " − " "
K_1 = the capacity of the + pole to earth.
K_2 = " " − " "

Then $V_1 + V_2$ = the potential difference existing between the dynamo + and − poles; and

$$V_1 = \frac{Q}{K_1}; \qquad V_2 = \frac{Q}{K_2};$$

so that

$$\frac{V_1}{V_2} = \frac{K_2}{K_1};$$

or, the potential differences between the respective poles and earth are inversely as their capacities. If both poles are alike and similarly situated, so that they have the same capacity, they will both be at the same potential difference from earth—the negative pole being lower than earth potential by an amount equal to half the dynamo volts, and the positive pole being the same amount above earth potential. It would only be in case the negative pole had a very much larger capacity than the positive pole that the negative pole potential would approach that of earth, assuming complete insulation.—Q.

Answer to No. 502 (*awarded* 7*s.* 6*d.*).—This problem can be solved by a method given in Clerk Maxwell's "Electricity and Magnetism," vol. i., Section 87. Maxwell defines the capacity of a conductor as its charge when its own potential is unity and that of all the other conductors is zero. He shows that the charge q_1 on any conductor whose potential is v_1 may be written in the form

$$q_1 = K_{1\cdot1}\, v_1 + K_{1\cdot2}\, v_2 + K_{1\cdot3}\, v_3 + \ldots$$

where $K_{1\cdot1}$ is the capacity of the given conductor according to the above definition; $v_2, v_3 \ldots$ the potentials of neighbouring conductors, and $K_{1\cdot2}, K_{1\cdot3} \ldots$ are constant coefficients called coefficients of induction. Now let v be the potential difference between the terminals of the dynamo under consideration, and let v_1 and v_2 be the absolute potentials of the two terminals, then

$$v_1 - v_2 = v.$$

We have supposed v_1 to be the + terminal, so that if we joined the terminals a current would flow from it towards the other. Let $K_{1\cdot1}$ be the capacity of the positive terminal and of all mains in connection with it, and let $K_{1\cdot2}$ be the coefficient of electrostatic induction between the two terminals and the masses of metal at the same potential in connection with them, then the quantity, q_1, of electricity in this main will be given by

$$q_1 = K_{1\cdot1}\, v_1 + K_{1\cdot2}\, v_2.$$

Similarly, for the other terminal we shall have

$$q_2 = K_{2\cdot2}\, v_2 + K_{2\cdot1}\, v_1.$$

Now, since the electrostatic capacity of the earth is practically infinite as compared with that of either of the mains, we must therefore have

$$q_1 + q_2 = 0.$$

Hence, from the above equations,

$$(K_{1\cdot1} + K_{2\cdot1})\, v_1 + (K_{2\cdot2} + K_{1\cdot2})\, v_2 = 0.$$

$$\therefore \frac{v_1}{v_2} = -\frac{K_{2\cdot2} + K_{1\cdot2}}{K_{1\cdot1} + K_{2\cdot1}}.$$

$$\therefore v_1 = \frac{K_{2\cdot2} + K_{1\cdot2}}{K_{1\cdot1} + K_{2\cdot2} + K_{1\cdot2} + K_{2\cdot1}}\, v.$$

$$v_2 = -\frac{K_{1\cdot1} + K_{2\cdot1}}{K_{1\cdot1} + K_{2\cdot2} + K_{1\cdot2} + K_{2\cdot1}}\, v.$$

Theoretically, at least $K_{1\cdot1}$, $K_{2\cdot2}$, $K_{1\cdot2}$, and $K_{2\cdot1}$ can be calculated, and hence v_1 and v_2 are determined in terms of the voltage of the dynamo. Clerk Maxwell proves that $K_{1\cdot1}$ is positive and $K_{2\cdot1}$ is negative, but $K_{1\cdot1}$ is always numerically greater than $K_{2\cdot1}$, and hence v_2 can *never be zero* if both poles are absolutely insulated from the earth.—J. C. R.

Answer to No. 502 (*awarded* 5*s.*).—In statical electricity it is a well-known fact that a quantity of one kind of electrification cannot be caused to exist without, at the same time, an equal quantity of the opposite kind is produced—that is, if a quantity of positive electrification is generated, at the same time an equal quantity of negative electrification is generated. Consider the case of a Wimshurst machine. The handle is rotated—mechanical work being done, thereby causing one knob to be made positive, the other negative. (The machine is supposed to be completely insulated.) Now, suppose a metal ball is completely insulated from the earth and unelectrified. A charged sphere (charged + say) is brought near. The immediate effect on the ball is to attract − electrification to the side nearest the sphere and repel + to the side opposite. Now, as the charge on the ball was zero to commence with, the + and − charges induced are evidently equal in quantity. If the ball is connected to earth for a moment, the sphere being retained in its former place, the + electrification disappears, and the ball has now a negative charge. Lastly, if the sphere be now removed, the − electrification disappears on the ball being earthed.

If instead of one ball two metal balls had been used thus, first touch the balls together and bring up the charged sphere in such a way as to charge one ball +, the other −. Now separate the balls, then take away the sphere. The balls, being insulated, retain their respective charges of + and − electrification. A spark may be passed between them or a wire heated by connecting it between them. In short, work may be done by the discharge. If now, the balls are put together, and the operations are repeated, more work is performed. This work is the outcome of the work done in moving the sphere. *By work of a mechanical nature we therefore obtain electrical work.* This, however, is the function of a dynamo.

Suppose the dynamo to be insulated and run on open circuit, equal quantities of + and − electrification are generated, as in the case of the balls. (That is on the assumption that no charge was imparted to the dynamo at the commencement,

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which charge, however, it would be unable to retain for any time). Therefore, assuming the machine to be symmetrical, the negative pole is as much below zero potential as the positive is above, the rotation of the machine maintaining such difference as exists. If the machine ceases to rotate, all charge vanishes. The fact that the + pole is as much above zero—that is, earth—potential as the – pole is below, may be proved by connecting an electrostatic voltmeter between the respective poles and earth. If the negative pole of the machine is earthed, the + will rise to the potential of the machine.

The effect is exactly the same in the case of a dynamo as in the case of a battery. A few experiments can easily be tried by means of a well-insulated battery and an electrostatic voltmeter. I myself once, whilst experimenting with an electrostatic voltmeter and a 100-volt battery, accidentally dropped one wire on to a concrete floor, which wire was joined to one pole of the voltmeter. The other pole being joined to the battery, I observed the deflection on the voltmeter to be about half the potential of the battery.

The only difference that exists in the case of a machine working on load is that part of the work being done in rotating the dynamo is disappearing in electrical work in the circuit, but the fact that the + pole is as much above as the – pole is below earth potential in a well-insulated machine is unaltered.—T. T.

Answer to No. 502 (*awarded* 5*s.*).—It is usually assumed that the potential of the earth is zero, and that the negative pole of a dynamo is as much below as the positive pole is above zero. To say the earth is at zero potential is a convention by which we are enabled to explain certain electrical phenomena. Generally, when two points having a potential difference are joined by a conductor, a current passes; we might then at first expect that on connecting either the positive or the negative pole to earth a current would be obtained. It must, however, be remembered that to get a current we must have a circuit; if, then, the dynamo is completely insulated and only one pole is connected to earth, no current passes, as the circuit is incomplete. Suppose, however, some part of the dynamo to be earthed, by connecting the brushes one at a time to earth, one at least, and perhaps both, would show a potential difference. By taking difference of potential between each pole and earth we are enabled to obtain the insulation resistance of a plant whilst running. We are correct, according to theory, in assuming that the earth is at zero potential, because if the positive and negative terminals of a dynamo or a battery are connected to earth a current flows. This current has its direction from the positive pole to earth and from earth to the negative pole; the enormous capacity of the earth not being appreciably affected by the equalisation. This theory is used to explain away the difficulty there is in imagining the number of earth currents that at one time were supposed to be passing from point to point through the earth.—M. M.

LEGAL INTELLIGENCE.

AN ELECTRIC LIGHTING CONTRACT.

In the Westminster County Court on Friday last, his Honour Judge Woodfall tried a case in which the London Electric Supply Company and the National Electric Free Wiring Company sued Messrs. Greenberg and Lake, of Peckham, to recover the sum of £10. 2s. 8d. in respect of the use of an electric installation supplied and fitted to their order.

According to the evidence called on behalf of the plaintiffs' case, it appeared that in the latter part of the year 1899 the defendants entered into a written contract with the respective companies for the wiring of the premises and the installation and supply of electric light, and for the first year the accounts were paid in due course, but at the expiration of that time the defendants commenced to make complaints as to the supply of light, and requested that the arc lamps outside the shop should be removed. That was done, but the 20-c.p. lamps inside the premises were left. According to the terms of the contract, the defendants agreed to pay the rent of the free wiring and fittings for a period of five years, but since the expiration of the first year they had declined to pay anything, although they had retained the fittings on the premises, and were in a position to make use of them.

The defence was that time after time the light failed, and that consequently the plaintiffs were requested to remove the arc lamps from outside the shop. They never did anything to put the installation in order, and as a result it was quite useless, and the defendants refused to pay for it.

In giving judgment **His Honour** said the case involved a somewhat important point as to contract, and he (the judge) had come to the conclusion that the plaintiffs in having removed the arc lamps and the meter had been parties to a recision of the contract, and that being so there would be judgment for the defendants with costs, but he would grant a stay of execution for three weeks pending notice of appeal.

ISLE OF MAN TRAMWAYS.

Sitting at Douglas, in chambers, on Tuesday, Sir James Gell, judge of the Manx Chancery Court, approved an agreement between the liquidators of the Isle of Man Tramways and Electric Power Company and Mr. Schenk (London), the purchaser of the company's system of electric tramways, for an extension of the date of the completion of the sale to Nov. 14 next. Mr. Schenk has paid a further deposit of £20,000, making a total deposit lodged in court of £50,200, all forfeitable in case of non-completion. The liquidator works the undertaking to Aug. 18 for the benefit of the company, Mr. Schenck paying 5 per cent. interest on the purchase money from that date to the completion of the sale.

SPEED OF TRAMCARS.

Four drivers of the Blackpool Corporation trams were on the 11th inst. charged at Blackpool with furiously driving tramcars.

The **Chief Constable** stated that he had received numerous complaints as to the excessive speed of the cars, and in consequence he had placed officers in plain clothes on the road to watch and time them. The by-laws set out that the cars must not travel at a greater rate than eight miles an hour, whereas the defendants on the 6th inst. were seen in Station-road, South Shore, travelling at the rate of 12 or 13 miles an hour.

The Chairman of the Bench observed that his experience was that the cars went too fast, while another magistrate, and an alderman, gave it as his opinion that the trams went altogether too slow.

One of the defendants stated that if they went too slow they were reported to the manager, and if they went quick to make up for delay and stoppages they were reported by the police.

The defendants were each ordered to pay costs.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN DISTRICT RAILWAY.

The ordinary half-yearly general meeting of shareholders in the Metropolitan District Railway Company was held on the 7th inst. at the Westminster Palace Hotel, S.W., Mr. R. W. Perks, M.P., in the chair.

The **Chairman**, in moving a resolution to adopt the report, said our Company had seriously suffered, and was suffering, from the competition of the Central London Railway and the London United Tramways in the West-end of London. He complained that railway companies were saddled with liabilities for vibration, while the London United Trams were exempt altogether from the parliamentary obligation. Also, the railway company were unable to pay any dividend at all upon their ordinary stock, and at present nothing on their preferences, were charged very high rates and taxes, while the tramway company, who had monopolised the roads in the West-end of London, and were paying remarkably handsome dividends, paid nothing whatever towards the local rates. The electrical engineers of the Underground Electrical Company were rapidly proceeding with the electrification of the Ealing and Harrow line, which they hoped to open for electrical traction before the end of the present year. The Underground Electric Railways Company of London, Limited—which was known previously by the name of the Metropolitan District Traction Company—had very largely increased its capital—from £1,000,000 to £5,000,000. The Electrical Company had now acquired the whole of the land at Lots-road, Chelsea, required for the power-house. Statutory powers had been taken to extend that power-house, and now, instead of generating power to the extent of 10,000 kw. or 15,000 kw., it would generate electrical power up to the capacity of 60,000 kw., and was being pushed on now with very great vigour. The difficulty with the Corporation of Chelsea and the Corporation of Kensington had been finally surmounted, and contracts had been made for the laying of cables in the streets between Lots-road and Earl's Court. Two experimental trains for use at once on the Ealing and South Harrow line had been ordered. One was being built by the Brush Electrical Engineering Company, Limited, and one by the British Thomson-Houston Company. The Brompton and Piccadilly-circus Railway had been originally promoted by independent parties, but with the moral assistance of the District Company. Subsequently the District Railway became interested as the one-third proprietor practically of that undertaking, and power was obtained to subscribe £200,000 to that undertaking. They did not propose to exercise that power, and would not be shareholders to any extent in the Brompton undertaking. That company had already provided all its capital, and did not need the assistance. The directors thought that the Brompton and Piccadilly-circus line would be a valuable feeder to this railway, and with the exception, probably, of the Sloane-street Station, it would not be a competitor. The directors thought that it was rather unfortunate that a combination with which Messrs. Morgans's house was so closely identified, who were trying to take possession of one of the main metropolitan routes

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and to knock the bottom, if they could, out of the revenue of the District Railway and other railways, should instruct their counsel to say to a parliamentary committee that they were their deadly competitors. The directors would do their very utmost to persuade Parliament that the other railway was not required, and that it would be a great financial fiasco should it be sanctioned. In reply to a question, the chairman said the old arrangement with regard to the power-house was that it was going to cost £400,000, and this Company would have had the right of leasing it at 5 per cent., which would have been £20,000 a year. Now, however, the power-house was going to cost £1,250,000, and, of course, they could not pay interest upon that amount, and therefore they would take their current either at cost or at an arbitration price. The Board had decided to abolish the omnibuses which were formerly run by the Company, as the directors considered that they did not pay.

The report was adopted.

BAKER STREET AND WATERLOO RAILWAY.

The half-yearly general meeting of the shareholders of the Baker-street and Waterloo Railway Company was held on the 7th inst. at Hamilton House, Victoria-embankment, E.C., Mr. Theodore Julius Hare (chairman of the Company) presiding.

The **Chairman** said during the half-year the sum of £66,011 had been spent on capital account; of this £42,590 was spent in the last three months of the half-year. The transfer of the construction contracts to the Metropolitan District Electric Traction Company only took place on March 7, and some little time had to elapse before the suspended works could be restarted, so that practically only three months' work was comprised in the half-year. The estimate of expenditure up to Dec. 31 next, including land, would be £175,000. The works were being pushed on as rapidly as possible, and satisfactory progress was being made. Between Baker-street and Waterloo there was, in the double line, about six miles of single tunnel; of this only a trifle over 1½ miles remained to be constructed, so that it might be said that 75 per cent. of the tunnelling between these points was finished. At the stations the lift shafts had been completed at Waterloo, Piccadilly-circus, and Baker-street, and were about to be commenced at Oxford-circus. Staircase shafts at Waterloo and Oxford-circus had been sunk. The booking hall at Waterloo had been covered in, and was ready for the internal fittings. All the land for the station sites from Baker-street to the depôt in St. George's-circus had been arranged for, and the Company was in possession, except at Trafalgar-square, and here possession would shortly be obtained and the work started. The Metropolitan District Electric Traction Company had given notice, under the powers of their agreement with this Company, that they would supply this Company with electric power at a price to be agreed, or, failing agreement, to be settled by arbitration. The construction contracts and agreements relating thereto had now been transferred by the Metropolitan District Electric Traction Company, whose capital was £1,000,000, to the Underground Electric Railways Company of London, with a subscribed capital of £5,000,000 sterling. The necessary legal formalities signifying this Company's sanction to the transfer were in course of preparation, and would be completed shortly. The advantages of the change to this Company were obvious, and, as they were informed at the last half-yearly meeting, the financiers behind the new company were of the very highest standing, and there could be no doubt that anything they undertook would be promptly and satisfactorily carried through. They had received interest on their shares up to June 30 last, including all arrears, as from Dec. 1, 1900. The Company's Bill had passed the Committee of both Houses of Parliament, but, owing to its being opposed, together with several other "Tube" Bills, on third reading in the House of Commons, it could not now receive the Royal assent until the autumn session. Several of the Tube Railway Bills promoted this session were opposed in their interests.

The report was agreed to.

NORTH METROPOLITAN TRAMWAYS.

The meeting of this Company was held on Tuesday.

The **Chairman** explained the nature of their negotiations with the Metropolitan Electric Tramways, Limited, who propose to work light railways in the neighbourhood of London. As those lines would be in direct communication with the North Metropolitan tramways, it was manifestly to the advantage of all parties concerned that the tramway lines should be worked in conjunction with the light railways. An arrangement was therefore made between the two companies under which the Middlesex lines of the North Metropolitan Company should be purchased by the other, subject to the approval of the shareholders and to the consent of the Board of Trade. By this sale the shareholders would receive the present full value of the unexpired term of 23 years for which the lines were held. In fulfilment of a further part of the arrangement, an Act of Parliament had been obtained for the purpose of electrifying the Middlesex lines, so that they might be worked as part of one system with the electric light railways in the county.

The meeting adopted the report and balance-sheet, and unanimously agreed to the proposed sale of the tramways.

Mr. J. Devonshire, the managing director of the Metropolitan Electric Tramways, Limited, who have already acquired a controlling interest in the North Metropolitan Tramways Company, was elected a director of this Company.

LIVERPOOL OVERHEAD RAILWAY.

The half-yearly meeting of the Liverpool Overhead Railway Company was held on Tuesday at Liverpool.

Sir William Forwood presided, and said he regretted that the gross receipts showed a diminution of £3,508. At the same time there had been a saving in expenses of £1,391. As to the decrease in revenue, there was no doubt they had suffered from the competition of the Corporation electric tramways, which tapped their traffic at several points. Negotiations had been going on with the view of extending the line to the Seaforth Station of the Lancashire and Yorkshire Railway, and though for the moment in abeyance it would have to come sooner or later, for the signs of the times showed that all the great suburban lines, such as the Liverpool and Southport lines and the Garston lines, would have to be worked by electricity. The shareholders must not be discouraged, as he believed they had seen the worst of the competition.

The report was adopted.

TAFF VALE RAILWAY.

At the half-yearly meeting of the Taff Vale Railway Company, at Bristol, on Tuesday, **Mr. R. L. G. Vassall**, chairman of the directors, who presided, referred to threatened competition from tramways, and said the Board thought the best way of meeting it was to endeavour, if possible, to increase and improve the facilities which they offered to the travelling public, and also to watch and see what was being done or would be done by other companies for the introduction of electric traction on their systems, and being guided by the experience which they would thus gain in deciding whether they would or not electrify any part of their lines.

PERTH TRAMWAY.

On Tuesday an extraordinary general meeting of the shareholders of the Perth and District Tramways Company, Limited, was held in the Guildhall, Perth, for the purpose of considering reports by the directors on the negotiations between the Town Council of Perth and the directors of the Company regarding the proposed transfer of the undertaking to the town. Mr. W. S. Ferguson, Pictstonhill, presided. The following resolution was unanimously agreed to: "That this meeting approve of the action of the shareholders, and resolve to recommend to the directors to ascertain definitely now (1) whether the town are to proceed with the negotiation disclosed in the report for the purpose of taking over the whole undertaking by agreement on the basis hitherto laid down by the directors, and that the price be such as to enable them to repay the shareholders 20s. in the £; (2) or, failing this, by compulsory purchase by the town of the portion within the burgh; and (3) failing both, whether the town would grant a concession of 32 years, formerly applied for, in order that the Company might themselves convert the tramways to electric traction, taking the supply of electricity from the town, providing terms can be agreed to."

NORTH-EASTERN RAILWAY.

The report of the North-Eastern Railway for the half-year ended June 30, 1902, which is to be presented at the ninety-seventh half-yearly meeting at York to-day, contains the following paragraph: "The revenue from passenger traffic in the neighbourhood of Newcastle having suffered from the competition of tramways, the directors have carefully considered what action should be taken to meet this competition. They consider that the best method of meeting it is to increase the train service on the lines affected by the competition, and as they are advised that this can best be done by using electric traction, they have decided to seek tenders for the electrical equipment of the lines extending from Newcastle Central to New Bridge-street, *viâ* Tynemouth, including the Riverside branch. The tenders will be received in the month of October next. The Bill promoted by the Company has passed through both Houses of Parliament, and is now awaiting the Royal assent. Before the Bill reached the committee stage in the first House, an arrangement was arrived at with the Midland, Great Northern, and Great Central Companies with reference to the various proposals for railways in the Maltby district in South Yorkshire, under which the line proposed by this Company and the Lancashire and Yorkshire Company, with slight alterations of route, is to be made by the five companies jointly. In this way it is hoped that the interests of the district and of all the railway companies will be served without unnecessary duplication of capital expenditure. The Bill provides for vesting the Goole and Marshland and Isle of Axholme light railway undertakings in the North-Eastern and Lancashire and Yorkshire Companies jointly."

BELFAST TRAMWAYS.

The report to be submitted to-day shows a balance at the credit of revenue account of £7,401. 18s. 10d., and the directors recommend that a dividend be paid at the rate of 5½ per cent. per annum, free of income tax, which will absorb £7,315, and leave £86. 18s. 10d. to be carried forward, and having regard to the exceptionally high price of forage and other adverse circumstances of the half-year, the directors consider this dividend satisfactory. The report refers to the City Council's proposal for the purchase of the Company's undertaking at £380,000. The directors consider that the sum of £445,700, which is arrived at by taking the debentures and preference shares at par and the ordinary shares at 13½, is, in their opinion, a fair price, and they would have recommended the shareholders to accept it; but they are not prepared to advise the acceptance of the reduced amount of £380,000, which would only give the ordinary shareholders about £11 per share. At the same time the directors submit to the shareholders a form asking them to answer "Yes" or "No" to the question: "Whether the offer of £380,000 by the Belfast Corporation shall be accepted?"

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Calarasi-Stirbey (Roumania).—The Municipality require tenders for public electric lighting. Tenders by Sept. 3.

Plymouth.—The Corporation invite tenders for overhead line construction, etc., in connection with the tramways. Tenders by Aug. 23. See advertisement.

Reading.—Advertisements will shortly be issued inviting tenders for the execution of the works to be comprised in the proposed contract No. 4 (for overhead work).

Harrogate.—The Corporation invite tenders for the wiring and supply of fittings for the electric lighting at the kursaal, Harrogate. Tenders by Aug. 18. See advertisement.

Deptford.—The Metropolitan Asylums Board invite tenders for electric fire-alarm installation at the Orchard Small-Pox Hospital. Tenders by Aug. 28. See advertisement.

Huddersfield.—Tenders are invited for a motor-driven tower wagon, for use on inspection and repair of overhead equipment. Tenders by Aug. 18. See advertisement.

Accrington.—The Watch Committee invite tenders for nine arc lamps and pillars. Particulars may be obtained from Mr. H. Gray, Electrical Engineer's Office. Tenders by Aug. 19.

Edinburgh.—The Corporation invite tenders for cast-iron pillar boxes for street section fuses. Specification, etc., can be obtained from the Resident Engineer, Dewar-place, Edinburgh. Tenders by Aug. 26.

Poplar.—The Electricity Committee invite tenders for supply of arc lamp carbons. Specification, &c., may be obtained at the offices of the Borough Electrical Engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by 25th inst.

Aberdeen.—The City District Lunacy Board invite tenders for an electric light installation at Kingseat Asylum, Newmachar, Aberdeenshire. Particulars may be obtained from Mr. A. Marshall Mackenzie, 343, Union-street, Aberdeen. Tenders by Aug. 25.

Malvern.—The Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work); engines, alternators, exciters, and switchboard; high and low tension concentric cables; and transformers. Tenders by Aug. 23. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1. The Government also propose to lay a cable between Punta-Arenas and Puerto-Montt.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories Tenders by Sept. 15. See advertisement.

Rugby.—The Urban District Council invite tenders for the supply and erection of one 150-kw. and one 60-kw. high-speed steam alternators, three-phase, switchboard, underground mains, arc lamps, public incandescent lamps, etc., and meters. Tenders by Aug. 20. See advertisement.

Bexley.—The Electric Lighting and Traction Committee invite tenders for permanent way, bonding, overhead equipment, car bodies, trucks, and electrical equipment. Specification, etc., can be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster. Tenders by Sept. 4.

West Ham.—The Council are inviting tenders for steam, exhaust, feed-water, and drain piping, water softener, steam traps and separators, and circulating and air pumps, discharge piping, water purifier, and vapour pipes for the electricity works. Tenders by Sept. 2. See advertisement.

Bristol.—The Electrical Committee invite tenders for foundations, culverts, subways, etc., at the Avonbank electricity works. Specification, etc., may be seen and obtained at the offices of Mr. H. Faraday Proctor, A.M.I.C.E., M.I.E.E., city electrical engineer, Temple Back, Bristol. Tenders by 12 noon on 28th inst.

Ilford.—The Urban District Council invite tenders for a combined track watering and sweeping car on maximum traction truck with complete electrical equipment. Specification, etc., may be obtained at the offices of Mr. John W. Benton, clerk to the Council, Town Hall, Ilford. Tenders by 12 noon on Aug. 19.

Bury (Lancs.).—The Tramways Committee invite tenders for supply and delivery of rails and fishplates: fishbolts and nuts, tiebars; points and crossings; and sole or anchor plates. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by 28th inst.

Doncaster.—The Corporation invite tenders for the supply, delivery, and fixing of an ejector condenser plant, with all necessary pumps, piping, etc., at the Corporation electricity works, Doncaster. Particulars may be obtained from Mr. W. Wyld, borough electrical engineer, Grey Friars-road, Doncaster. Tenders by Aug. 28.

Newport (Mon.).—The Asylum Visiting Committee invite tenders for electric generating plant and electrical wiring and fitting for the proposed new lunatic asylum at Caerleon, Mon. Specifications, etc., can be seen at Mr. A. J. Wood's offices, 22, Surrey-street, Victoria-embankment, W.C., and obtained from the Borough Engineer. Tenders by Aug. 20.

West Hartlepool.—The Corporation invite tenders for supply, delivery, and erection complete of additional steam and exhaust pipes, feed-pipes and feed-pump, and all necessary drain-pipes. Specification, etc., can be obtained from Mr. H. F. Frederichs, borough electrical engineer, Electricity Works, Burn-road, West Hartlepool. Tenders by Aug. 20.

Swansea.—The Council invite tenders for the whole or portions of the following: supplying and laying telephone conduits and cables, erecting telephone poles, standards, arms, etc., fixing subscribers' instruments, the supply of creosoted telephone poles, insulators, wooden arms, ironwork, galvanised iron arm bolts, nuts, and washers, wire, batteries, instruments, switchboards, etc. Tenders by Sept. 1. See advertisement.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

Madrid.—The Public Works Department invite tenders for the extension of electric tramways in the east of Madrid, and also for a new line and working of the same for not more than 60 years. A preliminary deposit of 3,368 pesetas and a final deposit of 16,844 pesetas is required, also the repayment of 3,189 pesetas and interest to the Sociedad del Tranvia del Este for preparation of the scheme. Particulars may be obtained from the above. Tenders by Aug 26.

Bristol.—The Board of Guardians invite tenders for supply of boilers and electric wiring and fittings, etc., for their infirmary proposed to be erected for the accommodation of about 875 sick patients at Stapleton. Specification, etc., can be obtained from Mr. J. J. Simpson, clerk, St. Peter's Hospital, Bristol. Contract No. 2 will be for the electric wiring, electric fittings, electric bells and telephones, and electric motors. No. 3 will be for the supply and erection of Lancashire steam boilers, economiser, steam-pipes, pumps, heating apparatus, hot-water mains and services, hydrants, laundry machinery, kitchen fittings, etc. Tenders by Sept. 10.

Christiania.—A dispatch has been received at the Board of Trade, through the Foreign Office, from his Majesty's Consul-General at Christiania, reporting that tenders will be received up to 12 noon on the 18th instant for the supply of solder tin to the Norwegian State Telegraph Department. Specifications, and conditions of tender may be inspected at the Technical Department of the Board of Telegraphs, Christiania, and also on application to the Inspector of Telegraphs at Trondhjem, Bergen, Stavanger, and Arendal, daily between the hours of 12 and 1. Apart from the usual Customs duties, a preference of from 10 to 15 per cent. is given to native manufacturers.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

Leicester.—The Tramways Committee invite tenders for electric tramway works and materials, under the following sections, each comprising a separate contract. For supply and delivery of steel girder tramway rails and fishplates; supply and delivery of bolts, nuts, and tiebars; supply and delivery of points, crossings, and special track work; supply and delivery of stoneware pipes and conduits; supply and laying of feeder cables, telephone and test wires, and supply and delivery of roadway frames and covers; supply and erection of overhead electrical equipment, and the supply of copper bonds; supply and erection at the power station of steam-raising plant; supply and erection at the power station of engines, generators, battery, boosters, switchboard, overhead travelling crane, etc.; supply and delivery of electric tramcars. Specification, etc., may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., engineer, Town Hall, Leicester. Tenders by Sept. 3.

Selangor (Malay States).—The Crown Agents for the Colonies invite tenders for certain plant and materials in connection with the electricity supply scheme for the town of Koala Lumpur, in the protected native state of Selangor, Federated Malay States: (Contract A, Section 1) supply, delivery, and erection of a generating station, consisting of two 600-h.p. high-pressure turbines, with pipes, two 400-kw. three-phase alternators, switchboard, and sundries. (Section 2) The supply, delivery, and erection of a sub-station plant, consisting of three 150-kw. motor-generators, two balancers, switchboards, and sundries. (Contract B, Section 3) The supply and delivery f.o.b. at a European port of steel poles, cross-arms, insulators, copper wire, &c., for the high-pressure transmission line. (Contract C, Section 4) The supply and delivery f.o.b. at a European port of arc lamps, iron posts, controlling apparatus, incandescent lamps and fittings. Tenders may be sent in for any or all of above three contracts. Specifications, drawings, general conditions, and forms of tender may be obtained from the Crown Agents for the Colonies, Downing-street, London, S.W., on and after 7th inst., on payment of £2 for Contract A, £1 for Contract B, and £1 for Contract C. Sealed tenders, endorsed "Selangor Electric Lighting Contract," and addressed to the Crown Agents for the Colonies, are to be delivered at Downing-street, London, S.W., by 12 noon on Aug. 21. All information regarding above contracts is to be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

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RESULTS OF TENDERS.

Newport (Mon.).—The tender of Mr. Krauss, Bristol, has been accepted for the work of reconstruction of the existing tramlines at £33,000.

Warrington.—The Town Council have accepted the tender of the British Thomson-Houston Company, at £5,996, for the supply of 11 tramcars.

Spennymoor.—The Urban District Council have accepted the tender of the Electricity Supply Company for lighting the blocks, tunnel, and Merrington-lane-road, at £2. 5s. per lamp per annum.

Elmton-with-Creswell.—The Parish Council have accepted the tender of J. Davis and Son (Derby), Limited, All Saints, Derby, for the supply and erection of plant for the distribution of electricity for lighting the villages, at £590. 10s.

Dewsbury.—The Town Council have accepted the tender of the Klein Engineering Company, Manchester, for the construction of a cooling tower at the electricity works, and that of Clay, Henriques, and Co., Saville Town, for the supply of the piping required for the above.

Nuneaton.—The Urban District Council have accepted the tender of the British Westinghouse Electric and Manufacturing Company for the supply and erection of 20 arc lamp columns, with brackets, etc. A number of other tenders have been sealed for the supply of street-lighting cables, private lighting cables, joint-boxes, and compounds.

Southport.—The Corporation have accepted the following tenders in connection with the equipment of the new tramline: British Thomson-Houston Company, section boxes, £65. 3s. 5d.; Electric Tramway Equipment Company, electrical equipment, £73. 10s. 8d.; Hadfield and Co., points and crossings, £235. 5s. The special fittings will be purchased from the makers of the most suitable patterns.

Bradford.—The Corporation have recently accepted the following tenders: Collinson Bros., Aldermanbury, Bradford, wiring the new Corporation conditioning house; G. A. Steinthal, Piccadilly, Bradford, wiring the new Corporation fire station; Easton and Co., Erith, Kent, converting the town hall passenger lift from hydraulic into electric power; British Thomson-Houston Company, Rugby, half-yearly supply of incandescent lamps; Cole, Marchent, and Morley, Prospect Foundry, Bradford, supply of exhaust steam oil separators for the Corporation new electricity generating station.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board have accepted the following tenders for the supply, delivery, erection, and construction of (Section A) three 500-kw. steam-driven, direct-coupled three-phase alternators, etc.; and (B) three 50-kw. steam-driven direct-coupled continuous-current exciters, etc. Contract No. 4 (Section A), Dick, Kerr, and Co., 110, Cannon-street, E.C., with Yates and Thom engines; (B) J. P. Hall, and Co., Oldham, with Belliss and Morcom engines. Contract No. 5 (permanent way) has not yet been settled.

Kinfauns Castle (N.B.).—The following tenders have been received for the supplying and erection of an electric lighting plant at Kinfauns Castle, N.B., to the specification of the consulting engineer, Mr. Morgan Williams, M.I.C.E.: E. Scott and Mountain, Newcastle-on-Tyne, £2,360. 10s.; Middleton and Townsend, Edinburgh, (*a*) £2,295. 3s. 6d., (*b*) £2,190; Macaulay, Clarke, and Maclaren, Glasgow, (*a*) £2,090. 15s., (*b*) £2,040. 15s., (*c*) £2,020. 15s., (*d*) £2,036. 15s.; Lowdon Bros., Dundee, (*a*) £2,058. 19s. 6d., (*b*) £2,008. 19s. 6d.; Mavor and Coulson, Glasgow, (*a*) £2,079. 5s., (*b*) £1,939. 5s. (accepted).

Stockton-on-Tees.—The Town Council have accepted the following tenders in connection with the extension of the electricity works: (Section 1, one 300-kw. steam generator), J. and H. McLaren, Leeds; (2, two Lancashire type boilers), Riley Bros., Stockton-on-Tees; (3, one switchboard panel and instruments), Reyrolle and Co., Limited, Hebburn-on-Tyne; (4 and 5, surface condenser and cooling plant—pipework and valves) Worth, Mackenzie and Co., Limited, Stockton-on-Tees; (6, extension feeders), Callender Cable and Construction Company, Limited, Belvedere, Kent; (7, mechanical stokers, economiser and feed pump), has not been awarded yet.

New South Wales.—The schedule of tenders accepted for the supply of telegraph, telephone, and electric light material to the Government for the year 1901-2 contains the following items: D. Diercks and Co. Proprietary, Limited, 163 to 169, William-street, Melbourne, 10 knots four-core multiple submarine cable (conditionally), £236. 10s. 6d. per knot; five knots seven-core multiple submarine cable (conditionally). £380. 19s. 4d. per knot: five knots 12-core multiple submarine cable (conditionally), £592. 5s. per knot. The India Rubber, Gutta Percha, and Telegraph Works Company, Limited, 279, George-street, Sydney, six miles cross-connecting wire, two conductors, wool covered, £5. 17s. 10d. per mile; three miles cross-connecting wire, three conductors, wool covered, £8. 11s. 6d. per mile. Rabone, Feery, and Co., 257A, George-street, Sydney, 2½ miles of 26 pairs aerial telephone cable, £318 per mile; 2½ miles of 52 pairs aerial telephone cable, £476 per mile. D. Diercks and Co. Proprietary, Limited, 163 to 169, William-street, Melbourne, 2½ miles of 78 pairs metallic return telephone cable, £529. 8s. per mile; 2½ miles of 52 pairs metallic return telephone cable, £386. 6s.; five miles of 39 pairs metallic return telephone cable, £324; five miles of 26 pairs metallic return telephone cable, £243. Siemens Bros. and Co., 16, O'Connell-street, Sydney, 2½ miles of 13 pairs metallic return telephone cable, £177 per mile. The complete list can be seen at this office.

Llanelly.—We understand that the Insulated Wire Company are now prepared to proceed with a scheme of electric light and traction for the district.

BUSINESS NOTES.

TRACTION.

Wrexham.—The work of laying the tramways is being carried out in Bridge-street and Regent-street.

Margate.—Passengers over the electric tramways on Saturday, Sunday, and Monday exceeded 107,000.

Darlington.—Plans prepared by Messrs. Kennedy and Jenkin, showing the various proposed lines of railways, have been approved.

Batley.—The draft proposed heads of agreement between the British Electric Traction Company and the Corporation is under consideration.

Audenshaw.—The Board of Trade have granted the District Council an extension of time for the completion of the tramway until Aug. 9 next year.

Merthyr.—The proposal of the Merthyr Electric Traction Company to increase their rate of speed on the Dowlais and Cefn sections of the railway has been agreed to.

Birkenhead.—The following are the tramway returns for the six weeks ended June 27: total mileage, 147,287¼; passengers carried, 1,279,326; total receipts, £6,364. 14s. 1½d.

Keighley.—The Town Council on Tuesday in committee had under consideration the question of electric traction for the tramways. No decision was arrived at, the discussion being adjourned.

Darwen.—Alderman J. J. Wilkes, chairman of the Electric Tramways Committee, in his report speaks highly in favour of the overhead trolley system. Mr. Lunn has also submitted a report.

Birkdale.—The District Council have received a deputation urging them to proceed with the laying of the line for the electric car section from Weld-road to Grosvenor-road, as contemplated some time ago.

West Bromwich.—The Town Council intend to apply for sanction to borrow £10,000 to enable them to carry out extensions at the electricity works to meet the increased demand in connection with the trams.

Dewsbury.—The Town Council intend to apply for sanction to borrow £2,750 in respect of the purchase of the portion of the Dewsbury, Batley, and Birstall Tramway Company's undertaking within the borough.

Southport.—Application is to be made to the Board of Trade for sanction to the borrowing of £16,500 for the purpose of constructing and equipping tramlines in Ash-street, Cemetery-road, Duke-street, and Shakespeare-street.

Wolverhampton.—On Friday the Royal assent was given by commission to a Bill confirming a provisional order granted by the Board of Trade to the Wolverhampton Corporation, authorising extensions of the Corporation tramways.

City and Surrey Electric Railway Co.—At a meeting of the shareholders of the City and Surrey Electric Railway Company, Limited, on Friday, it was resolved to amalgamate with the National Electric Traction Company, Limited.

Rochdale.—The Board of Trade has declined to sanction the proposed deviation of the esplanade tramways. The receipts on the various routes during the month of July totalled £636. The total number of passengers carried was 101,666.

Wallasey.—With regard to our note last week on the suggested loan of £9,500 for additional plant, we are informed that the matter is in the hands of Mr. J. H. Crowther, the Corporation's electrical engineer, who designed the whole of the station, car-sheds, etc.

Twickenham.—The Board of Trade's postponed trial trip through Isleworth and Twickenham on the extension of the London United Tramway Company came off on Tuesday. The trip proved extremely satisfactory, and the line was opened for regular traffic on Wednesday.

Yarmouth.—On Sunday the electric tramcars had 14,827 and on Monday 21,417 passengers. Quite as many were carried on Tuesday as on Sunday. The total for the three days exceeded 51,000. We understand the receipts on Monday amounted to considerably over £100.

Formby.—The Birkdale Urban District Council will receive a deputation with a view to arranging with the Birkdale Electric Traction Company the extension of the electric tramway system from Birkdale to Formby, which means direct communication by electric cars from Formby to Southport.

Harrogate.—The Council propose to seek power in the next session by a Bill to provide electric tramways in and for the district of Harrogate, and the borough surveyor and electrical engineer have been instructed to prepare a draft and submit the same to the next meeting of the Tramways Committee.

Walsall.—The construction of the permanent way of the new tramways is to be commenced immediately. The erection of the car-sheds and depôt has already begun, and the borough surveyor has been authorised to engage a practical man as clerk of works to superintend the construction of the tramway depôt.

Manchester.—On the 12th inst. the vice-chairman of the Tramways Committee (Mr. W. H. Wainwright) laid the foundation stone of the new electric car-shed and offices to be erected at Ardwick for the purposes of the municipal tramways. The site is near the Nicholls Hospital, and the cost of the buildings is estimated at about £50,000.

Coronation.—The procession of illuminated and decorated tramcars was a prominent form of celebration at Huddersfield, Hull, Birkenhead, and a number of other towns. Mr. J. W. Courtenay, advertising contractor of the Leeds tramways, has given a number of prizes to those drivers and conductors who showed most taste and skill in decorating their cars during the coronation festivities.

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Ashton and Hurst.—The new scheme of electric trams to connect Ashton-under-Lyne and Hurst was officially tried and inspected at noon on Friday. A double-deck car, lent by the Oldham, Ashton, and Hyde Electric Tramway Company, was requisitioned, and the Tramways Committee, with the Corporation officials, were driven along the route, making a circuit of Hurst urban district.

Exeter.—The City Council on Aug. 8 were discussing the proposed routes for the electric tramways. The special object for which the meeting was called—to pass a resolution asking the Board of Trade's sanction to the purchase of the present trams by the Council—could not be attained, there not being two-thirds of the members present. It was accordingly decided to call the meeting for Sept. 10.

Wallsend.—On Monday a trial run of one of the trams took place on the route between Wallsend and North Shields. The date of the Board of Trade trial has not yet been fixed, but is expected to take place shortly. All the cars are fitted with Newall's patent magnetic brake, an apparatus to which is ascribed the capability of being able to stop a car travelling at the rate of 20 miles an hour inside 10 yards.

Willington Quay.—A plan has been submitted by Messrs. Dick, Kerr, and Co. showing three schemes for dealing with the tramway track opposite the Commissioners' gates, and they wished to know which the Council desired them to adopt. The committee recommended that the contractors be instructed that the Council considered the lines should be lowered to as near the level of the old road as possible.

Steyning West.—At their next meeting the Rural District Council will consider a letter from the British Electric Traction Company intimating that they understood that the Council would favourably consider the offer of a net sum of £22 yearly in connection with the tramway scheme so far as it concerned Kingston-by-Sea and Lancing. If they did so, the company expressed their intention of going through those two districts.

South Shields.—At the meeting of the Town Council held on the 6th inst., it was decided to apply in the next parliamentary session for powers for the purpose of working the trams by electric traction. Mr. J. H. Cawthra, chief electrical engineer to the borough, was instructed to furnish the Tramways Committee with a report on the various systems of electrical traction adopted at home and abroad, and also to prepare estimates for same.

Colchester.—The Council are discussing in committee the advisability of at once undertaking the widening of North Bridge. A deviation of route proposed by the promoters of the Southend, Bradwell, and Colchester light railway scheme was adopted, subject to the conditions: (1) that Layer-road where crossed by the line be not lowered for the purposes of the bridge over the same; (2) the span of the bridge to be not less than 36ft. in width.

Hartlepool.—The Hartlepool Electric Tramway Company have offered the Town Council to light the town upon much more favourable terms than any outside company, conditional upon the Corporation extending the company's lease of the tramways for a further period of seven years, and they have asked the Corporation not to complete a contract with any other company until after an interview with their directors. The matter is before a committee.

Sunderland.—On Sunday afternoon, as a tramcar was coming up Fawcett-street, one of the overhead trolley wires broke and fell to the ground. The driver and the conductor secured and prevented anyone touching the wire, and traffic on the section was restored in about half an hour. It is estimated that 85,000 people were carried on the Corporation tramways system on Saturday. The traffic was mainly on the Roker section between six and eleven o'clock at night.

Ayr.—It was reported at the last meeting of Town Council that from £2,000 to £3,000 additional beyond the sum authorised by Act of Parliament requires to be borrowed to complete the tramways undertaking. The additional expenditure has been incurred in doubling the line in various places and erecting workmen's dwellings. The town clerk was instructed to communicate with Mr. John Kennedy, the Corporation's parliamentary agent, on the subject.

Glossop.—The measurement of the roads between Barton and Davyhulme has been forwarded to the syndicate who propose to construct a system of electrical tramways between Barton Bridge and Glossop—a distance of over 15 miles—and an intimation had also been given that where the roads were not of sufficient width to allow of the necessary space required by the Board of Trade between the footpaths and the tramlines, the syndicate would have to purchase the land required at their own cost.

Blackpool.—The receipts from the promenade and Lytham road routes for July, 1900, when 1d. stages were in operation, were £4,833. 3s. 2d., and the receipts for the same month this year, with a minimum fare of 2d., were £4,284. 19s. 1d., a decrease of £538. 4s. 1d. The decrease is attributed, not to the increased fare, but to the falling off in the number of visitors, but probably the loss would have been less if 1d. fares had prevailed, as there would have been an increase in the local receipts.

Bury.—The overhead tramway system has been adopted by the Town Council. The request made by the Johnson-Lundell Electric Traction Company, Limited, for an extension of time in which to lay down an experimental line in Bury to demonstrate their system has been refused, and a special meeting of the Council will be held early in September for the purpose of passing a resolution requiring the Bury, Rochdale, and Oldham Tramways Company to sell as much of their undertaking as lies within the borough.

Oldham.—The Tramways Committee are trying for one month stopping places on the circular route. It is stated that the committee are unable to maintain a reasonable time-table owing to the large number of times the cars were stopped on this route. The longest distance between any two of the proposed stopping places is 250 yards. The average power used in running a car is about 24 h.p., but it takes about 50 h.p. to 60 h.p. to start a car, and thus great wear and tear is entailed on the cars and motors.

Croydon.—At a recent meeting of the County Council a report from the Tramways Committee was adopted, in which it was recommended that Mr. Edward F. Morgan, the borough road surveyor (formerly in the surveyor's department at Reading), should be voted 200 guineas in recognition of the very able way and the great care and attention which he has given to the laying-out of the track. Alderman Sir Fredk. Edridge, the chairman of the committee, has also privately presented Mr. Morgan with a handsome timepiece, suitably inscribed.

Birmingham.—The fact that the British Electric Traction Company have secured a controlling voice in the management of the affairs of the City of Birmingham Tramways Company is likely to have a far-reaching effect upon the tramway problem of the Midland city. The Council are inclined to listen to the Electric Traction Company owing to the fact that some of the existing leases have 10 years to run, but the citizens, in general, appear not at all satisfied with a prospect of losing the control of the tramways when they were practically within their grasp.

South Lancashire Tramways Co.—This company announce that, subject to satisfactory arrangements being come to with the local authorities as to street widenings not yet completed, the Bolton, Leigh, Atherton, and Tyldesley sections of the system will be opened for traffic at the end of August. By that time the central generating station is to be ready. The Bolton Corporation have recently extended their Daubhill service so as to connect with the company's lines, and through communication will thus be provided from Bolton to Atherton, Tyldesley, and Leigh.

Swinton and Pendlebury.—At the last meeting of the Urban District Council the clerk reported that he had written to the manager of the Salford Corporation tramways, asking the probable date of the substitution of electric for horse traction on the Swinton and Pendlebury tramways, and had received a reply to the effect that everything possible was being done to come to some conclusion with the Manchester Carriage and Tramways Company in regard to the purchase of the Swinton and Pendlebury lines, but he regretted that matters were progressing very slowly. The Salford Corporation were losing a considerable sum every day by the horse cars.

Burnley.—The tramway profits from March 1, 1901, to March 31, 1902, were £5,234. 17s. 9d. gross. This amount compares with £7,000 formerly earned by the tramway company in the later years of its existence, which must be taken as satisfactory, as out of the 13 months under review the tramways were not working five on account of reconstruction. For the four months of the new year the passengers carried numbered 2,024,188, and the receipts were £12,300. A new gong is being placed on the cars. It has also been decided to fit them with traversing jacks, by means of which a car can be raised in a few minutes in case of accident, and anything underneath taken out.

Staffordshire.—The award of Mr. Ernest Moon, K.C., in the matter of the South Staffordshire light railways order is as follows—viz.: "That the British Electric Traction Company, Limited, were entitled to use the paving, metalling, and other material excavated by them from roads in the urban district of Bilston, in the manner and for the purpose in and for which it was proved that such paving, metalling, and other material was used by the said company, and that such paving, metalling, and other material was applied by the said company in or towards the reinstating of the roads in question in this reference. Each party to bear their own costs of the reference."

Cardiff.—The receipts from the Corporation electric tramways on Monday amounted to £485. 6s. 2d., as against £500—the largest amount ever taken in Cardiff in one day—on Coronation Day. On Monday, however, 54 electric cars were on service, compared with 48 on Coronation Day. The precise number of the passengers on Monday has not yet been ascertained, but though the fares include 2d. route tickets, Mr. Ellis (the electrical engineer) states that the receipts taken represent over 100,000 passengers. The great bulk of them were conveyed over the Roath route, but owing chiefly to the great attraction at the Cardiff Arms Park, the traffic in the centre of the town itself was exceptionally heavy.

Mirfield.—At the last meeting of the District Council it was reported that on the previous Friday the deputation appointed by the Council had attended Huddersfield, and met the Tramways Committee. The deputation asked the Corporation when they were prepared to lay the tramways from Bradley to Mirfield. The deputation put before them this issue: whether they would lay the tramlines themselves or let the British Electric Traction Company do so. The Traction Company were quite willing to put down the rails if the Corporation would surrender their power. Since then the Corporation had been over the roadway from Bradley to Mirfield, and would give the Council an answer in about a fortnight's time.

Worcester.—A special meeting of the City Council was held on Tuesday to deal with certain matters with reference to the laying of the lines for the conversion of the trams to electric traction. The Streets Committee reported that they recommended that the British Electric Traction Company be asked to construct double lines wherever it was possible, and upon this request drawings had been prepared by the company's engineer providing for double lines in the centre of the city at an additional cost of £3,000, and making a total of £100,000. After much discussion, an amendment was agreed to by a large majority adopting a system of single lines in the centre of the streets, and asking the tramway company to submit amended plans.

Leeds.—The receipts on the tramways on Bank Holiday amounted to £1,565, on Sunday to £583, and on Saturday to £1,053, making a total of £3,201. On Bank Holiday a year ago the takings were £1,183. 6s. 7d., on the preceding Sunday they were £495. 12s. 10d., and on the Saturday £938. 18s. 6d., making a total for the three days

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of £2,622. 17s. 11d. The amount taken on the Roundhay route on Monday, exclusive of the Street-lane service, was £386. 3s. 1d. The Tramways Traffic Committee have recommended that a line should be made connecting New Market-street and New York-street, so as to enable outgoing cars for York-road and Beckett-street to proceed without being under the necessity of waiting at the end of the single line in Duncan-street.

Deptford.—The Borough Council have agreed to receive a deputation from the committee recently formed to further the object of tramway development in Deptford. The Highways Committee of the London County Council after considering the resolution passed by this Council inviting the County Council to consider the desirability of formulating a scheme for the construction of tramways between the Lower-road, the Broadway, and Lewisham, have replied that it is not advisable that either of the proposals should be adopted at the present time, as the construction of a double line of tramways along either of the routes would involve extensive and costly street widenings, and certain railway bridges would have to be reconstructed. The proposals stand now deferred *sine die*.

Accidents.—A collision occurred at Levenshulme, but no passengers were reported injured; the driver, however, was cut about the head with falling glass. On Saturday a child was run over by a car and killed at St. Helens. A fatal tramcar accident occurred at Chatham on Monday to a man in charge of an ambulance van. At Newcastle a man, whilst crossing the line, was knocked down by a car and received such injury as necessitated his removal to the central police station in order to have it attended to. Abbe Isward was riding a petroleum-driven motor tricycle in Paris on Tuesday and crashed into an electric tramcar, which was travelling at a rapid rate. The Abbe fell from his machine and rolled under the car, which crushed him badly. He was taken to a hospital, but died soon after admission.

Devonport.—In the Station-square at St. Budeaux on the 12th inst., Mr. J. C. Tozer, chairman of Devonport Corporation Tramways Committee, performed the ceremony of "breaking the ground," and thereby inaugurated the extension of tramways in various parts of the borough. He said the contract for the new lines, which Messrs. Griffiths, of London, had secured, was £37,000, while the cost of the line from the station to Saltash-passage was estimated at £15,000. The best engineer had been engaged for the construction of the lines, and he was sure Mr. Chadwell had the confidence of the committee who employed him. They had also established electricity works at a cost of £80,000, and they were assured that after the first year's working, under the chairmanship of Mr. Smith, there would be a slight profit for the benefit of the ratepayers.

Hove.—The Joint Committee on Trains yesterday recommended to the Town Council the preparation of a Bill for next session of Parliament for obtaining powers to construct tramways, etc. Three routes are recommended, one of the most important of which is to be from Hove Station through the centre of the town to the front, with a terminus in Waterloo-street, close to the lawns and sea-wall. It is estimated that the total capital expenditure on the overhead system would be £103,700, and on the part open conduit system £149,700. The capital expenditure for private supply to 15,000 8-c.p. lamps would be an additional £11,400. The estimated receipts and total expenses show a profit of £3,636 per annum on the overhead system and only £866 per annum on the conduit system, the latter amount being insufficient to provide for contingencies. The estimated receipts and expenses for private electricity supply show a profit of £816 per annum with 15,000 lamps connected.

Newport (Mon.).—On Tuesday the erection of the new power station, and the consequent electrical equipment of the tramways, was discussed. Good progress is being made in the erection of standards in the outlying and suburban parts of the borough for the electric traction and the consequent disappearance of horse trams, and when the main streets are reached this arrangement will be varied to cross supports held in place by wall brackets. We understand that the tenders received for the reconstruction of the tramway lines so as to make them suitable for electric traction, and for carrying out other work in connection with the change of system in order to expedite the incoming of the new era of electricity, show a very great saving of capital expenditure as compared with the parliamentary estimate upon which the outlay had been formally calculated. For the work which was covered by the tenders received the parliamentary estimate was something like £63,000, whereas the tenders provisionally accepted only amount to about £43,000 to £45,000.

Light Railways.—The latest parliamentary papers contain the Light Railway Commissioners' order, modified and confirmed by the Board of Trade, authorising the construction of light railways in the urban districts of Rishton, Clayton-le-Moors, Great Harwood, and Padiham, the rural districts of Clitheroe and Burnley, and the parishes or townships of Read, Simonstone, and Whalley, and (under certain conditions) in the county borough of Blackburn. The Board of Trade have, after modifications, confirmed the following light railway orders made by the Light Railway Commissioners: Llanelly and District Light Railway Order, 1902, authorising the construction of light railways in the urban district of Llanelly and the rural district of Llanelly, in the county of Carmarthen; Vale of Rheidol Light Railway (Amendment) Order, 1902, authorising the construction and working as a light railway, under the Light Railways Acts, 1896, of the railway authorised by the Vale of Rheidol (Light) Railway Act, 1897, and amending the Vale of Rheidol Light Railway (Aberayron Extension) Order, 1898. The Colne Town Council have received an intimation that the amended order of the light railway had been confirmed by the Board of Trade on July 25. There is a further amendment, however, before the authorities affecting the taking over of the line to Trawden.

Liverpool.—Forty-three district inspectors, ticket examiners, drivers, and conductors of the Corporation tramways have passed the "first aid" examination of the St. John's Ambulance Association. The proposed extension of the present Dingle route to Garston will come before the Tramway Committee in the course of the next few weeks. The first section of the South Lancashire tramway system, which connects the city of Liverpool with the towns of Prescot and St. Helens, was opened for passenger traffic on June 24, and has since been in daily operation. The returns of traffic have been completed from the opening until the 6th inst. They show that during these 44 days the total number of passengers carried was 176,194, being an average of over 4,000 per day, wet and fine, Sunday and Saturday. The trams have been in special favour during holiday times, and some of these details are worth citing. The returns for the three days of the Coronation festivities in June were as follows: Thursday, June 26, 7,178 passengers; Friday, June 27, 7,567 passengers; Saturday, June 28, 5,165 passengers. These figures, large as they are, were far exceeded on Monday, Aug. 4, Bank Holiday, when no fewer than 9,088 passengers travelled on the trams between Liverpool and St. Helens. The receipts have also been phenomenal. The weekly average has risen as high as 36·62d. per car mile; another week it was 23·69d. per car mile. The explanation of these notable returns is no doubt the cheapness of the transit and the frequency of the service.

Manchester Tramways.—The accounts of the Corporation Tramway Committee for the year ended March 31, 1902, give the traffic returns from June 7, 1901, and show a total car mileage of 1,831,126, a total of 23,590,288 passengers in the 10 months. The total receipts amount to £91,619. 8s. 4d., the average per car mile being 12·00. It will be recalled that the committee operated the Upper Brook-street and Regent-road routes by horse traction for a short period, and the percentage is shown as: electric traction, 12·20; horse traction, 9·79. On the entire 10 months' working the gross profits £33,196. 16s. 10d., on total revenue of £111,307. 12s. 7d. To this profit is added bank interest, £3,289. 14s. 3d., and surplus account transferred, £15,548. 2s. 1d., making £50,034. 13s. 2d. available. This amount was applied as under: interest on mortgage debt, £17,086. 6s. 1d.; sinking fund, £678. 12s. 3d.; instalment of loans, £1,669. 14s. 10d.; contribution in relief of the rates, £20,000; reserve, renewals, and depreciation account, £10,600; a total of £50,034. 13s. 2d. The total operating expenses are shown as 8·10 per car mile. The committee state that during the year they have had an administrative staff, offices, car-shed accommodation, cars, and equipments available for a much larger system than that which has been in operation, and consequently the expenses per car mile have been greater during the present year than they will be in future. As the tramway system is extended the operating expenses per car mile will gradually decrease. About 1,000 workmen have been employed on the permanent way during the year. The Corporation is now equipping with its own staff the additional lines on the system. The committee have secured 11 acres of land for the erection of a car-shed, repairing works, and depôt in Hyde-road. The Manchester tramway system, with its 150 miles of track, is connected with a much larger system of tramways, aggregating probably some 500 miles of track, consequently there is no doubt that in the future the committee will be called upon to deal with many difficult problems as to interchange of traffic in connection with this larger system of tramways.

LIGHTING AND GENERAL.

Goring.—A local company propose to apply for powers for lighting Goring and Streatley.

Pacific Cable.—The Royal assent has been given to the Pacific Cable Amendment Bill.

Peterhead.—The Town Council are determined to oppose the Electric Supply Corporation.

Colchester.—The Council have ordered 150 Nernst lamps from the Electrical Company, Limited.

Batley.—Mr. F. O. Kirby has been engaged for two months to assist in the borough surveyor's office.

Berwick.—The Urban Electric Supply Company will commence to lay an installation as early as possible.

King's Norton.—The Council are advertising for leasing their powers under the electric lighting order.

Hove.—Reference to the proposal of the Town Council to promote a Bill for electricity supply will be found elsewhere.

Frome.—Application will be made for sanction to borrow £20,000 for electricity works. Mr. Medhurst is the consulting engineer.

Durham.—The Corporation have received £685. 7s. 10d. from the Electric Power Distribution Company on account of street repairs.

Wakefield.—The City Council have resolved to apply for sanction to borrow a further sum of £15,000 for electricity works extension.

Brentford.—The question of gas and electric light fittings for the new workhouse has been referred to a small committee of the Guardians.

Dewsbury.—An enquiry will be held shortly into the application to borrow an additional £10,000 for extension of the electricity works.

Salisbury.—The consideration of the tenders of the gas company and the electric company has been postponed until the October meeting.

Barnstaple.—The Town Council have decided to borrow £21,600 from the Ecclesiastical Commissioners for the purposes of the electric lighting scheme.

Stroud.—A small committee has been appointed by the Urban District Council to consider the question of electric lighting, tramways, and power.

Grantham.—The Telephone Committee have entered into negotiations preliminary to the establishment of the proposed municipal telephone system.

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Ossett.—The General Purposes Committee have engaged an engineer to report upon the subject of a refuse destructor and electric lighting installation.

Oldham.—The Town Council have decided to apply to the Postmaster-General for a license to carry on telephone business within the Oldham exchange area.

Rugby.—Mr. A. A. G. Malet has held an enquiry into the application of the Urban District Council for sanction to borrow £9,000 for electric lighting purposes.

Ashton.—At a meeting of the Building Committee of the Guardians, two sub-committees were appointed to deal with the question of the water supply and electricity.

Sleaford.—The Urban District Council have resolved to extend the electric cable through New Quarrington, to light the extensive foundry erected by Messrs. Hempstead.

General Electric Co.—The Company's premises, the scene of the Queen Victoria-street fire, are being fitted with steel-wire ladders, reaching from the street to the top floor.

Sheffield.—The Great Central Railway are about to construct a siding from their main line to the new electric power station at Neepsend at a cost to the company of £1,210.

Birkenhead.—The application of residents at Egerton-park with reference to the proposed laying of electricity supply mains in, under, and along the roads in the park has been refused.

Louth.—A committee is preparing a detailed report upon a proposal to establish electrical works for providing light and power. The sum proposed to be expended upon the undertaking is £10,000.

Deptford.—The Council have informed the London County Council that they are in favour of the reintroduction of the London County Council's Electric Supply Bill into Parliament next session.

Bradford.—The Technical Instruction Committee propose that Mr. H. Bohle, of Birmingham, be appointed lecturer at the technical college in electrical engineering, at a salary of £200 a year.

Darlington.—The electric lighting mains are to be extended from Grange-road, along Polam Plantation, and the salary of Mr. J. R. P. Lunn, borough electrical engineer, is to be increased by £50 per annum.

Carnarvonshire.—The County Council have referred to a committee Mr. Assheton Smith's application for a provisional order enabling him to supply electric light to Portdinorwic, Dinorwic Quarries, and district.

Chesterfield.—At Tuesday's meeting of the Town Council reference was made to the progress of the electric lighting of the town, and it was said there need be no fear of the rates being called on to aid the committee.

Heywood.—The loss on the electric lighting account amounts to £149. 16s. As the works have only supplied current for six months the committee have decided to carry this deficiency forward to next year's account.

Tonbridge. The surveyor's plan showing the proposed waterway from the Medway to the electricity works, and the proposed depôt, has been referred to a committee. The surveyor estimates the cost of the works at £577.

Hartlepool.—We understand that the Town Council have approved the draft agreement with the Northern Counties Electrical Supply Company for the supply of current for public, private, and power purposes within the borough.

Brierley Hill.—The District Council are asking the Midland Electric Power Company if they would be ready to provide electricity for lighting the district in the coming winter season, and upon what terms they would supply current.

Mold.—The Urban District Council have resolved to accept the offer of the National Electric Wire Company to prepare and submit a preliminary report upon the cost of lighting the town with electricity, and as to a suitable site for the central station.

Bangor.—The electrical engineer (Mr. Price White) in his report for the month of June stated that there had been 48 per cent. increase in the number of units sold, and that 135 lamps had been added, making a total connected up to the end of month 7,145.

Swinton.—The Lancashire Electric Power Company will commence operations in a few weeks, and expect to be able to supply the district with current (on terms already placed before the Council) not later than the commencement of the lighting season of 1903.

Ogwen.—The District Council have consented to Mr. Assheton Smith's application for a provisional order for the purpose of supplying electricity for lighting and other purposes to the parish of Pentir, except so much as is included in the Bangor electric light area.

Beverley.—The Town Council have decided, as the Local Government Board have sanctioned the borrowing of £17,784 for electric lighting purposes, to confer with Edmundsons' Corporation as to the terms on which they will be prepared to instal and carry on the works.

Hereford.—The Electric Lighting Committee in their last report state that the current sold during the quarter ending at Midsummer amounted to 17,912 units, as compared with 12,557 units in the corresponding quarter of last year, yielding a revenue of £380. 9s. 7d., as compared with a revenue of £241. 5s. 9d. in the corresponding quarter of 1901.

Fareham.—The Council have sealed an agreement re the Portsmouth municipal telephone. The privilege rent is 5s. 2d. per mile of 20 to 30 poles, instead of 1s. per pole as previously paid by the National Telephone Company. The lines on the quay will be underground, and that the Corporation will carry a portion of the electric supply wires on their poles.

Dalton.—Messrs. Upperton and Co., London, have notified to the Council that it is intended, on behalf of a company to be formed, to apply, on or before Dec. 21 next, to the Board of Trade for a provisional order under the Electric Lighting Acts of 1882 to 1890, to supply electricity for all public and private purposes within the urban district of Dalton-in-Furness.

Maidstone.—The Urban District Council have adopted a report by the Electric Light Committee recommending that the mains be extended up the Bower Mount-road from the London-road at an estimated cost of £275; and that the electric light be installed at the gardener's cottage, Brenchley Gardens, and the caretaker's room, public lavatories, and market buildings.

Cleckheaton.—The District Council have appointed Mr. Albert Pickersgill, chief assistant electrical engineer to the Dewsbury Corporation, engineer to the District Council. There were 104 applicants for the post, and the commencing salary is £200 a year. An enquiry is to be held with reference to the Council's application for sanction to borrow a further sum of £6,000 for electricity purposes.

Felixstowe.—A proposal to offer the electrical supply company the sum of £7,000 for their works, and that they should pay the Council 6 per cent. interest in that amount for 25 years, has been postponed. The Council would collect the revenue of the business, handing over the balance after deducting the interest. If extension of the business was necessary, the decision was to rest with the Council.

Clayton.—At the monthly meeting of the Clayton-le-Moors District Council a letter was read from Messrs. Tahourdins and Hitchcock, stating that the undertakers of the Rishton, Great Harwood, and Clayton-le-Moors electric lighting order were unable to comply with Section 99 of the order, and asking the local authorities to take over the powers of the order, and purchase the undertaking for the sum of £150.

Canadian Arch.—The Canadian Arch was for the second time lit up with Nernst lamps on the 9th, 10th, and 11th inst., by the Electrical Company, Limited, 122-124, Charing Cross-road, W.C. Six hundred Nernst lamps of the one-ampere size were used, and the result for the second time proved to be a huge success. The makers and their English representatives deserve the high comments heard from all who saw the illumination.

Caerphilly.—The District Council are consulting Mr. Hill, the general manager of the South Wales Electrical Power Company, on their electric lighting order. The company can supply the Council with electrical power for distribution generally at 1½d. per unit for a limit of 100,000 units, and there is a possibility that their mains from Treforest will be laid across the mountain and thence through the Aber Valley to Llanbradach.

Redruth.—The Urban Electric Supply Company, who are preparing the Camborne-Redruth tramway, and are engaged to light Redruth with electricity, have been making strenuous efforts to complete their work. Two engines have been put into position, one of which will be sufficient to give light to Redruth. The four cars have also come to hand. It is rumoured that officials are confident of having the tramway at work early in September.

Hull.—At the meeting of the local Chamber of Commerce on Tuesday a communication was read with respect to the provision of underground telegraphic cables to certain large centres in the country. Mr. Dumonlin moved that the attention of the Postmaster-General be called to the fact that it was necessary that Hull, as one of the principal ports in the kingdom, should also have an underground telegraph service. The motion was carried.

City of London Union.—At the last meeting of the Board plans and specifications by Mr. Adrian Collins for lighting the infirmary by electricity were approved. The estimated cost of the work is £1,500. The Local Government Board will be asked to sanction the Guardians inviting tenders from the following three firms: Messrs. Pinching and Walton, Messrs. Lund, and the General Electric Lighting Company, without in the first instance advertising for sealed tenders.

Loughborough.—The Rural District Council have received a communication from the Notts and Derbyshire Electrical Power Company pointing out that the company would be prepared, if the Council thought advisable, to pay the cost for the Council to lay the mains for the supply of electricity for motive power, and would assist the Council in obtaining a provisional order. A representative of the company has been invited to attend a meeting of the Council to further consider the matter.

Frimley.—It will be remembered that about three years ago the Council considered the question of the electric lighting of the district, and engaged an expert to report. Sir Edwin Markham, the governor of the Royal Military College, has now recommended the electric lighting of the college, and if the Government will take the electricity for lighting the colleges and the Deep Cut Barracks, the Council would have a good customer. The Council will, therefore, further consider the matter.

Broughty Ferry.—Considerable progress has now been made in laying the cables for the electric light. The construction company have a large staff of workmen employed, and the concrete footway on the south side of East Brook-street has been broken up and the electric channel laid. In East Castle-street the cable has been laid and a portion of the footway filled in. The buildings at the gasworks are now well forward. The Town Council have decided to erect 12 arc lamps in the streets.

Cardiff.—The Corporation intend to apply for powers to enable them to hire out or sell motors. The electrical engineer's plans for the lighting of streets from the tramway pillars in the place of the pillars now used have been approved by the committee, and the work will now be carried out. Steps are being taken to comply with an application from tenants on the Bute Estate both for power and light. It is stated that every street in which cables have been laid will be electrically lighted before the coming winter opens. The work is being pushed forward energetically.

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Whitby.—The Postmaster-General has agreed to provide a telegraph office at North-road post office, and has applied for sanction to erect a big telegraph pole there. The erection of such a pole is thought by the Council to be a hideous thing, and an eyesore to the district, and they suggest that a wire be put underground.

Glasgow.—The last report of the Committee on Telephone Service states that on July 29 the number of instruments applied for was 7,658, and that the number of subscribers at present connected with the exchange was 6,050. Lord Blythswood, who is well known as an amateur electrical expert, has just presented to the Royal Infirmary a Wimshurst machine built by himself at Blythswood House, Renfrew. The machine is one of the largest in existence, and has been fitted up in the new electrical department of the infirmary.

Bolton.—The municipal technical school have placed an order with Messrs. Witting Bros., Limited, electrical engineers and contractors, for the preliminary equipment of the new dynamo-room. The order comprises single and polyphase alternators, single and polyphase motors, direct-current motors, direct-current dynamos, transformers, a rotary converter, and a complete switchboard. The same firm also recently received an order from the Brompton and Kensington Electricity Supply Company, Limited, for two motor-generators, each consisting of a Heyland motor driving a continuous-current generator, for accumulator charging.

Birkdale.—In moving the minutes of the Electricity, Lighting, and Licensing Committee, at the last meeting of the Council, Mr. Clinning alluded to the official switching on of the current at the Shafteabury-road generating station on the previous Friday, and said as the time went on the price of electric light would be considerably reduced if the company sold about the maximum quantity. As had been stated, they had no third price. Sevenpence per unit would be the first charge, and there would be a second charge when a certain number of units were consumed, which would mean the reducing of the price of the electric current to 2d.

Islington.—The Borough Council have been considering a letter from Stoke Newington, which stated that the borough having obtained an electric lighting order, they considered that it would be of mutual advantage to themselves and the neighbouring boroughs (Islington and Hackney) if they obtained electricity in bulk. They inserted a provision for that purpose, but the Board of Trade refuse to consider the matter except upon application from Islington and Hackney. Consequently the borough asked Islington to make application to the Board of Trade to supply electricity in bulk. The matter is now before the Electric Lighting Committee, who have power to act.

American Pacific Cable.—A Reuter's telegram from Washington states that President Roosevelt has granted the application of the Commercial Pacific Cable Company, which purposes to construct a cable from San Francisco to China, with landings at Hawaii, Guam, and the Philippines. The President has also granted the company access to certain charts of soundings and profiles of the ocean bed belonging to the Navy Department. Among the conditions on which the application is granted are that the Government shall have the right to purchase the cable at any time, and to assume full control of it when the country is at war or when war is threatened.

Swingbridges.—At the last meeting of the Northwich Urban District Council a curious state of affairs transpired relative to the electrical swingbridges over the River Weaver. There are two bridges, one being an alternative route over the Chester main road. Late the other night it was found that both bridges had stuck in being turned, and the public were prevented from crossing the river. The manager of the Weaver Trust wrote stating that the stoppage resulted from extraordinary causes. One bridge was stopped by the failure of an electric main, and the other almost at the same moment by a similar cause—namely, the burning of the main fuse. Such an odd coincidence could scarcely occur again.

Reading.—At the last meeting of the Town Council a report was adopted containing a recommendation that during the construction of the tramway tracks ducts be laid in the tracks from Factory Bridge to Oxford-road railway bridge, from Silver-street to King-street, and from Crown street through West-street to Caversham-road bridge for the purpose of lighting the streets by arc lamps if hereafter it should be deemed desirable to adopt that mode of lighting. It is proposed that the Corporation should supply and own their cables and take the current in bulk by meter at any point mutually convenient to them and to the Reading Electric Supply Company, as, for instance, the municipal buildings or the police station.

Ayr.—The electrical engineer (Mr. A. J. Fuller) in his last report gives the following figures: "Number of consumers as per last report, 556; number of consumers connected during month, 18—total, 574. Number of lamps connected as per last report, 23,378; number of lamps connected during month, 550—total, 23,928. Units generated as per last report, 101,866; units generated during month, 62,953—total, 164,819." With regard to the Electric Lighting Acts Amendment (Scotland) Bill, instruction has been given for a letter to be sent to the Secretary of Scotland pointing out the objections to the existing limited period for repayment of such loans, and asking him to extend it by the insertion of the necessary provisions either in this Bill or in some other Bill dealing generally with the same subject.

Kensington.—In reply to a claim for rent on lines not yet established, a formal notice to be given to the National Telephone Company that unless the whole of the works referred to in the agreement of Oct. 16 are completed within two months such agreement will be regarded as determined, and for the company to be further informed that the Council are not prepared to recognise any liability for the payment of any rental under the agreement until the borough engineer has certified that telephonic communication has been completed between the several establishments. The Council have decided to serve a notice upon the Post Office authorities either to remove certain telephone pipes, which they contend have been laid not deep enough, or to lower the same and lay them to the satisfaction of the borough engineer, in accordance with the conditions attached to the consent given by the Council on April 29 last.

Tyneside.—A number of statements have been recently given which show the progress of electricity on Tyneside. Not the least is this indicated by the progress of the demand at South Shields, where in the year 1897 there were 90 consumers, the number in the recently completed year being 730, whilst the increase in the number of units sold is at least fully as large. The growth of the demand at Newcastle was shown in the papers that were read a week or so ago at the Institution of Mechanical Engineers, whilst the large works that are in course of completion to supply the increase of the demand are visible to the travellers by the high-level bridge who look down on the river. There there has been erected a large undertaking which is one of the most notable of the attempts to manufacture and supply electricity cheaply. There are many others being made in the north-east, and it may be said that the electrical industries are busy and likely to continue so for some time to come, though some of the areas of supply are now being filled.

Eastbourne.—The Electric Light Committee in their last report state that the accumulated profit as shown by the borough accountant's report was £5,078. 9s. 7d., which was earned as follows: £1,816. 2s. 9d. during the 15 months ended March, 1901; £3,262. 6s. 10d. during the year ended March 31, 1902. The committee estimate that when the full capital expenditure has been made the account will have to bear a yearly burden in respect of sinking fund and interest for the new loan of no less than £3,100. In addition to this, sinking fund and interest will be incurred in respect of capital expenditure £11,250 not included in the foregoing account, and this will amount to £710. The total sinking fund and interest will, therefore, be £3,810 if and when the whole of the above sum of £11,250 is expended. The increase of income during the past financial year ending March 31, 1902, over that ending March 31, 1901, is 20 per cent. The revenue this year is estimated to reach £17,500, but if the charge for electric light be reduced from 7½d. to 6d. per unit there will be a decrease in income of £3,500 per annum.

Cardiff Telephones.—The Post Office authorities are rapidly completing their trunk-line telephone system. At present there are two or three routes of wires on poles between Cardiff and Newport, but the capacity of the poles has been almost reached. With the double purpose, therefore, of providing for the future development of the system, and also as a precaution against the possibility of a total breakdown in case of a heavy storm, an underground paper-insulated cable, supplied by the British Insulated Wire Company, is being laid between Cardiff and Newport on the main road through St. Mellon's. The work was begun last year, when gangs of men were employed digging a trench and laying an iron pipe all the way between the chief post offices of the respective towns. At the present time the Post Office workmen are engaged upon the jointing process. The work is under the superintendence of Mr. W. W. Vyle, the superintending engineer of the South Wales district, and under the active supervision of the engineers, Messrs. Robinson and McNicol, of Newport, and Messrs. Price and McMullin, of Cardiff.

Maritime Alps.—The energetic American having been foiled for the time in his attempt to capture the Mediterranean coal trade—largely owing to the lower prices of the British article—has had his eye on the water power of the Maritime Alps. In this case also he has not succeeded. The Americans, according to a note by our Marseilles Consul, which recently appeared in the *Daily Telegraph*, found a French company already in the field, being organised with a view to securing all the water power available in the Alpes-Maritimes from Marseilles to Mentone. The object of the proposed company is to supply electric light and also electric power to all the towns on the south-eastern coast of France. It is also hoped to supply power to the electric locomotives which the director of the Paris-Lyon-Méditerranée Railway Company proposes to test on the Cannes-to-Monaco section of the line during the winter season. It is said that Mr. Noblemaire, director of the Paris-Lyon-Méditerranée Company, has made it a personal matter to start electric traction on the Mediterranean Coast line before his retirement from the directorship of that company.

Ealing.—Mr. Albert E. Lewis, the business manager of the electric lighting department, states in his last report as follows: "The June quarter meter readings have again shown a remarkable increase in the output, private consumers having taken 82,920 units, an increase of 39 per cent. on the sales for the corresponding quarter last year. The income derived was £2,093. 12s. 4d., the average price being 5·61d. per unit, against 5·63d. per unit last year. That the superiority of electricity as an illuminant is becoming more and more appreciated is evidenced by the continual increase in the output, the sales for the present quarter being 91 per cent. in advance of the output for the corresponding period two years ago. Seventy-five new applications for supply were received between March 31 and June 30, making the total number of consumers at that date 1,066. The figures for the corresponding quarters during the last three years are: 1900, 43,350 units; 1901, 59,543 units; 1902, 82,920 units." The Council have resolved to extend the mains in Hollingborn-gardens at a cost of £98. 14s. 2d., and to extend the feeder mains and to instal a 50-kw. transformer in Highview-road at £616.

Fire.—On Saturday evening the electric lighting of Blackpool was suddenly cut off, both private and public lighting being entirely suspended owing to a fire on the main switchboard at the electricity works. The only course to take in such an event was the shutting down of the plant operated through the switchboard, and this was promptly done by the engineers in charge. Mr. Furness, the borough electrical and tramway engineer, was soon at the works, he having noticed the sudden extinction in Church-street. With buckets of sand the fire was quickly extinguished, but not before considerable

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damage was done to the main cables and switchgear. On examination it was found impossible to give a supply until repairs had been effected, and new cable and fuses substituted. All members of the staff were on the works, having hastened there immediately on hearing of the stoppage of supply, and at once commenced the work of repairs, which were sufficiently advanced to allow of the current being switched on for lighting early on Sunday morning. Fortunately the tramway switchboard was not damaged, and, therefore, no interruption took place with the tram service. Mr. Furness greatly commends the prompt action of the engineers in charge at the time, for had not the lighting plant been shut down immediately, and a plentiful supply of sand used, the results would have been disastrous. The cause of the fire is attributed to one of the main high-tension feeder fuses arcing after the fuse had blown. The lighting board is of a very old type, one of the first of its kind, and is considered in many of its details obsolete as compared with the later types of switchgear now in use in many of the alternating-current stations. The repairs effected to give a supply do not remove the danger which exists with this early type of board, and we presume that Mr. Furness will take an early opportunity of recommending a modernisation of the present switchgear.

Midland Railway Company.—At the half-yearly of this company, at Derby, the chairman said, in answer to a question, that it was not intended to electrify the whole or any part of the Midland Railway at present. So far as the Midland Railway was concerned, there was really no part of the railway which lent itself particularly to that means of traction. It was the intention of the North-Eastern Company to electrify part of their line. But that was only part of the main line—a portion in regard to which they suffered great competition from existing tramways. In a case like that electricity might be used for economy and to the benefit of the company. Although the Midland directors had no present intention of doing anything in that direction, he thought engineers generally were of opinion that electricity would in the future probably be the means of traction. When, he could not say, but whenever it came it must be gradual. For instance, they had 2,700 locomotive steam-engines, which had cost between five and six millions of money. They could not possibly contemplate the idea of changing such a large number all at once. He thought the process would be that when 300 or 400 engines came in for renewals they would be renewed as electrical motors, and certain portions of the lines would be adapted for their use. That process would go on until the whole line would be electrified. The transformation would, however, take some time. At present they renewed 95 engines each half-year, so that it would take at that rate about 15 years to change the whole motive power from steam to electricity. If the directors came to the conclusion that it was better to make more rapid progress they would do so, even though it might be at the expense of the revenue. There was a portion of the Cheshire Lines in which they were interested upon which he thought it quite possible that electricity might be used with good result, and that was the line between Manchester and Liverpool. The Cheshire Lines belonged to three companies—the Midland, the Great Northern, and the Great Central—and their working by electricity would be a good object lesson to those companies, who would be able to watch the results before electrifying their systems.

Kendal.—Last week the new electric light station erected in Parkside-road was formally opened and the light switched on by the Mayoress of Kendal (Mrs. G. Gilkes). The scheme has been carried out by Messrs. Handcock and Dykes, Messrs. Johnson and Phillips supplied the engines and dynamos, and the British Insulated Wire Company obtained the tender for the cables. The engine-room is 49ft. long by 26ft. wide, the roof being supported by steel principals, and boarded and panelled in pitch pine. The switchboard is elevated 3ft. 6in. above the floor line, and a subway equal to the whole area of the engine-room gives access to the engine and dynamo foundations. The floor, which is tiled, is formed of expanded metal and concrete, and the interior walls are neatly and artistically finished. The boiler-house is 49ft. by 37ft., with roof principals of steel, lofty, and well lighted and ventilated, and with ample provision for future extension of plant. Stores and overhead water-tank are provided in the well-lighted accumulator-house, which measures 39ft. in length by 17ft. 4in. in width. The chimney, 50ft. in height, is built partly of limestone and partly of freestone. That additional space will be required is evident from the fact that the total number of 8-c.p. lamps connected, or their equivalent in arc lamps and motors, amounted to 2,496, there being at present 44 consumers, and a large number of others will shortly require a supply. Current is supplied at present at a rate of 6d. per unit for lighting and 3d. per unit for power. Mr. A. H. Dykes, representing Messrs. Handcock and Dykes, said it had been anticipated that after the station had been started and run for a year they would have at least 2,500 lamps connected, a number which would shortly increase to 5,000. He had much pleasure in stating that at the present time there were connected to the station, to be quite exact, 2,498 lamps, which was practically 2,500. Judging from other towns, the consumption would average about 20 units per lamp, and at 6d. per unit it would bring them in a revenue of something like £1,500 per annum. Against that their station expenses should not cost more than £600 a year, including salaries and coal. Then they must allow a sum of £600 for interest and depreciation, so they would see with economy that they ought to make the station pay, and make both ends meet. They should at once prepare to extend their plant. He had no doubt that in the course of a year or two they would be able to reduce the price of the current. Mr. Ritson, who had acted as resident engineer under Messrs. Handcock and Dykes for the engineering part of the work and had been responsible for the buildings, was unfortunately leaving the town to take up a position at Ramsgate, but he left it with the satisfaction of knowing that the undertaking had made a good start, and was likely to prove of considerable importance to the town. A supper and the usual speeches completed the ceremony.

PROVISIONAL PATENTS, 1902.

JULY 30.

16858 Improvements in transmitting and utilising electricity. Richard Paulson, 16, Rutland-road, Hove, Sussex.

16861. Magnetic device for indicating an electric current of a given amount traversing a conductor and for closing or opening a switch or contact, specially applicable to the indication of leakages and for cutting off the main current in such cases. Walter Alexander Purdon, Joseph Edmondson, John William Dawson, and the firm of Edmondson and Purdon, Limited, Penny Bank-chambers, Halifax.

16863. Improvements in surgical electric lamps. Herman Joseph Jaeger, 57, Barton-arcade, Manchester.

16874. Improvements in trolley poles for electric tramways and the like. Matthew Small and Charles Kerr, 115, St. Vincent-street, Glasgow. (George John Thomas, United States.)

16887. Improvements in and relating to detectors of electro-magnetic waves and means of actuating one or more relays or other apparatus thereby. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

16896. Improvements in electrically-controlled semaphore signals for railways. Siemens Bros. and Co., Limited. Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

16902. Improvements in telephone systems. William David Watkins, 36, Chancery-lane, London. (Complete specification.)

16904. Improvements in or relating to regulating devices for dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16905. Improvements relating to contact fingers for electric controllers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16906. Improvements in electric circuit breakers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16923. Improvements relating to the manufacture of incandescent electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16924. Improvements relating to electromagnetic switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16925. Improvements relating to the control of electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16927. Improvements in or relating to starting devices for induction motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16928. Improvements in counters or tell-tales for electric circuit breakers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

16939. Improvements in or relating to apparatus for electric transmission, more particularly adapted for operating and controlling automatic type-setting and composing machines. Jules Lagarde, 111, Hatton-garden, London. (Complete specification.)

JULY 31.

16941. Automatically controlling the electric illumination of clocks and similar objects. James Thomas Harington, 50, Stockport-road, Levenshulme, near Manchester.

16957. An automatic safety appliance for overhead wires for electrical tramways. Frederick William Hawdon, Akenside-hill, Newcastle-upon-Tyne.

16962. Improvements in electrical switches or cut-offs. Patrick Kennedy, Prince's-chambers, Wolverhampton. (Complete specification.)

16979. Improved method of and apparatus for transmitting the movements of a primary compass card to a secondary compass card at a distance. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

16981. Combined sounding telegraph and telephone. Carl Nordén and August Hjalmar Andersson, 52, Chancery-lane, London. (Complete specification.)

16983. Improvements relating to rail connections for electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Continuous Rail Joint Company of America, United States.) (Complete specification.)

16984. Improvements relating to electrodes for secondary batteries. Paul Alfred Gouin, 45, Southampton-buildings, Chancery-lane, London.

16989. Improvements in electric cables. W. T. Henley's Telegraph Works Company, Limited, and Henry Savage, 53, Chancery-lane, London.

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16992. Improvements in or connected with signalling devices for electric tramways and other systems of electric traction. Ambrose Mitchel Martin and Thomas Tennant, 6, Lord-street, Liverpool.

16994. Improvements relating to sectional conduits for electric wires and the like. William Leo McGowan, 45, Southampton-buildings, Chancery-lane, London.

17002. Improvements in the manufacture of electric conductors. Victor Löwendahl, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUG. 1.

17013. A new system of electric traction for tramways, railways, and similar traffic, which, working by induction, supersedes all trolley, conduit, third or insulated rail, or any other intermittent or permanent contact systems. Laughlan Paton Greig, Corporation Electricity Works, Bury St. Edmunds.

17073. Improvements in trolley systems for electric railways employing a surface rail. William Phillips Thomson, 6, Lord-street, Liverpool. (Andrew Watson, United States.) (Complete specification.)

AUG. 2.

17094. Improvements in electric wall or floor coupling sockets. George Alfred Glover Davies, Harold Willison Kent, Bertram Gurney Stewart, and George Ewing, 27, Haslemere-road, Upton-lane, Forest Gate, London. (Complete specification.)

17106. Improvements in and relating to overhead trolley lines or conductors and the like. Henry Schuster Cowx, 556, Chester-road, Old Trafford, Manchester.

17111. A new receiver for wireless telegraphy. Louis Heathcote Walter, 83, Holland Park-avenue, London.

17127. Improvements in or connected with underground conduits for electric tramways and railways. William Cope, 136, Bristol-road, Birmingham. (Complete specification.)

17134. Improvements in holders for incandescent electric lamps. Lancelot Hall Newton and Robert Rutson Fowler Neville, 70, Palace-chambers, Westminster, London.

17135. Improvements in electric incandescent lamp-holders and switches. Lancelot Hall Newton and Robert Rutson Fowler Neville, 70, Palace-chambers, Westminster, London.

17136. Improvements in incandescent electric lamps. Lancelot Hall Newton and Robert Rutson Fowler Neville, 70, Palace-chambers, Westminster, London.

17141. Improvements in automatic electrical switches. Abraham Sanford Adler, 28, New Bridge-street, London.

17142. Improvements in automatic switches for electrical circuits. Abraham Sanford Adler, 28, New Bridge-street, London.

17143. Improvements in electrical systems for lighting and power. Abraham Sanford Adler, 28, New Bridge-street, London.

17173. Improvements in electric station indicators for use in connection with railway trains. Franz Losádi, 47, Lincoln's-inn-fields, London. (Complete specification.)

AUG. 5.

17196. Improvements in electrical resistance devices specially applicable to electric heaters. Laurence Maxwell Waterhouse, 34, Castle-street, Liverpool.

17202. Improvements in holders for the commutator brushes of dynamo and other electric machines. Frank Tillman Weidaw and Frederick Lincoln Barney, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17220. Improvements relating to electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.) (Complete specification.)

17222. Improvements in electric cranes, winches, and the like. Frederick Wilfrid Scott Stokes, 32, Victoria-street, London.

17253. Water-proof, acid-resisting, and electrically non-conducting glove. Friedrich Eckert, 53, Chancery-lane, London. (Complete specification.)

17260. Improvements relating to electric lighting and to the apparatus therefor. Hugh McGillivray, 18, Buckingham-street, Strand, London. (Complete specification.)

AUG. 6.

17267. Improved electrostatic high-pressure voltmeter. William Thomson, Baron Kelvin of Largs, 154, St. Vincent-street, Glasgow.

17271. Improvements in and relating to guards for electric tramway cars and the like. Thomas Fleming Renfrew, 96, Buchanan-street, Glasgow.

17324. Improvements in and relating to electrical bonds between rails or like conductors. John Corry Fell, 1, Queen Victoria-street, London. (Montraville M. Woods, United States.) (Complete specification.)

AUG. 7.

17349. An appliance for the use on electric cars, and other electric traction. John William Mazurke, 161, Undercliffe-street, Bradford.

17384. Improvements in dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17380. An improvement in the electromagnetic treatment of ores, slimes, and the like, for separating their constituents. Carlos Leuschner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17385. Improvements in means for regulating electric circuits. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17386. Improvements relating to electric condensers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17387. An improved combined carbon-cutter and screw-driver for electric arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17388. Improvements in systems of electrical distribution. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17389. Improvements in and relating to the insulation of high-potential electrical apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17390. Improvements relating to clamps for trolley wires. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17392. Improvements in electric incandescent lamps. George Hookham, 18, Southampton-buildings, Chancery-lane, London

17396. Improved receiver for use in wireless telegraphy and telephony. La Compagnie Française des Télégraphes et Téléphones sans Fil, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 8, 1902, being date of application in France.) (Complete specification.)

17406. Improvements in or relating to carbons for electric arc lamps. André Blondel, 111, Hatton-garden, London.

17411. Improvements relating to signalling apparatus chiefly designed for use in connection with boats. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Detroit Electric Signal Company, United States.) (Complete specification.)

17413. Improved means for measuring the movements and velocities of bodies in motion. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Electricitäts Actien-Gesellschaft vorm. W. Lahmeyer und Co., Germany.)

AUG. 8.

17419. Improvements in recording mechanism for electric and other instruments. William Thomson, Baron Kelvin of Largs, 154, St. Vincent-street, Glasgow.

17431. Improved liquid cement for patching cycle and motor tyres, insulating electric wires, and the like. Edward Blundell, 4, High-street, Wem, Salop. (Complete specification.)

17460. An improved regulating lever and instantaneous brake applicable to machines driven by electric motors. Bradbury and Co., Limited, and William Charles Dryborough, 4, St. Ann's-square, Manchester.

17487. An arc lamp with alternating currents. Gabriel Patrouilleau and Auguste Robert Mondon, 65 and 66, Chancery-lane, London.

17490. The improved king of lights, applicable for, oil, gas, electricity. Joseph Levi Burgess, 125, Ledbury-road, Bayswater, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 28.

1901.

13583. Regulation of the generation of electricity at generating stations. Routin. (Date applied for under International Convention, Dec. 22, 1900.)

15880. Electromagnetic controlling apparatus chiefly for use in connection with surface-contact electric railways. British Thomson-Houston Company, Limited. (Hewlett.)

15881. Surface-contact electric railways. British Thomson-Company, Limited. (Potter.)

16036. Electrical speed indicating or recording apparatus. Cubitt.

18228. Method of testing the lines of electrical fire-alarm, burglar alarm, and call systems. Eckstein and Bell.

18430. Means or apparatus for detecting or indicating light waves, Hertzian waves, and other radiations. Bose and Bull.

18898. Electric current controllers. von Zweibergk.

19440. Automatic cut-out device for overhead trolley wires as used for electrical traction. Halliwell.

19660. Safety apparatus for use en top-seat tramcars worked on the trolley system. Short.

19686. Electric arc rupturing devices. Short.

19757. Method of controlling electric arc lamps. Lewis.

19770. Electrical demand indicators. Dubois.

22152. Electric cable conductors. Hitch.

26535. Manufacture of electrodes for arc lamps. Hopfelt.

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1902.

4936. Conduits or pipes for electric cables and the like. Oates.

12121. Telegraphic apparatus. Damaskinos.

14855. Electrical transformers for mono and polyphase currents. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	Aug. 9	5,213	5,174	+ 39	154,051	142,252
Blackburn Corporation	,, 8	819	698	+ 121	16,408	13,258
Blackpool Corporation	,, 7	2,103	2,218	- 115	17,793	18,841
Blackpool-Fleetwood Tramways	,, 9	1,775	2,143	- 368	6,517	7,684
Bolton Corporation	,, 10	1,644	1,458	+ 186	49,996	45,710
Bradford Corporation	,, 3	3,390	1,193	+ 2,197	83,349	27,342
Bristol Tramways Company	,, 8	6,283	3,373	+ 2,910	—	—
Carlisle Tramways Company	,, 2	209	215	- 6	5,274	4,915
Central London Railway	,, 9	6,859	5,825	+ 1,034	39,431	35,902
City and South London Railway	,, 10	2,686	1,781	+ 905	16,274	11,049
Cork E. T. and L. Company	,, 7	881	613	+ 268	16,451	14,579
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 9	354	373	- 19	6,741	6,606
Dublin & Lucan Electric Railway	,, 10	182	170	+ 12	—	—
Dublin U. T., electric cars	,, 8	4,306	4,426	- 120	—	—
Dublin S. District, Electric	,, 8	1,355	1,361	- 6	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 9	12,826	12,041	+ 785	—	—
Halifax Corporation	July 30	2,573	2,600	- 27	21,516	—
Huddersfield Corporation	,, 26	1,058	1,013	+ 45	—	—
Hull Corporation, E. S.	Aug. 9	2,407	1,855	+ 552	33,525	32,187
Liverpool Corporation	,, 2	10,750	9,807	+ 943	296,235	271,504
Liverpool Overhead Railway	,, 10	1,797	1,917	- 120	9,864	10,572
Newcastle-on-Tyne Corporation	July 12	2,688	—	—	—	—
Portsmouth Corporation	Aug. 9	2,771	1,359	+ 1,412	—	—
Sheffield Corporation	,, 10	4,842	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Sunderland Corporation	July 20	1,356	1,351	+ 5	18,756	17,043

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £43 decrease.

Barcelona Ensanche y Gracia, £88 decrease. Barcelona £532 increase.

Brisbane, £415 increase (month of June, £10,187; increase, £1,813).

Buenos Ayres and Belgrano Electric (month of June, receipts £12,229 increase £478), £64 increase.

Calcutta, £246 increase.

Cape Town (month of June), receipts, £14,148; expenditure, £6,689.

Isle of Thanet Electric, £26 decrease

Mexico Electric (month of July), receipts, £20,300; expenditure, £12,600.

Perth Electric, £79 increase.

Port Elizabeth (month of June), receipts, £3,849; expenditure, £1,891.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¼-⅜
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-½
—— Ordinary, 1-125,000	1 ..	¼-½
British Insulated Wire, Ord., 1-70,000	5 ..	7¼-7½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5½
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6¼
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1¼-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	1½-2
—— 4½ per cent. 1st Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16½
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	2¾-3¼
—— 5 per cent. Debentures	100 ..	101-106 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	78-83
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-100
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-5¾
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20½-21½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15½
Telegraph Construction and Maintenance	12 ..	37-40
—— 5 per cent. Bonds	100 ..	102-105
Electric Railways.—		
Central London, Ordinary	100 ..	105-108
—— 4 per cent. Pref.	100 ..	106-109
—— ,, ,, deferred	100 ..	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	71-73
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	126-129
—— ,, ,, ,, '96	100 ..	127-130
—— ,, ,, ,, '01	100 ..	121-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 —	92-95

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	103-106
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	9¼-9¾
—— 7 per cent. Preference	5 ..	9¼-9¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9
—— Nos. 20,001-30,000	5 ..	8½-9½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, £10 Ord.	6 ..	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4½-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-5¾
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8½-9¼
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9½
—— 6 per cent. Cum. Pref.	10 ..	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6¾
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4½-4¾
—— 5 per cent. Debenture Stock, Red.	100 ..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	4¼-4¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	94-99
Metropolitan, Ordinary	10 ..	15½-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	13¼-14½
Oriental, 1879	1 ..	—
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	97-100
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	5¾-6¼
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	102-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	103-105 p.c
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10 ..	12¼-13½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12½-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅛-1¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¾-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	95-98
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref.	Within 1-82,500 10 ..	10¾-11¼
—— ,, ,, ,, ,,	1-82,500 5 ..	8-8½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	107-109
—— ,, Prov. Crts.	50 ..	81-83
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	14s. ..	¾
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	70 p.c. ..	70 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Preferred, 590,001-790,000	3¼ ..	4⅝-4⅞
—— Deferred Stock	100 ..	56-60
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¾-5¼
—— 3½ per cent. Deb. Stock, Red.	100 —	96-98
—— 4 per cent. Deb. Stock, Red.	100 —	102-106
Oriental Telephone and Electric Company	1 —	15/16-1 1/16

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NOTES.

Pembroke College, Cambridge —The new master of this college is Sir George Gabriel Stokes, F.R.S., whose appointment to that important office is announced. We are sure the appointment will prove an exceedingly popular ones in view of Sir George Stokes's great services to the art of science in his younger days. He is now in his eighty-fourth year.

Cable Rates —We have received a copy of the Coronation number of the *British, Australasian, and New Zealand Mail*, in which we observe a long article on cables and cable tariffs. It is apparently written by a strong advocate and supporter of the cable companies, and it is not therefore surprising to find that he is in favour of maintaining high rates for cable messages in the interests of the companies themselves.

Lighting by Means of Alcohol —We understand from the *Journal* of the Society of Arts that at the recent Paris Industrial Alcohol Exhibition, a silver medal was awarded to Mr. Laurent for his application of electricity and use of carburised air to the lighting of incandescent lamps from a distance, and that a work of art was awarded to the Société La Washington, of Paris, for its collective exhibits. This society also received a gold medal for its lamps of high power, with two or three mantles and independent reservoir, for carburised or uncarburised alcohol.

London University.—The new regulations concerning the matriculation examination of the London University are now available, and can be obtained on application to the Registrar of the University, at the Imperial Institute. It will be remembered that under these regulations, as pointed out in our issue of the 1st inst., Latin will no longer be a compulsory subject, and mechanics may be substituted for it. This will be a great boon to engineers who wish to take the university degree, and who find their recollection of Latin insufficient to meet the requirements of the university.

Timing by Electricity.—In the recent motorcar contests at Welbeck an ingenious method of timing by electricity was introduced. A wire was laid across the track close to the ground, and as this was depressed by the wheels of a motorcar an electric current was set up which stopped the watch. At the finishing point another watch was in synchronism with the first, and was also automatically stopped by the car as it passed the post. By the aid of a specially laid telephone the two sets of time-keepers exchanged the figures and made the necessary subtraction, and by this means the speed of each car was ascertained to within a fifth of a second.

Electrical Response in the Skin.—Some important researches into the electrical response of the skin have recently been carried out by Dr. A. D. Waller, of the physiological laboratory of the University of London. In these tests specially devised excitations were made to determine the length of time during which signs of life may be considered to remain in fresh healthy skin. In view of the surgical transplantation of skin, it is important that Dr. Waller has succeeded in obtaining signs of vitality as long as 10 days after excision. It is concluded that the period is greater in man than in the rabbit or cat, on which experiments have also been made.

Personal.—The retirement is announced of Mr. F. W. Webb, the chief mechanical engineer of the London and North-Western Railway Company, after a connection with that company extending over nearly half a century. By virtue of his position Mr. Webb was the principal official of the great railway works at Crewe, and in the railway world he is perhaps best known as the inventor of the three-cylinder compound locomotive. Mr. Webb is also the patentee of many well-known mechanical and electrical appliances used in railway working. On the occasion of the celebration at Crewe in June, 1900, of the completion of the four-thousandth engine built at the London and North-Western Railway Works, Mr. Webb had conferred upon him the honorary freedom of the borough.

Motorcars in Japan.—Although it is not to be expected that it can ever be as popular in Japan as in Europe, there is every prospect that that country will soon afford a fair market for the automobile Several of these machines have been imported into Japan already, and they may gradually come into use for purposes of business. We learn that the postal authorities there are considering the advisability of employing automobiles for the transportation of the Imperial mails at Tokyo. Should the decision be favourable to the proposal, it is thought that those cars that are run by steam would be considered unsuitable for carrying mails, because of the real or fancied danger of fire, and it would then be a question whether gasoline or electricity would be employed for driving the machine.

Tramways in New Zealand.—The city of Wellington, in New Zealand, was among the foremost of the cities in that colony to adopt a scheme of electric tramways, but it is only now that the Corporation find themselves in a position to ask for tenders for the construction and equipment of such a system. It speaks much for the patriotic tendency of the city that these tenders are to be called for principally from England, and it has instructed its engineer to proceed home for that purpose. That gentleman is Mr. W. R. Wright, who, it will be in the recollection of our readers, was appointed to the position of tramways engineer to the city of Wellington some 12 months ago from Bootle, in this country. We understand that it is his intention to travel *viâ* the States, and to examine some of the more recent tramway undertakings there before proceeding to England.

Electricity on Italian Railways.—A fresh move in the development of electric traction in Italy for railway working is being taken in connection with the railway communication between Rome and Naples. We have it on good authority that the Government have appointed a committee of electrical engineers to consider a scheme for an entirely new line between those two cities, with the object of making the journey in less than two hours. The line would be double-tracked throughout, and electrically equipped on the third-rail system. To cover the distance between Rome and Naples in this time the speed of the trains would have to average over 60 miles per hour, but the proposed maximum rate of speed is not given. The country in this part of Italy is rich and fertile, and it is believed that an electric railway through it would do much from an agricultural point of view to open up the land still further.

Indicator of Synchronism —An instrument for paralleling alternators was recently described in *L'Industrie Electrique*. It is really a non-synchronous motor with identical stator and rotor windings, with two phases for use with single-phase alternating current, and with three phases for three-phase currents. The stator is connected to the network and the rotor to the alternator, which is to be connected in parallel. In the case of single-phase current, the windings of the two phases are connected to two terminals, the one through a non-inductive resistance, and the other through a self-inductance as great as possible,

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in order to get as nearly as possible a phase difference of one-quarter of a period. It is so arranged that the magnetic fields produced in the windings of stator and rotor revolve in the same direction. It follows that at synchronism the rotor remains at rest in space, and that it turns in one direction or the other when one of the fields revolves more quickly than the other.

Electrical Preparation of Colloidal Mercury.—Mr. J. Billitzer, in a paper abstracted in the *Journal* of the Chemical Society for August, says colloidal mercury is obtained by electrolysing very dilute solutions of mercurous nitrate between electrodes of platinum, zinc, iron, lead, or nickel; it imparts a yellow or brown colour to the solution. The best result is obtained with a 0·004 N solution of the nitrate, and a current of 0·2 to 0·3 ampere at 200 volts; the larger the electrodes, other conditions being the same, the more easily is the colloidal metal formed. Pure colloidal mercury is also obtained by carrying out Bredig's method of "pulverisation" with amalgams or precipitates of mercury on wires which are not themselves pulverisable. In the same manner, other metals can be "pulverised" which hitherto have not been obtained in the colloidal form, for example, copper, nickel, iron, zinc, and lead; in all cases, the action is facilitated by using a roughened surface and a loose, superficial aggregation.

Tube Railways in New York.—Following much on the lines of our "twopenny tube," we learn that plans are being prepared for a new tube railway between New York and Brooklyn, and it is a curious coincidence that while American financiers are exploiting electric traction in our metropolis, an English syndicate is promoting the most recent scheme of its kind in New York. According to the information we have received, at the head of this syndicate is Lord Kintore, the other members being Earl Grey, Sir Chas. Rivers Wilson, and Mr. Washington Hume. A franchise from the Railroad Commission to proceed with the construction of the tubular railway has already been obtained, and it is intended to make the line as nearly identical with the Central London Railway as possible. The idea is to merely transport passengers under the river at a uniform fare of 1½d. The exact cost of the road cannot yet be definitely fixed, but it is roughly estimated at about a million and a quarter sterling.

Power Transmission at Grenoble.—A most interesting programme has been arranged by the various engineers and capitalists in the Grenoble district for a congress to consider the best way of utilising and distributing the power from waterfalls. The district in question is one exceedingly well provided with water power, and in which, according to the circular letter which has been sent round, more than 200,000 h.p. has been harnessed in the last 20 years. Under the programme arranged for those who attend the conference the members will have facilities for exploring the valleys of the Drac, Romanche, Arc, Isére, and Arve Rivers, and of inspecting the waterfalls employed for large varieties of works. The conference commences on Sunday, Sept. 7, and the last meeting is, we understand, to be held on Sept. 13 at Chamonix. More particulars respecting the congress can be obtained from Mr. Charpenay, of the Société des Forces Motrices du Haut-Grésivandan, at 2, Place due Lycée, Grenoble.

Johannesburg Tramway Scheme.—It seems that all hope of electric tramways in Johannesburg is not yet gone. From what appeared in our issue of the 1st inst., it will have been gathered that the proposal of the Johannesburg City and Suburban Tramway Company to introduce an electric system was met by the public in a very hostile manner, and the reason given for this was that as a number of the tradespeople and local farmers were interested in getting a market for their forage it did not suit their book to have the horse supplanted by electric traction in the city. Information now to hand shows that the Corporation are stirring themselves in the matter, with the result that a special committee has been appointed to consider the establishment of municipal trams. A full report is to be brought up by this committee at an early date, and it is to be hoped that the Council in coming to a decision upon it will not be guided by any such purely selfish considerations as those which have previously influenced the attitude of the public in the matter.

Electrical Signalling.—An electrically-controlled apparatus which indicates the approach of a train some minutes before it arrives, and also shows the number of the platform at which the train will come in, has just been brought into use at the Waverley Station of the North British Railway Company. From the information before us, the apparatus, which is enclosed in a glass case, contains two indicators, one to serve each of the lines coming into the station from the east and south respectively. The arrangement is worked electrically from the signal cabin, the apparatus in which has two dials. When the signalman receives notice of the approach of a train he makes an electrical contact, by which the necessary information as to the arrival of the train is given to the public at the station. The invention is the work of Mr. David Wells, assistant telegraph engineer to the railway company, and if it proves successful after a fair trial at the Waverley Station the arrangement will probably be extended to other stations on the company's system.

Researches on E.M.F.—Under this title a paper by Mr. M. Berthelot is shortly abstracted in the August number of the *Journal* of the Chemical Society. Thus, the author first considers at some length the various causes of difference between the actual thermal value of a chemical reaction, the apparent value under the conditions of the voltaic cell, and the voltaic thermal value. Determinations were then made of the E.M.F. produced by simple liquid mixtures in which there is no action of the liquid on the electrode. The following cases were investigated: (1) action of an acid on a base; (2) action of an acid on its sodium or ammonium salt; (3) action of an alkaline base on a salt of the same base; (4) action of acids on salts of other acids; (5) action between two solutions of the same salt at different concentrations. In the first case, E.M.F.'s of about 0·5 volt were obtained, the values being lower than those calculated from the heats of neutralisation. In all the other sets of experiments, values varying from 0·1 to 0·4 volt were obtained, but in no case could exterior electrolysis be produced by the number of cells.

Wireless Telegraphy for the United States Navy.—The United States Government are realising that wireless telegraphy on ships is a very advantageous thing, and they are about to carry out experiments with the object of selecting a system for their navy. The proposal was first under consideration some months ago, when a lieutenant of the United States navy was dispatched to Europe to investigate the various systems of wireless telegraphy in use, and he has now returned with eight sets of instruments, which are to be put to test between the Washington Navy Yard and the Naval Academy at Annapolis. The object of the tests, we understand, is to select a system which shall consist of the best features of all the systems, and which shall enable the interchange of messages between countries which have adopted and put into use different forms of apparatus. It is noteworthy that the Marconi system is not included in those to be

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tested at Washington, the representatives of the United States having been unsuccessful in making terms with that inventor last year. Nevertheless, the results of the trials will be watched with great interest.

Formation of Insoluble Precipitates by Electrolysis.—This subject is attacked by Messrs. Max le Blanc and E. Bindschedler in a recent paper which is shortly abstracted in the issue of the *Journal* of the Chemical Society for August. The formation of lead chromate by the electrolysis of a solution of sodium chlorate and chromate with a lead anode is investigated. With solutions containing from 1½ to 12 per cent. of salt, 70 to 90 per cent. of which is chlorate, the lead chromate is formed near the anode, separating from it by its own weight, whereas in solutions containing a large proportion of chromate an adherent layer of chromate and peroxide of lead forms on the anode. The yield of lead chromate is theoretical in the first case, practically zero in the latter. Sodium nitrate, acetate, or butyrate give practically the same result as chlorate. With the mixed electrolyte, the current is mainly transported by ClO_3 ions, the chromate ions are therefore soon removed almost completely from the electrolyte in contact with the anode, and the precipitation of lead chromate takes place at some small distance from it. With a more concentrated chromate solution, this is not the case.

Wireless Telegraphy on the Congo.—Information has reached us to the effect that the Marconi wireless telegraph station at Banana, at the mouth of the River Congo, is now completed, and is expected to be in operation in a month or two. Work is at present going on at Ambriz, which is a fairly large town on the Portuguese Congo coast, about 130 miles distant from Banana. At Ambriz another station is in course of erection, and when completed a connection between Boma, the capital of the Congo Free State, and Europe will have been established. This will be effected in the following manner: from Boma to Banana, a distance of 50 miles, by pigeon post; from Banana to Ambriz by wireless telegraphy; from Ambriz to Loanda, about 75 miles, by the existing land wire; and thence to Europe by submarine cable. Thus, out of a total distance of over 250 miles from Boma to Loanda, about 130 will be covered by wireless telegraphy. Later on, we understand, it is intended to join Banana with Boma by the Marconi system, thus dispensing entirely with the ancient practice of pigeon post. It may be mentioned that the Marconi installation at Banana is composed of a telegraph pole over 70 yards high, provided at the base with a portable cabin for the instruments. A petroleum motor will be employed for driving the dynamo. The work has been carried out by four engineers, two of whom are English.

An Electric Ropeway.—One of the most recent examples of an electric ropeway in Switzerland is given by Mr. de Vevey in the course of an article in *L'Electricien*. This connects the village of Luzerne with the heights of the Gutsch, which are largely visited by tourists on account of the magnificent view to be obtained therefrom. The line has a very considerable length, about 1,728 yards, and the difference in altitude is about 450 yards. The grades vary from 13 to 34 per cent., and there are many curves to be rounded having a radius of about 540 yards. The rolling-stock consists of two cars attached to the extremities of the steel cable, which runs on guides between the rails. It is driven by a 70-h.p. continuous-current electric motor. The generating station includes two belted 30-h.p. generators, one being held in reserve. Gas-engines supplied from a gas producer are employed as the prime movers. The current is carried from the generating station to a sub-station, containing a battery of accumulators composed of 114 Pollak cells, with a capacity of 402 ampere-hours, at a rate of discharge of three hours or 276 ampere-hours per one-hour discharge. The normal rate of charge is 180 amperes. The battery supplements the electric generators during heavy load when the traffic is great, but during stops between consecutive trips the generators charge the battery. Except during the morning and evening, when the difference in load is great, the batteries alone drive the motor and furnish lighting for all the stations. Both the operating and financial results of the system are described as excellent.

Motors for Elevators.—The last issue of the *Transactions* of the American Institute of Electrical Engineers contains a rather interesting paper by Mr. Geo. F. Sever on the power consumption of elevators operated by alternating and direct current motors. The record of electrically-operated elevators in New York City shows that there are approximately 3,000 operated by direct-current motors and 300 operated by alternating-current motors. One reason given by the author why this disproportion exists, is that the direct-current motor has been available for a longer period than the alternating. Another is the uncertainty as to the amount of power necessary for each. To sum up his conclusions, with the cost of power at 2½d. per horse-power hour for both types of elevator, it would appear more economical to use the direct-current elevators in those places where both direct and alternating currents are available. If the controlling apparatus be more simple with the alternating-current system, and the absence of a commutator on the motor can be counted as an advantage, the extra expense of operating an alternating-current machine might be offset by the decrease in repairs and attendance. Apart from the last considerations, there appears to be every advantage in favour of the use of the direct-current motor. The same issue of the *Transactions* reprints the following papers: "The Telephonic Status Quo," by Mr. A. A. Abbott; "Telephone Rates from an Engineer's Viewpoint," by Mr. F. J. Dommerque; "Telpherage," by Mr. Chas. M. Clark; "Some Notes on European Practice in Electric Traction with Three-Phase Alternating Currents," by Mr. C. H. de Muralt; "A Novel Combination of Polyphase Motors for Traction Purposes," by Mr. E. Danielson; "Methods of Illumination and Units of Light" (discussion), and "Edison's Tungstate of Calcium Lamp, Novel Lamps and Filament Material," by Mr. W. J. Hammer.

Telephones for Divers.—An important application of the telephone, of which not much has been written, is its use in diving operations. The Admiralty were the first officially to recognise the value of the telephone for such work, and their example was quickly followed by the United States authorities, who now incorporate the provision for telephones in the regular specifications for diving apparatus The diving armour does not differ externally from the ordinary equipment, the telephonic attachments being entirely within the helmet. Each helmet is provided with a cap of stout canvas with a leather chain-strap, one side of which is fastened the telephone receiver so that it is held securely against the ear and can by no possibility slip out of position. Inside the helmet, in such a position that the diver can speak directly into it by slightly turning his head, is the transmitter. The connecting wire cable, about ½in. in diameter and heavily insulated, enters the helmet near the top through a water-tight valve, which permits it to be immediately disconnected if it is at any time desirable to dispense with the use of the telephone. The diver's assistant is equipped with a similar cap and receiver, and round his chest is strapped a small nickel-plated shield, on which is mounted the transmitter with a funnel-shaped

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mouthpiece pointing upward, so that he can speak directly into it by slightly lowering his head. Round his waist he carries the battery of five cells enclosed in a neat hard rubber case. It is the work of but a few moments to make the necessary wire attachments and put the little line in working order. Thus equipped the attendant has both his hands free to handle the air-pump or hose, or to comply with any directions that the diver below may telephone up to him. The superiority of the telephone over the old-fashioned signal line used by drivers would be apparent if its value in almost all classes of submarine work had not already been amply demonstrated.

Electrical Fires.—The proportion of "electrical" fires to those due to other causes when taken from actual figures is undoubtedly small, as we recently showed in these columns, from the records taken by the Electrical Bureau of the National Board of Fire Underwriters of the United States. It is well known that electricity often suffers in reputation for alleged dangers of this sort of which it is entirely innocent. Our Chicago contemporary, the *Western Electrician*, has gone to the trouble of instancing a few cases in which considerable damage has been done by fire which was alleged at the time to have been caused by electricity, but which was afterwards found to be due to other sources of combustion. In one case a £13,000 loss reported as the result of a fire caused by electricity, was found to have been incurred through the spontaneous combustion of some oiled rags. In another a fire involving a loss of £33,000, attributed at the time to the use of electricity, was afterwards proved to have been caused by the overheating of some celluloid which was in the building. Another fire due to ignorance of the heating effect of an incandescent lamp resulted because a towel was thrown over a lighted incandescent lamp in a hotel chambermaid's room and allowed to remain. In course of time the towel became ignited, resulting in considerable loss. The breaking down of a transformer, due to careless wiring, is instructive. In a case cited by our contemporary, the secondary wires of the transformer entered a building through an iron ventilating shaft, between the ceiling and roof, being insulated from the shaft by means of clay bushings and running some 23ft. to the cut out meter and switch. By improper wiring in installing some fixtures, grounds were made with the ventilator and tin roof. The strain produced on the insulation of the transformer was too great, and a breakdown resulted between the primary and secondary coils. This allowed the passage of high-tension current in the secondary coil, and resulted in the burning out of the coil and the starting of a fire.

Combined Electric Power and Irrigation Schemes.—In some of the gold-bearing regions of the Western United States, hydraulic mining has been applied very extensively. Lately, however, this form of mining has been prohibited in certain parts of California by the Government, owing to the river and streams in the neighbourhood being blocked by the earth deposits washed down. Many extensive water schemes were put down for the purpose of securing the high pressure supply necessary for the work, and the effect of the later laws was to make these water storage schemes available for any other purpose. They were readily seized, and soon became profit-making concerns. The water pressure formerly used for mining jets has been applied for generating electrical power by means of turbine-driven dynamos. The electrical power so generated is distributed to the surrounding towns and villages, and the spent water also is sold to the farmers and fruit growers in the neighbourhood for irrigation purposes. A typical scheme of this description is that of the Central California Electric Power Company, which has taken over a part of the hydraulic system of the South Yuba Water Company, controlling over 400 miles of water conduits and mains in the heart of the Sierra Nevada mountains. The electric power company has been in existence for some two years or so, during which time the business has developed to such an extent that, from time to time, considerable additions have had to be made to their power system. Already the company has two electrical generating works in full operation, and at the present time it is busily engaged in erecting still another. The extent of their business will be gathered from the fact that the electrical machinery to be put down in the beginning at the new station includes two Westinghouse polyphase alternators, each capable of generating over 1,500 h.p. These will be direct connected to waterwheels, and will supply electricity to the neighbouring towns, including Grass Valley, Nevada City, Sacramento, and many others. The area of the electrical supply is unusually large, and will necessitate the erection of transmission lines over distances of from 40 to 50 miles. The profit-earning possibilities of such a combined system as this are considered very favourable, and although the combination of an electrical power distribution with a public hydraulic supply is unique, and has been brought about more by accident than design, it would appear that such schemes might well be brought into use with advantage even in districts where hydraulic mining has never had occasion to be tried.

Telegraphs.—The report of the Postmaster-General for the year ended March 31 last reveals a net deficit on telegraphs of £651,806, or £314,165 more than last year. This is accounted for by the very heavy expenditure which had to be met last year, for although the revenue amounted to £3,570,046, an increase of £110,693 upon the previous year, the expenditure on telegraphs also increased by £424,858, the total figure being £4,221,852. Including interest on capital, the deficit on the year is £950,666. The total number of messages sent over the wires of the Department, however, shows an increase of 855,080, the actual figures being 90,432,041, as compared with 89,576,961 in the previous year, and the receipts have correspondingly increased. These amount to £2,821,866, as compared with £2,766,665, giving an increase of £55,201 in the receipts. Taking a few of the principal items giving this result, ordinary inland telegrams increased in number by 1,536,330, and in money paid by £63,878. On the other hand, Press and foreign messages decreased by 745,645 and 14,501 respectively, representing a total decrease in revenue of £8,627. Including 13 at railway stations, 272 additional telegraph offices were opened during the year; the total number of telegraph offices in the United Kingdom at the present time is 11,784—9,430 at post offices and 2,354 at railway stations. Referring to the damage to telegraph wires last winter through storm, the Postmaster-General puts the cost of making good the breakdowns at £30,000, and in the same connection he discusses the question of providing underground lines. The London and Birmingham underground line has proved of great value in emergencies, and he expresses the hope that next year it may be possible to place at his disposal larger funds in order to accelerate the execution of a comprehensive scheme. This line will be carried on during the present year to Warrington, where it will join existing underground lines between Manchester, Liverpool, and Chester. The line from Preston is to be extended to Lanark, whence branches will be laid to Glasgow and Edinburgh, and it is in contemplation to extend the underground system from Manchester to the principal Yorkshire towns through Bradford and Leeds, and thence to Newcastle-on-Tyne. In addition to these underground extensions, much is being done to

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give greater stability to the telegraph service by the erection of reserve wires carried as far as possible by alternative routes. Note is made further on in the report of the laying of the Belgian telephone cable which will establish direct telephonic communication between England and Belgium. It is approximately 50 knots long, and is the longest cable of its kind in the world. The wires in the cables form two circuits, which will be placed at the disposal of the public very soon. Mention is also made of the laying of the laying of the first section of the Pacific cable, and of the numerous reductions introduced in the past year in the telegraph rates to different parts of the world.

British Association.—We have received, by the courtesy of Mr. W. M. Heller, of the National Education Office, Dublin, and Mr. Chas. H. Lees, of Owens College, Manchester, respectively, the provisional programmes of the meetings arranged for Sections L and A of the annual convention of the British Association at Belfast next month In the latter section the following are the most important communications which will be received: "Report of the Electrical Standards Committee"; "Electrical Oscillations," by Prof. W. B. Morton; "Magnetic Detectors in Space Telegraphy," by Prof E. Wilson; "Graphical Method of Determining the Discharge of a Condenser through a Variable Self-Induction," by Dr. E. W. Marchant; "Preliminary Experiments on a New Standard of Light," by Mr. J. E. Petarch; "Rotation of the Ether with the Earth," by Prof. F. T. Trouten; and "Temperature of Radiant Energy," by Dr. J. Larmor. Lord Rayleigh will introduce the question of the accurate conservation of weight in chemical reactions. The first meeting in Section L opens at 10.30 a.m. on Thursday, Sept. 11, at which hour Prof. Henry E. Armstrong will deliver his address. The papers to be brought up for discussion on this day are: "Recent Reforms in Irish Education—Primary and Secondary—with a View to their Co-ordination," by Dr. W. J. M. Starkie (Resident Commissioner of National Education); report on "The Teaching of Mathematics"; report on "Conditions of Health Essential to the Carrying on of Work of Instruction in Schools." On Friday the meeting opens at the same hour with a debate on "Irish Educational Work." The following papers will also be read: "Intermediate Education in Ireland—Review and Prospect," by Mr. R. M. Jones, M.A. (Academical Institution, Belfast); "The Introduction of Practical Instruction into Irish National Schools," by Mr. W. Mayhowe Heller, B.Sc. (Head Organiser of Science Instruction); "Technical Instruction in Relation to Industrial Development in Ireland," by the Right Hon. Horace Plunket (Vice-President Board of Agriculture and Technical Instruction); report on "Teaching of Science in Elementary Schools." The meetings of Section L will be resumed on Monday, Sept. 15, at 10.30 a.m., opening with a debate on "The Training of Teachers," by Prof. Withers, Miss Walter, and others, followed by a paper on "The Subjects to be taught as Science, and the order in which they should come," by Dr. Kimmins. On Tuesday there will be a debate on the "Teaching of English," by Mr. P. T. Hartog, Canon Lyttleton, and others, and a joint discussion with Section G on "The Training of Engineers" At the concluding meeting on Wednesday, commencing at 10 o'clock, the papers will be on "Educational Experiments"; "Native Study in Urban and Rural Schools: its Scope and Limitations," by Mr. R. Hedger Wallace; "School Museums," by Mr. J. H. Leonard; and "University Education in Relation to the Study of Science as a Professional Qualification," by Mr. W. M. Hartley, F.R.S.

Post Office Telephones.—Perhaps the most interesting part of the Postmaster-General's report on the Post Office for the year ended March 31 last is that dealing with the Telephone Department. In this connection very considerable progress is shown to have been made in that period, apart from the inauguration of the central exchange of the London telephone system in February this year. On March 31 last the number of trunk circuits under Post Office control in use was 1,165, giving a total of about 98,000 miles of wire. Out of the capital sum of £2,300,000 authorised for the development of the trunk system, the expenditure to date is £1,896,649, the year under review being responsible for £201,570 of this sum. The gross trunk revenue was £238,720, as compared with £211,209 the previous year, and the average value of each transaction was 5 68d., or practically the same as in the preceding year. Turning to the London telephone system of the Post Office, this has so far proved itself to be a very successful undertaking. Whereas provision in the first instance was made for the accommodation of 5,400 subscribers, the number of applications received has been so great that arrangements have had to be made for an early extension of the switchboard so as to accommodate over 10,000 lines. Discussing the equipment of the central exchange, Lord Londonderry observes that the central-battery system of supplying all the electricity required from the exchange has fully justified its adoption. It has rendered possible a simplification of the apparatus supplied to subscribers, and the abolition of the batteries which were formerly required to be placed at their premises, and whose failure was a source of difficulty. Also, the use of the lines by subscribers is much simplified, and the incandescent lamp signals at the exchange, which mark every stage of a conversation, enable the operators to give more rapid and efficient service to a greater number of subscribers. Besides the Putney and Kingston-on-Thames exchanges, other suburban exchanges are being constructed at Wimbledon, Richmond, Chiswick, Twickenham, and Croydon. More important exchanges are about to be opened in the neighbourhood of Victoria-street, Westminster, and in Cromwell-road, S.W.; others are being constructed in Oxford-street and in Finchley-road. As a result of surveys which have been made, it is probable that exchanges will also be established at Sutton and Epsom. Mention is made in the report of the dissatisfaction felt at the slow rate at which the demand for telephonic service in London can be met, but it is pointed out that already over 600 miles of underground pipes have been laid, and about 330 miles of cable, containing from 200 to 432 wires, have been drawn into them. Out of the capital sum of £2,000,000 authorised by Parliament, an expenditure of £972,317 was sanctioned up to March 31 last. With reference to the agreement with the Telephone Company as regards intercommunication, it is satisfactory to observe that the communication between Post Office subscribers and those of the company is now as rapid and as efficient as between the subscribers to the same system. Municipal telephones have also been going ahead in the past year, licenses having been granted to the Corporations of Brighton, Chard, and Portsmouth, and to the Norwich Mutual Telephone Company. Applications for licenses from several other corporations and from one or two local companies are now under consideration. The revenue from the Post Office private wires and provincial telephone exchanges was £152,142 last year, as against £155,694 in the previous year. The amount of royalty received under licenses for exchange working was £151,626, of which the National Telephone Company contributed £149,907.

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YARMOUTH TRAMWAYS.

Somewhere about Whitsuntide last we paid a visit to Yarmouth to interrogate our friend the borough engineer (Mr. Cockerill) as to the completion and opening of the tramway system. Mr. Cockerill very kindly devoted a part of the holiday time to give us information, and our heartiest thanks are due to him for supplying drawings,

MR. F. ARNOLD, CHAIRMAN OF TRAMWAYS COMMITTEE.

photographs, and notes about the most recent of the many municipal works of Great Yarmouth.

The Town.

Great Yarmouth is of considerable antiquity, and most probably formed a collection of huts in the time of the ancient Britons. At any rate we can assume anything we please, because the historians neither assert nor deny, nor does the oldest living inhabitant remember. In the Roman period there was a "Count of the Saxon Shore," an officer of some notability, but whether he had his principal residence at Burgh Castle or at Caistor historians differ. Domesday book goes a little further, and gives the information that it was a Royal domain. The early Norman

MR. J. W. COCKERILL, BOROUGH ELECTRICAL ENGINEER.

kings conferred blessings upon it in the shape of charters, though perhaps the blessings were sometimes bought at a high price, though one of Henry III. is the first which contained the prefix "Great." Queen Anne's charter abolished government by "bailiffs," substituting a mayor or chief magistrate, with 12 aldermen and 36 council men, over six wards into which the borough was divided. It was first represented in Parliament in 1294 by two burgesses elected by the Corporation. Until 1813 there was no cross street in Yarmouth. All ran north and south to the beach, and the only outlet for vehicles of any width was at the extremities of the quay. Those who have visited Yarmouth know these north to south streets are very narrow, and are called rows. They are 145 in number, and it is assumed the town was so built to get as large a population as possible within the fortifications. To remedy the want for means of cross

MR. H. A. MILLINGTON, TOWN CLERK.

traffic, Regent-street was made in 1813. That same year saw the first passenger steamboat between Yarmouth and Norwich. Gasworks were erected, and the town first lighted by gas on Dec. 6 in 1824. The railway from Yarmouth to Norwich was opened in 1844. It will thus be seen that Yarmouth was generally ready to go with the times in matters of progress. Its latest work has been the construction of an electric tramway system, having adopted electric lighting some years ago, with Messrs. Preece and Cardew as the consulting engineers.

Early Municipal Life.

In 1599 Nash writes of the township, "that for state and strict civil ordering, scarcely admitteth any rivals."

MR. F. L. TURNER, TRAMWAYS MANAGER.

In 1876 we again find recorded the opinion, "It is a very well-governed town." As in many other places, the corporate life of Yarmouth was grafted upon its guild life. Far too little attention is paid by busy men to this phase of business development—guild life—yet the trusts of to-day would seem to be a recrudescence of the guilds of mediævalism. Nall in his chapters on the East Anglian Coast says: "Many guilds (from *ghulden* or *ghilden*, to pay) or societies for the promotion of trade, commerce, and

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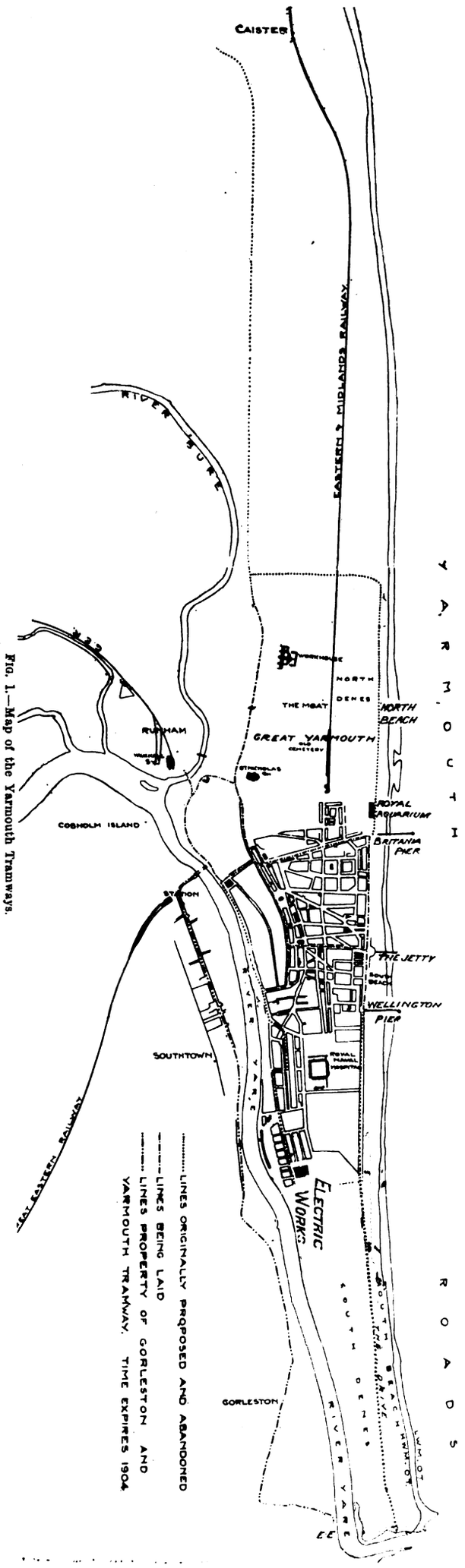

Fig. 1.—Map of the Yarmouth Tramways.

religious purposes, were in existence from an early period in Yarmouth. . . . The Guild of the Holy Trinity, or Merchant Guild, which formed the Corporation or governing body of the town, was by far the most important. At the dissolution of the religious orders in 1545, their property was confiscated and applied to the public use of the town. The name of the Merchants' Guild merged into that of Corporation, and by that name it continues to administer the municipal affairs of the borough." It must not be understood from this that the existing municipality has received no change from 1545 to the present day. Evolution has been pretty constant. In Anglo-Saxon times the governing body consisted of elected port reeves, after the Conquest of bailiffs nominated by the Crown, and so to the time above mentioned, although long before "wise men" were chosen and sworn to "enforce and strengthen" the bailiffs. These "wise men" were later called aldermen. "In 1388, 10 Richard II., an ordinance was made empowering the 24 jurats (aldermen) to choose '24 other wyse men to have syght of merchandyse.' Afterwards this latter body increased in number and became 'common council men.'" Thus by degrees the Corporation of Yarmouth was built up.

Opening of the Tramways.

Yarmouth has a population of between 50,000 and 60,000, and a rateable value of £200,000, with from 110 to 115 miles of roads and streets. In one direction, north to south, its boundaries are seven miles apart, while from east to west they narrow down to three-quarters to one mile. Of late years it has risen to great importance as a health resort, and its summer population is out of all proportion to its settled population. The authorities of a town of this character are bound to consider most carefully the requirements of visitors, and as the prosperity of the town depends partly upon the attractions it affords, as well as upon its geographical position, it is often expedient for the authorities of such towns to undertake work which in ordinary cases would be left to private enterprise. Whatever the moving spirit, Yarmouth decided upon electric tramways, and the system was formally opened on June 19 last, when three cars, draped with flags and filled with notable passengers, traversed the entire route, after which ceremony the public service commenced. The history of the undertaking, and the description of the opening ceremony, is very well given in the report of the *Eastern Daily Press* of June 20 last, from which we may quote the following.

For some years Yarmouth Corporation had considered the question of an electric tram service, and at the outset private companies made several attempts to obtain the concession, but the Council in 1898 decided on a municipal scheme, and obtained parliamentary powers in 1899. Thereupon a Tramways Committee was appointed, with Alderman Frank Arnold as its president, and then, strangely enough, civic feeling swung right round in 1900-1, and it was decided to invite tenders from electric traction companies for the leasing of the trams. The chairman was so opposed to the principle of handing over the streets and trams to a private company that he resigned, and Mr. C. S. Orde, the present deputy-mayor, succeeded him. When, however, the offers were received it was found that there was practically no competition, and the terms offered were considered ludicrously inadequate. The Corporation then reaffirmed the previous decision to work the trams as a municipal venture. Mr. Orde relinquished the chairmanship of the committee, which was again taken by Mr. Arnold, and from this stage work has steadily proceeded, until to-day Yarmouth possesses a first-rate service of electric cars, upon which the town is to be congratulated, and which were highly spoken of by the inspectors of the Board of Trade. The inspectors rode over the track, accompanied by Major Cardew (of Messrs. Preece and Cardew), the Council's consulting engineer, Mr. Frank Arnold (the chairman of the Tramway Committee) and the borough surveyor.

It had been contemplated starting the works in 1899, but it was then found, owing to the iron trade boom, that steel rails were at too high a figure, and it was deemed

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expedient to wait till inflated markets had worked down to a normal price level. This policy was abundantly justified in the great economy of first cost gained, but it involved delay till 1901. Belgian rails were accepted on account of the price quoted being so much below the tenders of British steelmasters, and 1,000 tons of the foreign rails were ordered. The Brush Electrical Engineering Works of Loughborough received the order for 14 cars, each accommodating 49 passengers, and delivered all of them within 12 weeks from the date of the order. There are about four miles of street route for the trams to travel, part of which is double tracked as the width of the roadway serves and the expediting of the service requires. In all six miles of track has been laid. The system is on the overhead trolley principle, and the

FIG. 2.

street standards and bracket arms carrying the copper wires have been made as ornate as possible. The steel rails used are of the girder type, weighing 90lb. per yard, and are 7in. deep with 1⅛in. groove. The track has been built on concrete made of sand and shingle from the beach and 1,500 tons of Portland cement, and paved with granite setts, lava basalt, asphalt cubes, and Australian jarrah blocks. At the electric light power station structural extensions had to be made, which were carried out by

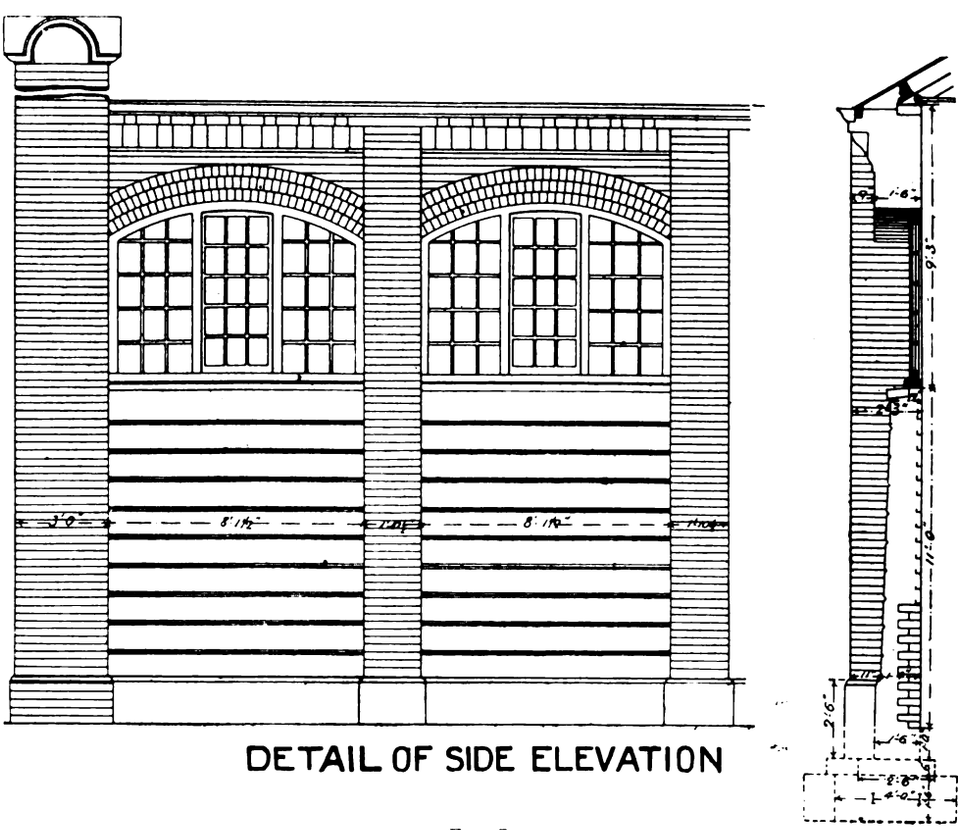

FIG. 3.

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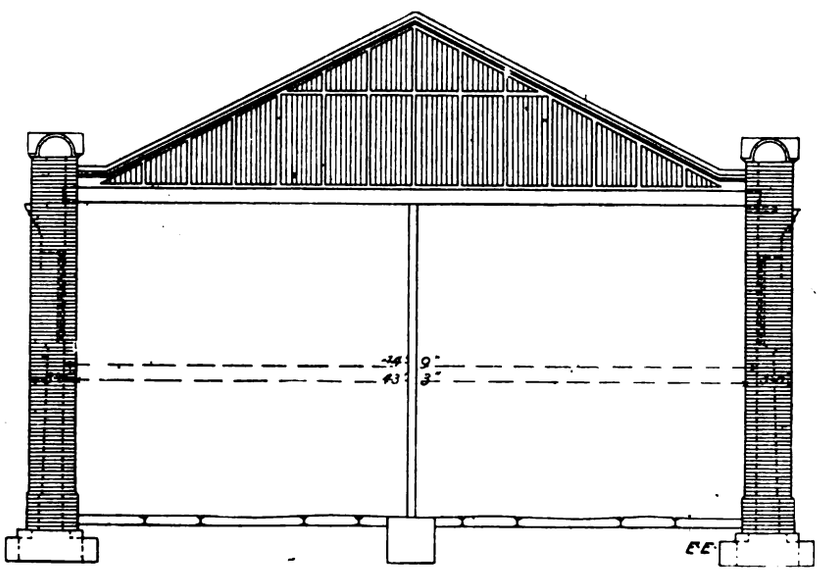
Mr. Eastoe, and new generating machinery laid down at a cost estimated at £10,000. This covers two 200-kw. machines and two 200-h.p. boilers. The total cost of the tramways was £50,000. The tramway depôt and general headquarters is on Caistor-road, opposite the Corporation destructor, and was built by Messrs. Grimble and Harman. Accommodation is provided in a spacious



WEST ELEVATION

FIG. 3A.

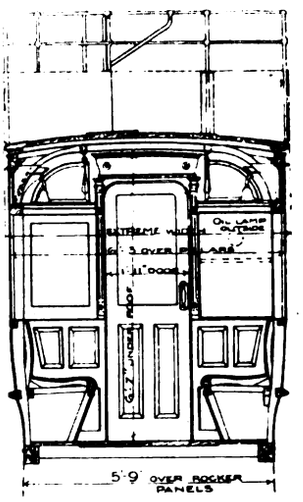


FIG. 5A.—End Elevation.

building lined with white and green enamelled bricks for 20 cars.

There are three main traffic routes. One starts from the depôt and passes through Northgate-street to Church Plain, and thence to the Market-place, where a strip has been taken off the western and southern sides of the market area, and continues through King-street and by Regent-road and the Drive to the Wellington Pier Gardens, heavy. The line contemplated along the South Quay to Friar's-lane and thence to St. Peter's-road has not been commenced, but as the tramways justify their existence this will be one of the branches that will form future additions. Though the tram zone is thus comparatively small it provides what was most needed—easy and rapid transit between the railway stations and the beach, and between the north and south of the town.

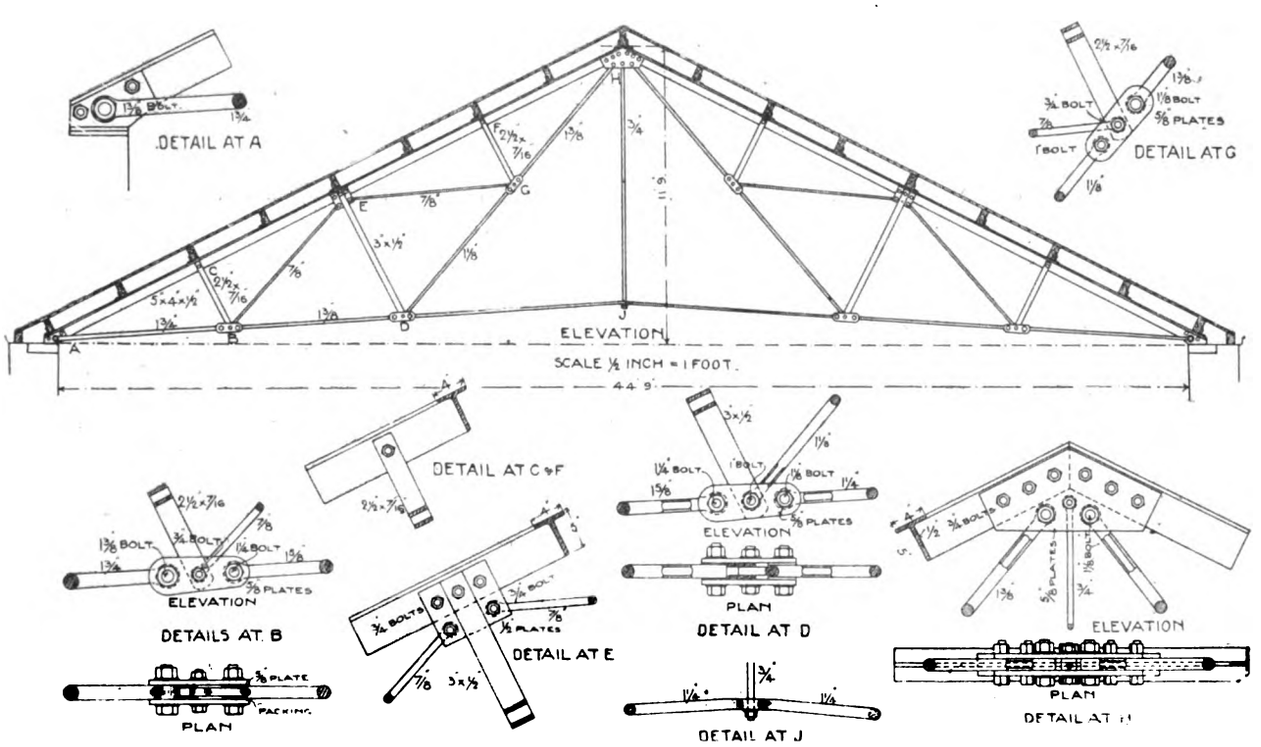


FIG. 4.

the present terminus. From this main traffic artery a branch springs at Fuller's-hill, and descending that incline passes along the North Quay, giving communication with Vauxhall Station, continuing by the quay to Regent-street, at the top of which thoroughfare it will strike what may be regarded as the main line in King-street. Through King-street another branch runs, passes down St. Peter's-road, and thus reaches the terminal point at the Corporation Beach Gardens. These two routes cover the chief lines of movement of Yarmouth's heavy summer traffic. A convenient loop line has been provided from Regent-road across Theatre Plain, connecting the line in the Market-place with the Regent-road tramway, which affords a ready means of avoiding congestion at the Regent-road corner of King-street, where vehicular traffic is always

Prior to the trams leaving the depôt there was a little speechmaking. Mr. Frank Arnold, chairman of the Tramways Committee, said that in 1896 the movement commenced for providing Yarmouth with trams. At first a company made overtures to them, but the Corporation decided that its trams should be under its own control. The present scheme was settled in 1898, and parliamentary powers obtained in 1899, but work could not then be pro-

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ceeded with as iron was making boom prices; £10 per ton was asked for the rails, which they obtained later at £5. 18s. 6d. The work was commenced in October, and they must congratulate the surveyor and all concerned on the very satisfactory progress that had been made, particularly during the winter. The Corporation had paid over £5,000 to the local labour employed on the work, and this was in addition to the money earned from the various contractors. The estimated cost was £49,750, and it was expected this figure would not be exceeded. One of the heart into the work. He hoped the time would come when there would be extensions by the South Quay to the Fish Wharf and along the Drive to the harbour's mouth.

The Mayor, in publicly declaring the tram system opened, praised the admirable manner in which the borough

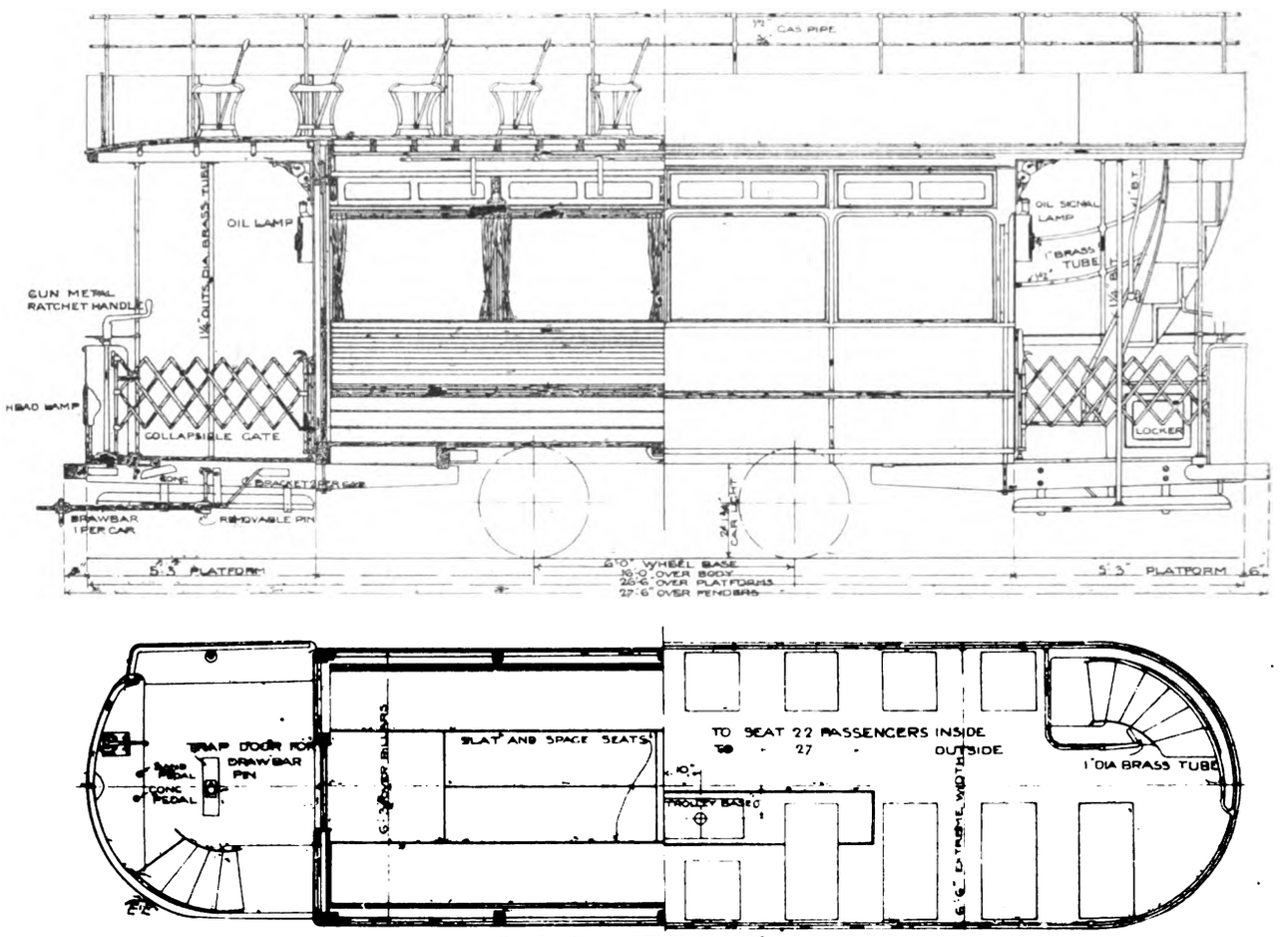

Fig. 5.—Plan and Elevations of Car.

surveyor had carried out this important work. These undertakings were, he said, very often delayed, but the surveyor had kept his word, and finished the tramways to time. Everyone in the town would give the undertaking their good wishes, and hope it would become a financial

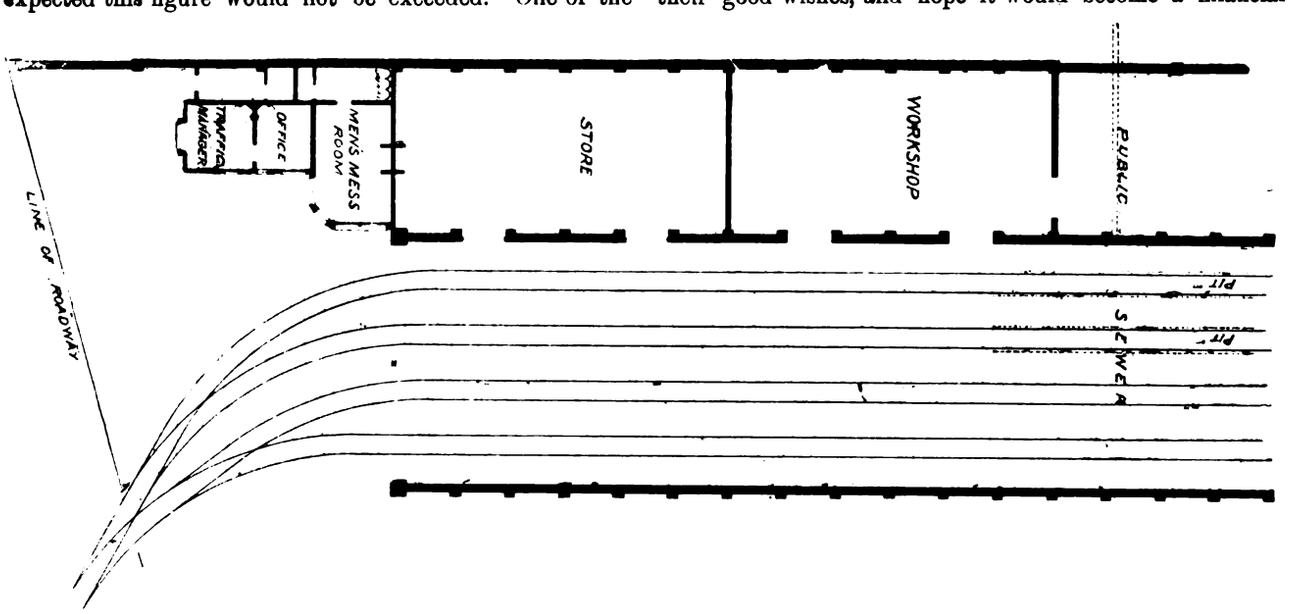

Fig. 6.—Car Shed.

Board of Trade inspectors, Colonel von Donop, expressed his satisfaction with the track. He could not help expressing their appreciation of the way in which the work had been carried on by the surveyor and his assistant, Mr. Eccleston, and also of the arrangement of the preliminaries by Mr. Turner, the manager. All of them had put their success. It was very important that Yarmouth should keep abreast of the times, and in providing electric trams Yarmouth was carrying out that principle, and coming into line with larger places. The suggestion that had been made in committee that they should try to run the cars as punctually as possible was a very good one, for a regular

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service would go a long way towards success. He sincerely hoped the trams would become a big success.

The company then entered the trams for the inaugural ride round.

Details of the Work.

A reference to our issue of Jan. 11, 1895, will give some information concerning the electricity supply of Yarmouth, the lighting station being opened in January of that year. Yarmouth, like many other towns, was being exploited for all it was worth. Mr. J. W. Cockerill, the borough engineer, who is, perhaps, as far-sighted and as energetic as most men, was not satisfied with his exertions to get the town to adopt the electric light undertaking, but pursued and endeavoured to obtain a tramway installation. After a good many ups and downs, and, as has been previously mentioned, a strenuous attempt to lease the tramlines to a company, a scheme was adopted and parliamentary sanction obtained, the Act being dated Aug. 1, 1899. Early in 1900 tenders were asked for, but the prices were too high, and for the moment the scheme was postponed. Twelve months after, almost to a day, tenders were accepted, and when the tender for 90lb. rails in 45ft. lengths at £5 18s. 6d. per ton was the price of the accepted tender, the rails to come from the works at Ougree, near Liège, whereas 12 months previously the prices quoted were nearly £10, it will be seen that waiting paid. The consulting engineers are Messrs. Preece and Cardew, who were definitely appointed on April 2, 1901. On May 9, 1901, a tender for cars was accepted from the Brush Company, and on July 31 tenders for the conduits from Messrs. Doulton and Co.; and for the poles, overhead equipment, and bonding by the British Insulated Wire Company, were accepted. Further tenders were accepted on Sept. 3—the Telegraph Manufacturing Company for the main feeders; Messrs. Doulton's for further work; Messrs. Askham Bros. and Wilson for the points and crossings; whilst the British Schuckert Company supplied the machines, and Messrs. W. H. Allen and Son the engines. The total estimate was £50,000, and the work has been carried out within that amount. We ought to have men-

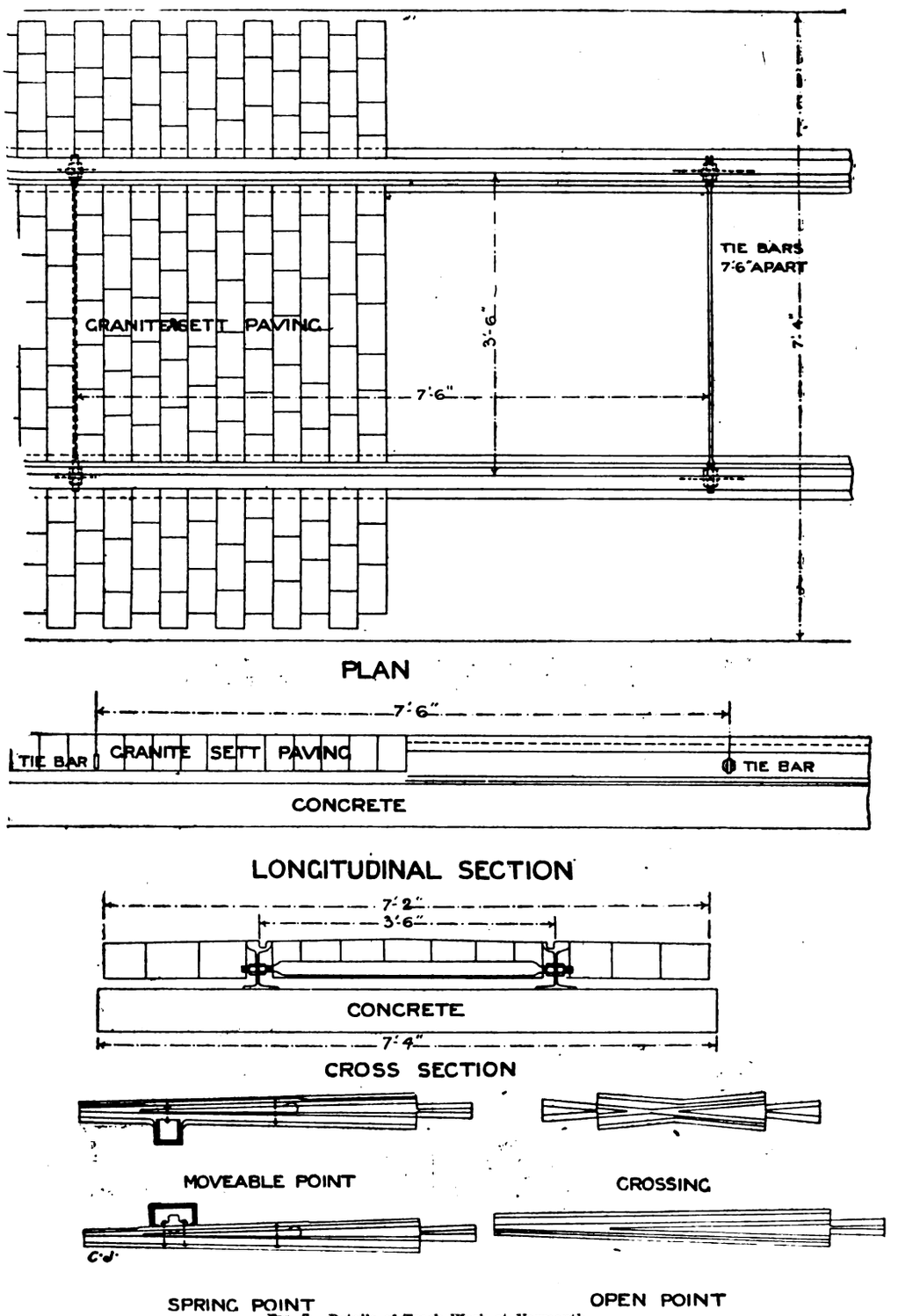

FIG. 7.—Details of Track Work at Yarmouth.

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tioned that Messrs. Crompton and Co. obtained the work for the battery and the booster, while Messrs. Grimble and Co. obtained that for the car-shed and offices. The street work has been carried out by the Corporation themselves, Mr. Cockerill being the responsible official, and having a most able assistant in Mr. Eccleston, who was appointed tramway assistant in February, 1901. The works were

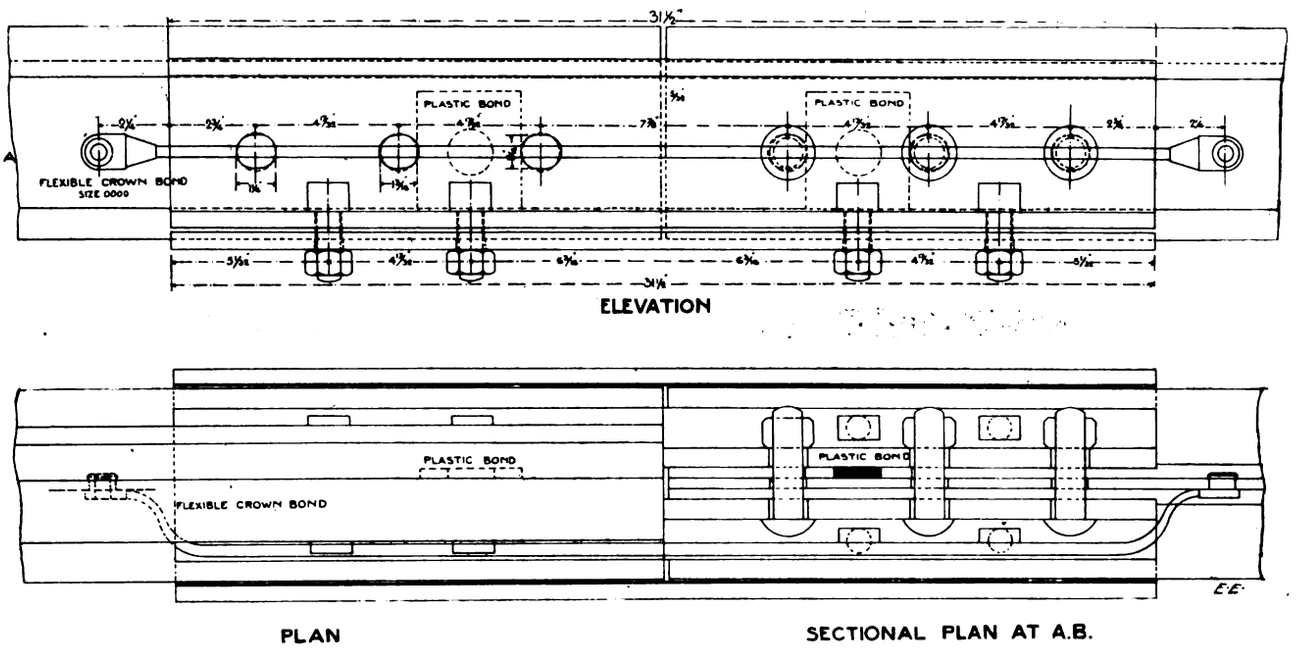

FIG. 8.

commenced late in October, 1901, and, as we have stated, were formally opened in June, 1902, being practically finished at the end of May.

The accompanying illustrations practically describe themselves, and will need but few words of explanation. The maps (Fig. 1), necessarily on a small scale, give some idea of the situation of the tramlines. The gentlemen whose portraits we give, together with Mr. Eccleston, have borne

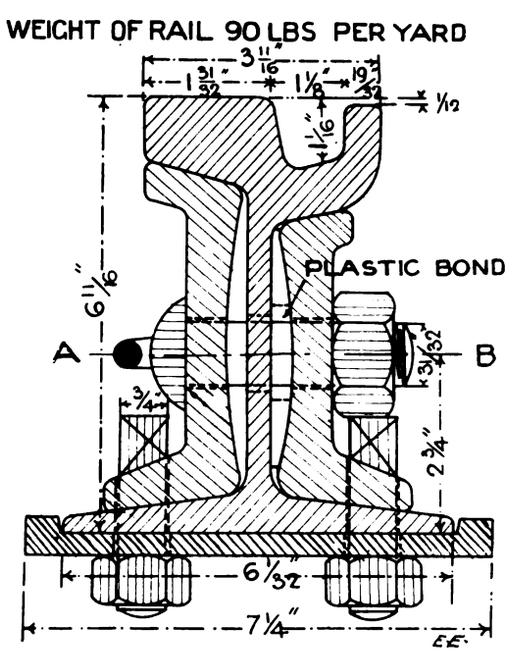

FIG. 9.—Sections of Rails, Fishplates, etc.

the burden and heat of the day, and if the Yarmouth tramways are in any sense to be termed a success, it is due to the untiring energy and devotion of these gentlemen to the work which they have had to carry out. Fig. 2 shows the car-shed and offices adjacent. Figs. 3 and 4 show details. Fig. 5 gives the details of one of the cars, and Fig. 6 shows the lines as going into the car-shed. Coming from the car-shed to the ordinary track, Figs. 7, 8, and 9 give in detail the various compound parts of the track.

Fig. 10 shows the sections of feeders supplied by the Telegraph Manufacturing Company. These cables are insulated with impregnated paper suited for 520 volts working pressure, the concentric cable being lead-covered and served, and the single cable lead-covered, armoured, and served. Figs 11, 12, and 13 show more specifically the work done by Messrs. Askham Bros. and Wilson, who supplied the automatic movable points and crossings of the best toughened crucible cast steel, and, indeed, all the special trackwork throughout the line. The rails, points, and crossings were fitted together at the works, marked, and sent away ready for laying in the system, thus saving a great amount of labour on the spot. It may be mentioned that Fig. 11 shows the junction at the Marine-parade and St. Peter's-road, of course laid out by Messrs. Askham Bros. and Wilson. Figs. 12 and 13 show details of special work.

Coming now to the central station, which is an extension of the original electric light station, Fig. 14 gives an exterior view of the building, while Figs. 15 and 16 show some details. Fig. 17 shows a plan of the arrangements, where it will be seen that the traction sets are quite

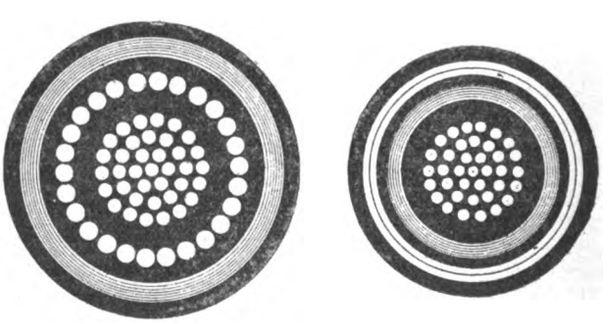

FIG. 10.—Sections of Cables.

distinct from the lighting sets, each, in fact, being complete in itself. Fig. 18 is a section through the building, while Fig. 19 is a photograph of the traction sets. These are a combination of engines made by Messrs. W. H. Allen and Co. with dynamos supplied by the British Schuckert Company. The dynamos are each designed for an output of 364 amperes at 500-560 volts when running compound, and 364 amperes at 460-500 volts when running as shunt machines at a speed of 350 revolutions per minute. The constructional details of these dynamos can be seen in Fig. 20. The machines are of the usual Schuckert continuous-current type. The speciality of the particular machines supplied to this Corporation is that they are arranged for either shunt or compound working, in the latter case being over-compounded in such a way as to raise the voltage from 500 to 560 from no load to the full load of

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364 amperes. This is arranged by bringing one terminal of the shunt and of the series winding of the fields to a single-pole throw-over switch, which is placed on the upper part of the magnet frame. The armatures are drum-wound of the special Schuckert surface-driven type, and the windings consist of rectangular bars, thoroughly insulated and securely attached to the core. The conductors are insulated from

FIG. 11.—Laying the Track.

the core by means of mica, and are driven by means of insulated driving strips, sunk at frequent intervals into the core, and extending the whole length of the armature. The end connections are made by bent copper strips, which, being entirely surrounded by air, are thoroughly insulated from each other and from all adjacent parts of the machines, and which from their fan-like arrangement produce a very powerful current of air, and considerably

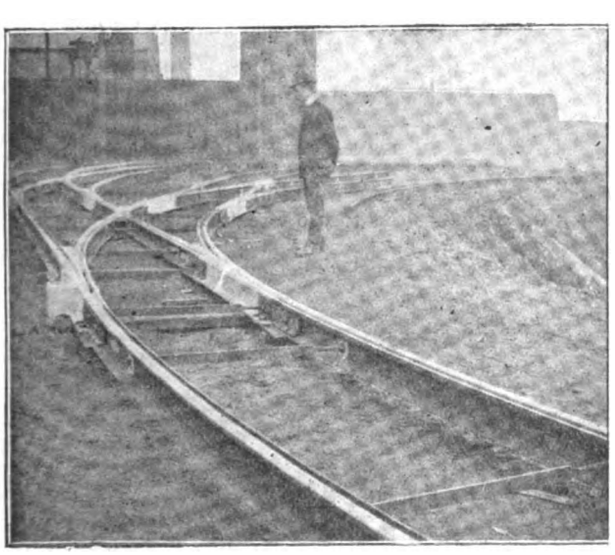

FIG. 12. Special Work.

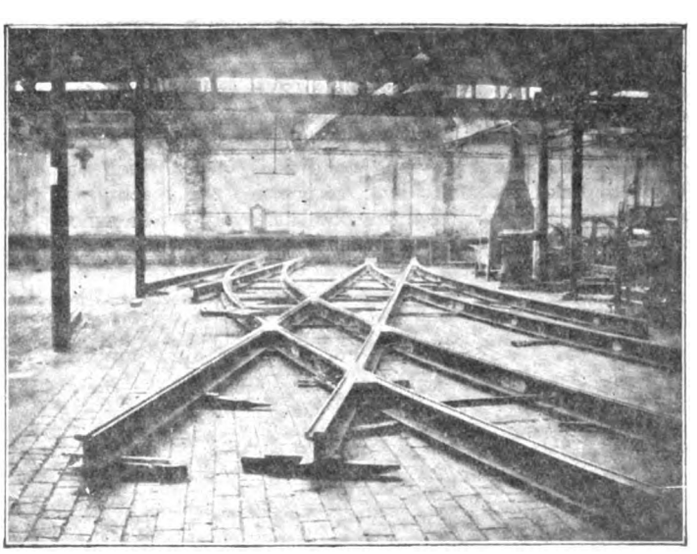

FIG. 13.—Special Work.

cool the windings when the machines are running. The magnetic field between the armature and the pole-pieces is so proportioned that the armature reaction is reduced to a minimum. The machines are designed for a maximum temperature rise of 72deg. F. after a 24-hour run at full load. The guaranteed efficiency at full load is 92 per cent.

A few words may be given describing the Chelmsford reversible booster. This machine is designed for use in central stations with the object of keeping the load on the main generators approximately constant in spite of large and sudden variations in the external load, and effects this by automatically charging and discharging the battery in connection with which it is used. Each booster consists of an ordinary shunt-wound motor coupled across the main 'bus bars and driving a differentially-wound generator. This generator has two field circuits: (*a*) the ordinary shunt, and (*b*) a special main which carries a definite portion of the main load of the station. The diagram of connections is shown on Fig. 21. The charge and discharge of the battery are governed in the following way: (1) When the external load is just equal to the normal full load of the generators in use, no discharge is required from the battery, and the field windings are so designed that under these conditions the excitation due to the special series coils neutralises the excitation due to the shunt winding. (2) When the external load is greater than the normal load of the generators, discharge current is required from the battery. This discharge current is automatically obtained, as the increased current in the external circuit increases the excitation due to the series coils, and the connections to the battery are such that the volts thus given by the

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generator are added to the battery. (3) When the external load falls below the normal full load of the generator the reverse action takes place, the shunt winding (*a*) overpowering the excitation due to the series coils, reversing the polarity of the generator and causing a charging current to pass through the battery. To take a special example. We will assume that the battery is being used in connection with a lighting and motor circuit at 500 volts. Under condition (2), where the battery is required to discharge, the booster should be designed to add about 40 volts when the battery is discharging at its maximum output, and give about 40 volts in the reverse direction when the maximum charging current is passing to the battery under condition (3). The resistance, C, is introduced to avoid the current from the booster passing through the series winding of the main generators. The switch, R, or a set of plugs, is used in connection with a compensating resistance, shunting the generator series coils. This switch has a double function: (1) it allows a varying number of main generators to be used in parallel; (2) it enables the point of reversal to be adjusted. Further, a shunt regulator, D, is provided in the generator shunt circuit. The above describes the normal working conditions under which the booster works automatically. In practice the machine is also required for fully charging the battery at certain times, and taking the examples given above, the booster will have to be large enough to give 120 volts occasionally. These higher voltages are obtained by short-circuiting the series coils and regulating the volts by the ordinary shunt resistance, D. Under these conditions the machine acts as an ordinary motor-booster. Motor-generators of this type have been supplied to the Birkenhead Corporation, and Mount Morgan, as well as to the Great Yarmouth Corporation. They are particularly useful in tramway stations on account of the rapidly varying load.

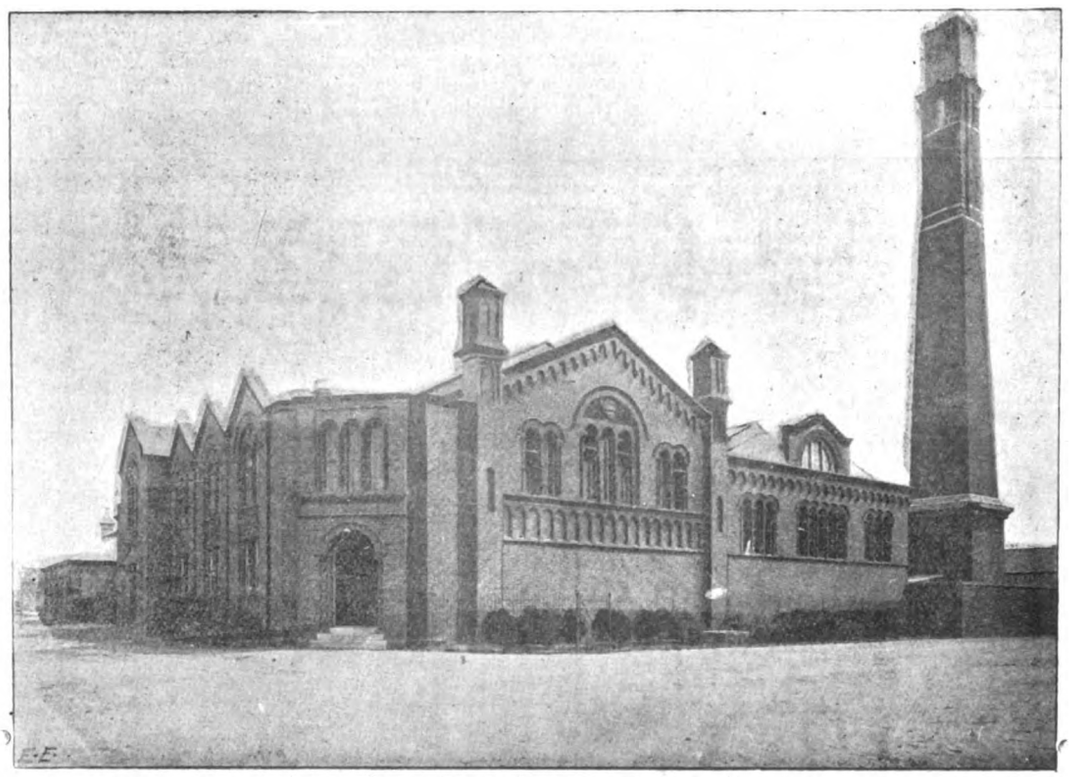

FIG. 14.—Exterior View of the Yarmouth Electricity Works.

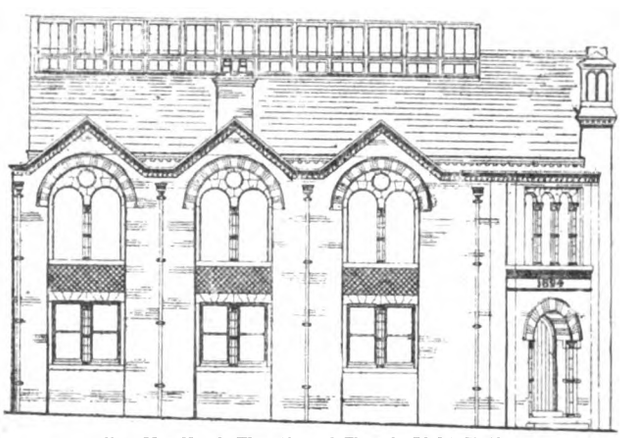

FIG. 15.—North Elevation of Electric Light Station.

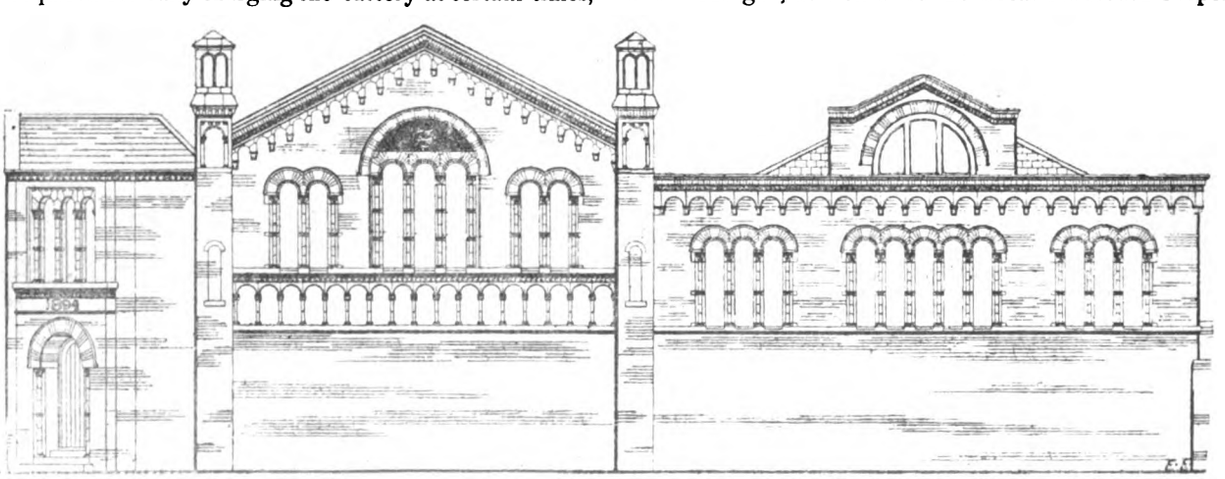

FIG. 16.

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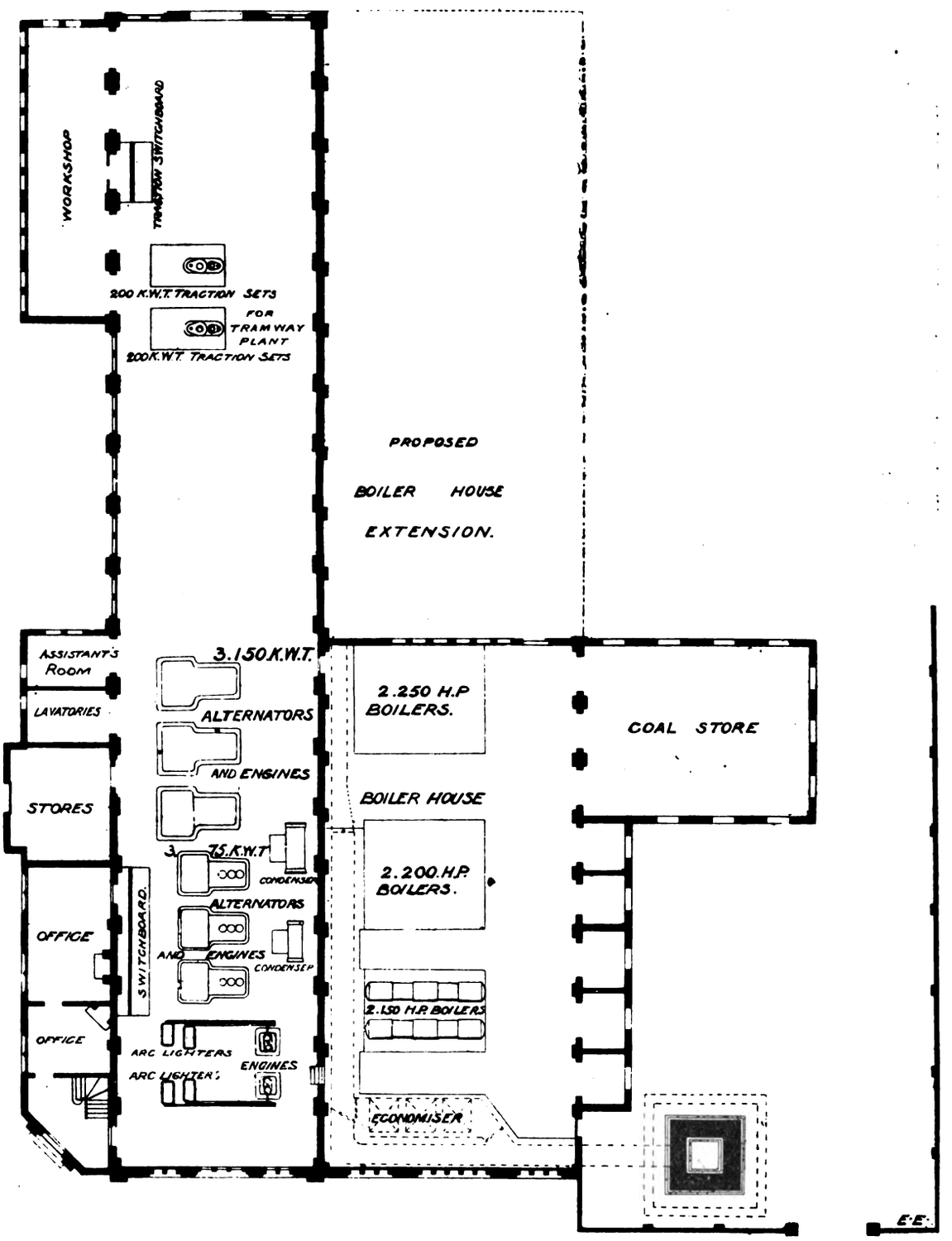

Fig. 17.—Block Plan of the Yarmouth Electricity Works.

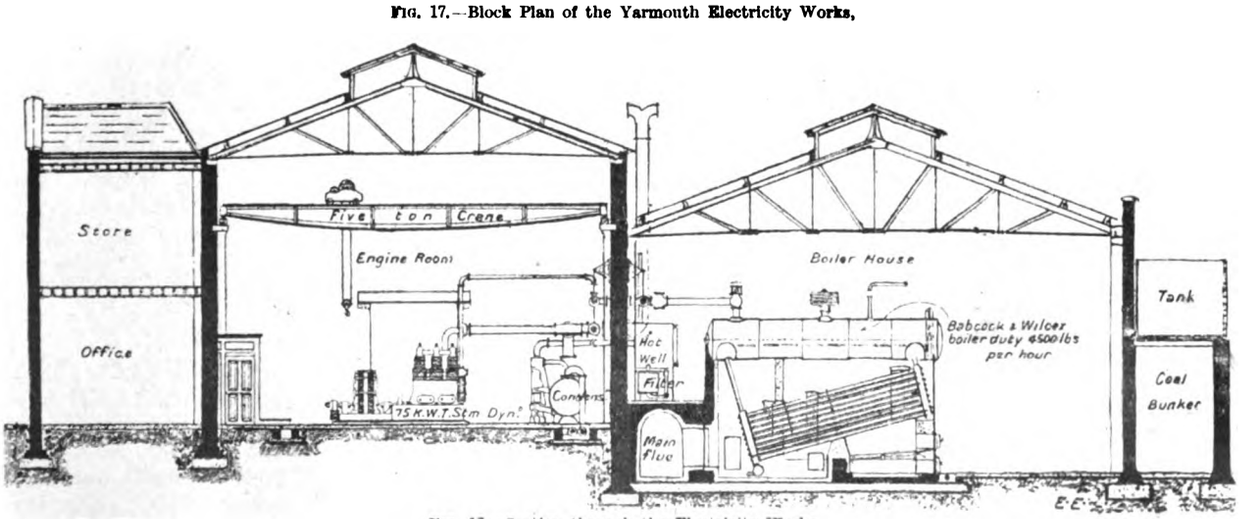

Fig. 18.—Section through the Electricity Works.

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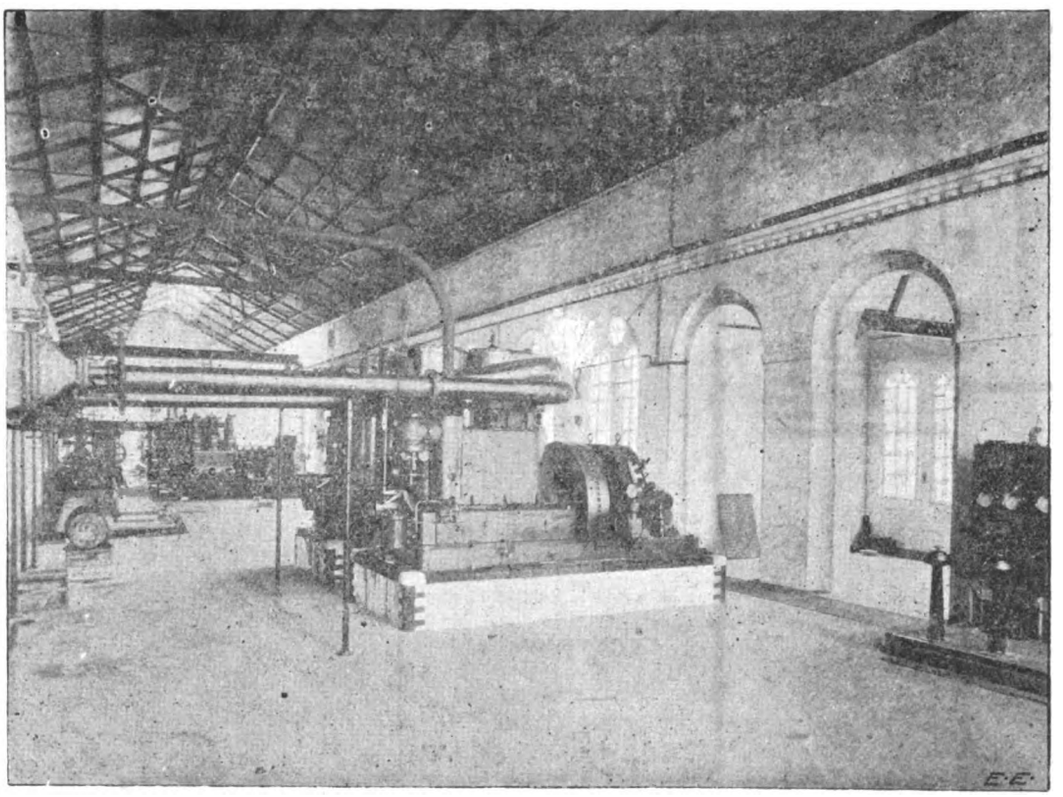

FIG. 19.—The Traction Sets at Yarmouth.

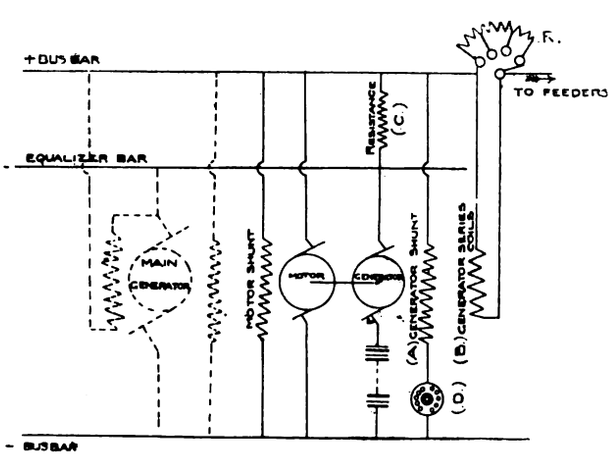

FIG. 21.

Figs. 22 and 23 give the diagram of connections of the main station and the sub-station boards. There is no particular feature in these boards, apart from the arrangements of the reversible booster switchgear, as all switches, fuses, and instruments are of Crompton's standard patterns except the automatic cut-outs, which are of the British Thomson-Houston type. The battery has a storage capacity of 360 ampere-hours when discharged at 45 amperes, but is capable of a momentary discharge of 280 amperes. This battery was supplied and fixed by the E.P.S Company, who were sub-contractors under Messrs. Crompton and Co.

WIRELESS TELEGRAPH STATIONS.

Public notice is given in the *London Gazette* of Tuesday last that stations have been established by the Marconi

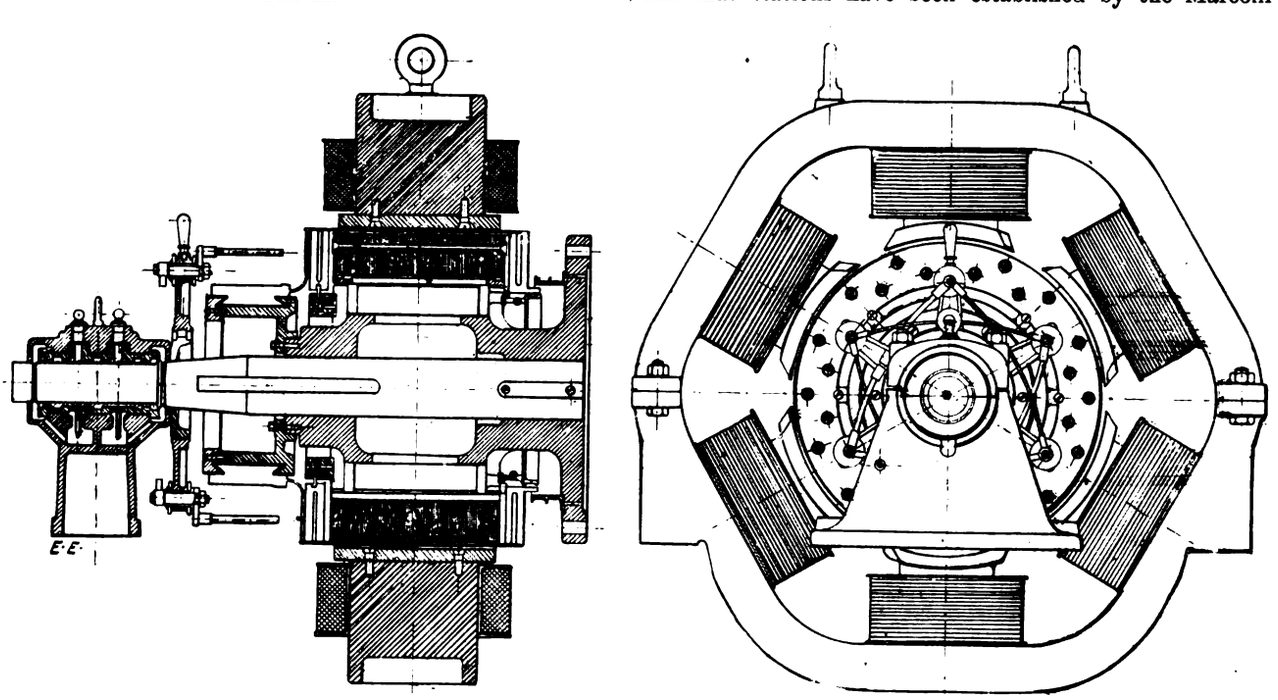

FIG. 20.—Britis Schuckert Dynamos at Yarmouth.

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Wireless Telegraph Company at the undermentioned places, and that messages can be received at these stations and forwarded to their destinations: Frinton-on-Sea, Essex; North Foreland, Kingsgate; Niton, near St. Catherine's Point, Isle of Wight; Haven, northern entrance to Poole Harbour; Lizard, a quarter of a mile westward of Lloyd's signal station; Holyhead, in the town; Rosslare, three-quarters of a mile north of railway station; Crookhaven, half a mile westward of village; Malin Head, Lloyd's signal station; Innistrahull, Lloyd's signal station; Borkum, River Ems, Germany; Borkum light-vessel, Germany; Nieuport, Belgium; Belle Isle, Labrador; Chateau Bay, Labrador; Sagaponack, near Sag Harbour, Long Island, U.S.A. The total number of wireless telegraph stations established by the Marconi Company is thus 16, of which, it will be seen, 10 are in the United Kingdom, three are Continental stations, two are in North America, and one in the United States. There can be no doubt that the facilities offered by these stations for enabling communication to be set up between ship and shore will be greatly appreciated by passengers crossing the Atlantic, especially by business men. As has recently been demonstrated, it is now possible by wireless telegraphy to be in communication with land for nearly half the time occupied in making the passage of the Atlantic.

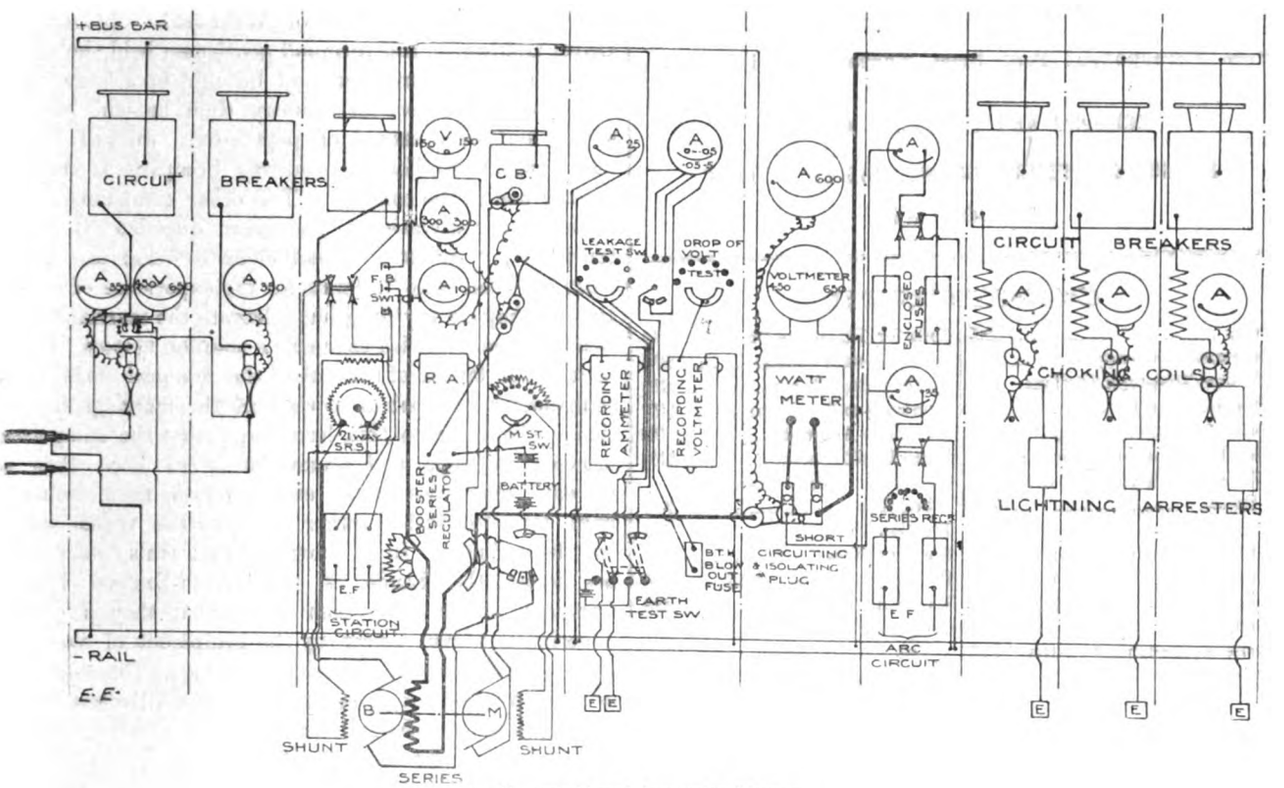

FIG. 22.—Switchboard Connection Diagram.

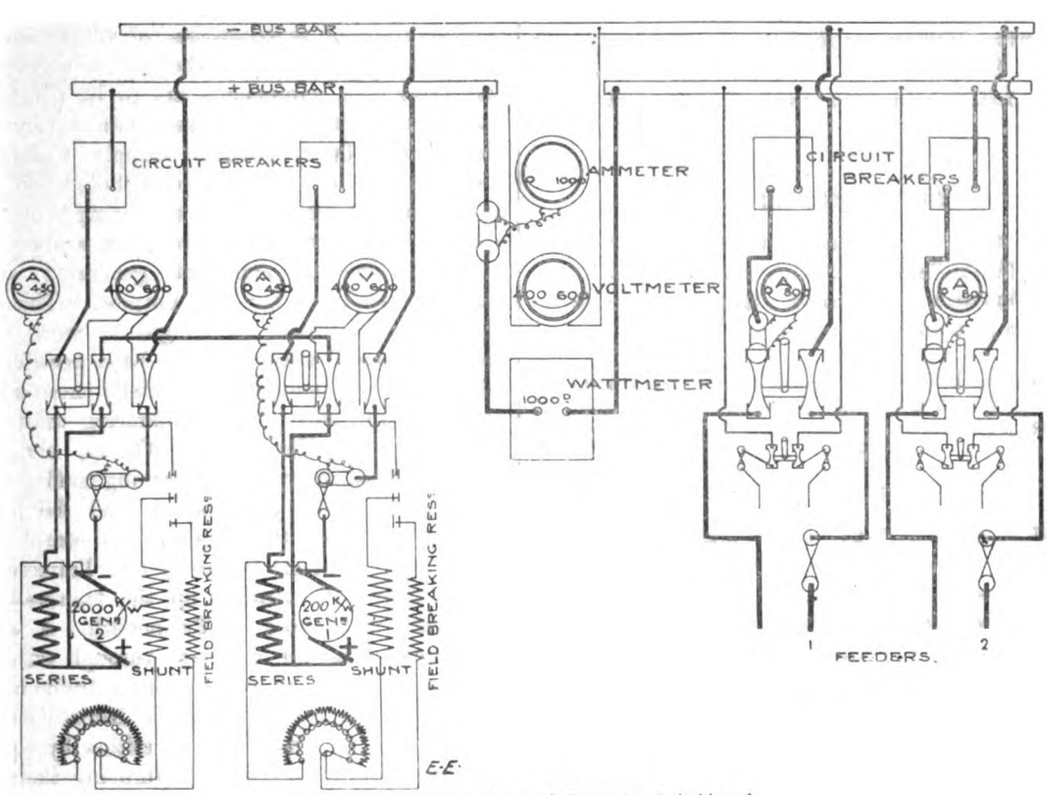

FIG. 23.—Connections, Yarmouth Tramways Switchboard.

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CONTENTS.

Notes	253	Coils for Telephone Circuits	275
Yarmouth Tramways	258	Appointments Vacant	276
Wireless Telegraph Stations	268	Forthcoming Events	276
Electric Railways	270	Questions and Answers	277
Correspondence	271	Worcester Accounts	278
The New Marconi Wireless Telegraph Station at Cape Breton	271	Legal Intelligence	279
The Dissipation of Energy by Electric Currents Induced in an Iron Cylinder when Rotated in a Magnetic Field	272	Contracts for Electrical Supplies	279
Trade Notices and Novelties	275	Traction Notes	280
		Lighting Notes	283
		Provisional Patents, 1902	286
		Traffic Returns	288
		Companies' Stock and Share List	288

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ELECTRIC RAILWAYS.

The frequent references to electric traction which have been made at the recent half-yearly meetings of the large railway companies of the United Kingdom remind us of the wisdom of the Vicar of Wakefield. According to Oliver Goldsmith, this reverend gentleman held the opinion that the man who married and brought up a large family did more good for his country than he who remained single and only talked of population. Judged on this basis, the North-Eastern Railway Company is the most worthy one in the country. The other companies owning main lines "investigate the great question of electric traction"; "collect information as to what can be and what has been done"; "wait for the experience of others." In fact, they do anything but celebrate the marriage of the steam locomotive with the electric traction system. It may be urged in favour of some that the financial state of the companies is not such as to warrant the marriage in question. The reply to this, however, is that the competition between railways and tramways is so keen that the railway companies must either equip their suburban lines for electrical working or lose the traffic carried by these lines. It is obvious that this competition has forced the hands of the North-Eastern Railway Company, but it is to their credit that they propose to experiment within a year by the equipment of over forty miles of their lines for electrical working. The magnitude of the so-called experiment which the directors of the North-Eastern Railway Company are making will be gathered from the following figures. It will involve the laying of conductors along two miles of four-line track, thirty-five miles of double track, and four miles of single track. We gather that it is not definitely decided whether the track is to be bonded and used as a return. The company will also make fifty new motor coaches and thirty-six trailer coaches, which will be equipped for the converted lines. These are to be run in short trains of three coaches, of which the middle one will be a trailer. Besides the above, high-tension cables and sub-station equipments are to be provided in order that power obtained as three-phase currents from the Newcastle-on-Tyne Electric Supply Company at six thousand volts may be distributed to the trains as direct current—in fact, the equipment is complete, with the exception that power is to be bought from a supply company and not generated at a special station established for the purpose. This will enable the electrical system to be got to work at an earlier date than would otherwise have been possible. The lines which are to be converted are chiefly those which connect up Newcastle with the neighbouring seaside towns of North Shields, Tynemouth, Whitby, and Cullercoats. The residential morning and evening traffic on these lines is a valuable one, and both it and the holiday traffic is threatened by the approaching completion of the lines of the Tyneside Tramway and Tramroad Company. These lines will connect up the tramway systems of Newcastle with those of Tynemouth. A well-organised and frequent service on these through tramlines will, as has been proved, play havoc with the traffic of the railway company. The directors of the North-Eastern Railway have decided to fight the competition by equipping their lines electrically, and vastly improving their service. A speed of twenty-two miles per hour, inclusive of twenty-second stops at the stations, is to be maintained by the three-coach electric trains. This increased speed, together with an increase in the number of trains per hour, will hold a large proportion of the present traffic. What is more important is that the increased facilities will induce more

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Newcastle residents to live at the seaside, and hence will open out new building sites and increase the number of season-ticket holders. It would be well if the other great railway companies were to follow the example of the North-Eastern, and there are without doubt a number of cases in which a prompt improvement of travelling facilities carried out on the above lines would prevent competition by interurban electric tramways. To conclude, the railway company which adopts electric traction and creates a healthy suburban traffic, does more for the country and its own shareholders than the company which sits on the fence and talks of progress.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BRISTOL MUNICIPAL TELEPHONES.

SIR,—I have always lived in the belief that direct references to each other's work should be avoided by professional men unless such references can be made courteous and complimentary. It may not be possible to give effect to this rule invariably, but when adverse criticism cannot be shirked, then it behoves the critic, not only for the sake of justice but for his own reputation, to make quite sure of his facts. It was with amazement, therefore, that I read Sir W. H. Preece's report to the Corporation of Bristol on their proposed municipal telephone service, dated April, 1902. In it Sir W. H. Preece not only permits himself to cast thunderbolts at the humble work of the present writer, but does so without taking the trouble to ascertain whether he is directing his disruptive energy at anything more substantial than shadows, for, strange to say, the objects of his wrath are in every case myths, although he states them as substantial facts! Here are some examples, which, for brevity, I arrange in parallel columns:

Report.	*Fact.*
1. "Brighton has adopted £7—*i.e.*, a £7 telephone rate—against this expert's advice."	The rates I recommended to Brighton were £5. 10s. inclusive, and £3. 10s. and 1d. per call toll, which were adopted.
2. "Huddersfield now proposes £7. 10s., under the same expert's advice."	I have never given any advice to Huddersfield, direct or indirect.
3. "It must be noted that while the Glasgow rate was fixed at £5. 5s., in Tunbridge Wells it became £5. 17s. 6d."	The Tunbridge Wells rate was proposed as soon as Glasgow's, and differed because the circumstances are quite dissimilar.
4. "What is the experience of Glasgow? There is an ominous silence as to the financial result of the municipal scheme."	The Glasgow Corporation's year ends on May 31. The accounts for 1900-1 were presented to the Town Council on Sept. 5, 1901, and were duly published. As required by the telephone license, copies were furnished to the Postmaster-General. The accounts for 1901-2 went through the same formalities last month.
5. "I have been told, but cannot vouch for the fact, that the estimates have been greatly exceeded."	Myth.
6. "The National Telephone Company have, however, experienced a record advance in their rate of progress in that city. . . . The growth of their business is, I am assured, phenomenal."	Quite untrue. An analysis of the company's Glasgow directory, issued last month, counting every name in it, shows a great falling off in direct lines to the Glasgow exchange since January last. This is partly compensated, so far as numbers go, by some increase in party-line instruments, but the loss of revenue must be very serious. It has been ascertained also that people whose names appear in that directory cannot be rung up. On the other hand, the Corporation have 6,300 lines speaking, 1,500 more to join up, and are booking orders at the average rate of eight per diem.
7. "They are paying £1,500 a year in terminal fees to the National Telephone Company."	Untrue, as the recently-issued Corporation accounts show.

This concludes the kindly references to me and my work. They are seven in number, and everyone is founded on fiction.

But what if I were to become critic in my turn and pull the rest of Sir William's very long report to pieces? I will not take credit for not doing so, because, as you could not possibly afford me the necessary space, my letter would probably not appear at all, and so my own defence would be lost.

I will, however, ask permission to say that on p. 1 of the report the Bristol Corporation are informed that they possess a monopoly of the tramways and waterworks in their city, the fact being that these enterprises are in the hands of companies; on p. 2 Sir William says of the Bristol telephones, "The service is well done," although on p. 1 he states that the Telephone Committee are aiming at a "more efficient service"; on p. 2 he says, "I cannot say that the business is well developed in Bristol"; and on p. 3, "Upon comparison with the figures in Bristol we cannot say that it is badly developed there." On p. 2 he says that telephony "is not well developed anywhere in Great Britain," which is in direct contradiction to his evidence before the 1898 Select Committee, while telephony in Glasgow, Guernsey, and Tunbridge Wells *is* well developed, thanks to the Corporations. The figures given on p 7 of the cost of establishing a telephone service are not in accord with experience, and are contradicted by the recently-published Glasgow Corporation accounts. The working expenses of a telephone system given on p. 7 are greatly overestimated, while, on p. 4, 5 per cent. is said to be sufficient to cover interest and sinking fund, which is an under-estimate. On p. 4 Sir William bases a calculation of income and working expenses on 6,000 lines, and in the next paragraph despairs of ever getting such a number! Surely the reasonable plan would have been to have made up his mind as to the number that could be got, and then to have estimated accordingly. Anyhow, the Glasgow Corporation have got over 6,000 in less than 12 months, so Bristol need not quite despair. If Bristol were telephoned to the same extent as Guernsey, it would have 9,221 telephones, and yet Guernsey is not *quite* such an important place as Bristol Bristolians are told that they ought to be contented with party lines—from two to ten on a string! "The party line meets all points and removes all objections to (causes for?) the complaint of dear telephony." They are also told that they ought to be content with the present tariffs of the National Telephone Company, and with everything that they happen to have. In short, as William's mother says in "Black-Eyed Susan" (Burnand's version: "Everythink as is, is for the best."

In fact, the report is such an elaborate and laboured piece of special pleading on behalf of the National Telephone Company, is so self-contradictory, and is so absurdly at variance with facts, that I cannot bring myself seriously to believe that Sir William Preece ever wrote it. Most probably, being occupied with much more important matters (for I see Sir William is now devoting himself to the electric lighting of Carnarvon), he has allowed some zealous and imaginative employé or advocate of the National Telephone Company to do the writing, and has (no doubt in all good faith and in the exercise of that good nature for which he is so justly celebrated) simply appended his signature.—Yours, etc.,

A. R. BENNETT.

65, Renfield-street, Glasgow, Aug. 19, 1902.

THE NEW MARCONI WIRELESS TELEGRAPH STATION AT CAPE BRETON.*

It will be remembered that immediately after the first successful transmission of signals across the ocean by the Marconi wireless system, the work of constructing three stations—two in America and one in England—for the regular transmission of commercial messages was put in hand. The European station is situated at Poldhu, Cornwall. On the American side of the ocean the station used in the original experimental work was erected on

* From the *Scientific American*.

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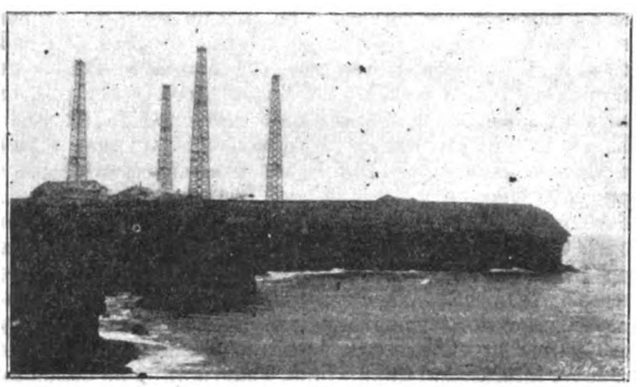
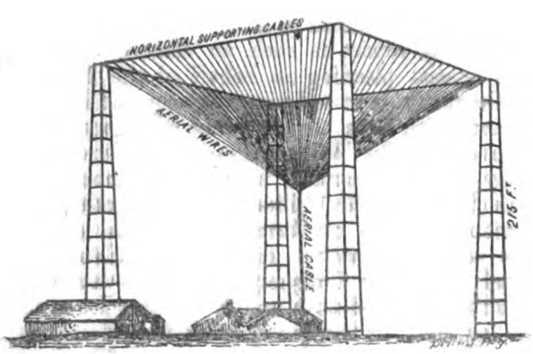
a lofty point at the entrance to St. John's Harbour, Newfoundland, but on account of the opposition of the Anglo-American Telegraph Company which holds a monopoly of Transatlantic telegraph rights in Newfoundland, Marconi abandoned that site and selected two new locations, one on the easterly coast of Cape Breton, Nova Scotia, and the other at Cape Cod, Massachussetts. The station at Glace Bay, Cape Breton, of which we present a group of illustrations, is located on a promontory of land, whose surface lies about 70ft. above mean high water. The plant consists of four huge towers for carrying the vertical wires, and a group of one-storey buildings arranged at the base of the towers, in which are contained the powerful electrical plant which has been specially constructed for the station.



The New Marconi Wireless Telegraph Station at Glace Bay, Cape Breton.

The present article is devoted to a description of the four great towers, which take the place of the familiar single mast that is used where transmission is to be conducted over moderate distances. It will be understood that for the regular transmission of commercial messages over distances measured by the thousand miles a vastly greater capacity is necessary, both in the generation and the reception of the Hertzian waves, than suffices for the ordinary messages over from 50 to 100 miles, of which we have heard so much of late. Hence the truly gigantic proportions of the aerial system which is herewith illustrated. The necessary height for the vertical wires has been attained by the erection of four braced wooden towers, each 215ft. high, at the four corners of a square which measures about 200ft. on a



The Marconi Receiving Station at Cape Breton.

side. Each tower consists of four legs, built up of 3in. by 12in. plank, the legs being braced together on each face of the tower by 3in. by 9in. braces. The planking of which the legs are built is laid up so as to break joint as much as possible, and secure the approximate strength of a solid 12in. by 12in. stick. The legs are spaced 30ft. from centre to centre at the base and 9ft. from centre to centre at the top platforms. The foundation of each tower consists of a mass of concrete formed in a hollow square, in which are embedded the 12in. by 12in. sills and the first panels of the lateral bracing. In section this concrete mass is 6ft. in width by 8ft. in depth, the external dimensions of the foundation being 36ft. by 36ft. and the internal dimensions 24ft. by 24ft.

The experience had with previous attempts to carry a set of lofty aerial wires, more particularly that at Cape Cod, which was wrecked in a heavy gale, proves that the weakest feature in those structures was the system of guy ropes with which they were held in position. The fall of the Cape Cod structure was due to the parting of the extreme weather guy ropes, the method of tying the towers adopted having been such that practically the whole strain fell upon a few stays. In the present case the towers are tied in such a way that the stress on each tower will be transmitted directly to its own set of cables, every one of which will be doing useful work. The wires are carried from three points on the towers (the lower and upper third and the summit), all wires having an inclination of 45deg. The ropes are all made of the best plough steel, the majority of them being 2½in., and a few 3in. The method of carrying the aerial wires upon the structure is as follows: Four 3in. cables are strung from platform to platform at the top of the towers, as shown in the accompanying diagram, and from these cables depend 150 aerial wires. These are drawn together and united in the centre of the tower into a single cable, which descends vertically to enter the transmitting and receiving house below. The average length of the aerial wires before they meet in the common central cable is about 140ft. During a recent visit of a member of the staff of the *Scientific American* to the Cape Breton station, Mr. Vyvyan, the engineer in charge of the station, stated that Marconi has ceased to use the coherer and has substituted a receiver of much greater reliability and capacity. It was always difficult to secure an absolutely reliable coherer of the old type, since out of 100 of these little instruments 30 or 40 might be good, 30 would be poor, and 30 would be absolutely unusable. The new method of receiving adopted by Marconi has a capacity should it be required of several hundred words a minute. This improvement, taken with the great power and capacity of the plant, render it practically certain that, when in the course of a few weeks the station is opened, it will prove to be capable of dealing with any class of commercial messages that may be required. Mr. Vyvyan further stated that it would be possible to receive and send messages to and from San Francisco, the earth resistance being very much less than is popularly supposed. The power of the new installation was far greater than would be demanded for transmission to Europe, and it is probable that before the close of the present year messages will be sent direct from Cape Breton or Cape Cod to Cape Town, South Africa.

THE DISSIPATION OF ENERGY BY ELECTRIC CURRENTS INDUCED IN AN IRON CYLINDER WHEN ROTATED IN A MAGNETIC FIELD.*

BY ERNEST WILSON.

(Concluded from page 228.)

Rotating and Alternating Magnetic Fields.

We have seen that the results of theory are fairly well verified by experiment. It remains to extend the formulæ to cases actually met with in the construction of dynamo-electric machinery. It is reasonable to assume that the electric currents distribute themselves in paths such that constant current density is preserved. The formula $2{\cdot}78\,\frac{B^2 f^2 t^2}{10^{16}\rho}$ may be taken to apply with a good deal of certainty in the case of circular plates in which the diamete is great as compared with the thickness, and in which the line of force are uniformly distributed in the plane of the plate. Comparing this with the formula $1{\cdot}65\,\frac{B^2 f^2 t^2}{10^{16}\rho}$ for alternating magnetic force, we may say that the rotating field would dissipate about 1·7 times as much energy in a given time as the alternating magnetic field. It should be remembered, however, that even when the lines of force are confined to the plane of the plate, the dissipation of energy for a given average induction density may be considerably reduced if the distribution is such as to give the induced E.M.F. a more rectangular wave-form. Some time ago I tried to account for the loss

*Paper read before the Royal Society.

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in a smooth-core drum armature, in which the magnetic field was distributed approximately as in these experiments. Bringing to bear the results of Prof. Baily's experiments on the dissipation of energy by magnetic hysteresis in rotating magnetic fields and the results arrived at in this paper, I am still unable to account for the observed loss on the assumption that the plates are insulated from one another. In dynamo-electric machines, where approximate uniform rotating fields are met with, the construction does not lend itself to such perfect conditions as, for instance, in the case of alternate-current transformer cores. It is doubtful if the lines of force are always confined to the plate. If one considers the section of an armature core in which ventilating spaces are provided, it is highly probable that at the ends of the core and at each ventilating space there is a considerable axial component, which would at once give rise to a serious increase in the dissipation of energy by induced currents. The teeth are sometimes filed out after placing the plates in position, and this may lead to considerable conductivity normal to the plane of the plate. Then, again, the plates are not always insulated from the shaft or spider which supports them. In multipolar dynamos it is questionable if one ever meets with a fair approximation to a uniform rotating field.

Longitudinal Variation of Intensity of Magnetic Induction.

In the previous paper it was stated that the intensity of magnetic induction diminishes in value and suffers retardation in phase as one proceeds from either end of the cylinder along its longitudinal axis towards the centre, in much the same way as was observed radially in a plane at right angles to the longitudinal axis and midway between the ends of the cylinder. This statement rested upon a comparison of the E.M.F. of coil I. with that of coil 1. In the present experiments an opportunity to examine this further was given, and coil 3′ (Fig. 1) was wound round an area 22·6 square centimetres at the end of the cylinder. The maximum values of the induction density over this area are given in Table I., so that a comparison can be made with the maximum value of the intensity of induction at the centre (coil 1). The phase displacements are also given. The results further confirm the statement made in the previous paper.

Conclusion.

In my former paper I omitted to thank Prof. Capper for the loan of the worm and wormwheel used in these experiments. I have pleasure in doing so now. I have also pleasure in acknowledging the help I have received from Mr. F. S. Robertson, and Messrs. M. S. Duffitt and R. M. Wartze. I wish to mention the intelligent interest taken by Mr. Duffitt in the theoretical part of the work, and the patience and care Mr. Wartze has given to the working out of results. Mr. T. Jones has again rendered valuable assistance.

THEORETICAL APPENDIX.—By J. B. DALE, M.A.

1. The rotation of a conducting sphere in a magnetic field is discussed by J. J. Thomson ("Researches in Electricity," p. 546). When the sphere is rotating about the axis of z, in a uniform magnetic field of force B parallel to x, the values of the current components when $\sqrt{(\mu\,\omega/\sigma)}\,a$ is very small are

$$p = -\tfrac{3}{2}\frac{\mu\,\omega}{(\mu+2)\,\sigma}\,z\,\mathrm{B}, \qquad q = 0, \qquad r = \tfrac{3}{2}\frac{\mu\,\omega}{(\mu+2)\,\sigma}\,x\,\mathrm{B},$$

ω being the angular velocity and a the radius. In the case of an iron sphere we may take $\mu = 10^3$, $\sigma = 10^4$, and the current components are approximately

$$-\tfrac{3}{2}\frac{\omega}{\sigma}\,z\,\mathrm{B}, \quad 0, \quad \tfrac{3}{2}\frac{\omega}{\sigma}\,x\,\mathrm{B}.$$

The currents, therefore, flow in circles in planes parallel to $y\,z$, having their centres on the axis of y.

Integrating round a circle, the value of the E.M.F. is found to be $3\,\pi\,\rho^2\,\omega\,\mathrm{B}$. This is likewise the value of the E.M.F. found on the assumption that the circuit is insulated and rotating in a field of magnetic induction equal to that in the sphere at rest.

The rate of heat production

$$= \sigma \iiint (p^2 + r^2)\,dx\,dy\,dz,$$

taken throughout the volume of the sphere. Transforming to polar co-ordinates, this becomes

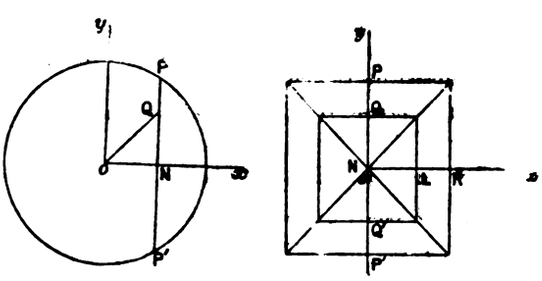
$$\tfrac{9}{4}\frac{\omega^2}{\sigma}\,\mathrm{B}^2 \int_0^a r^4\,dr \int_0^\pi \sin^3\theta\,d\theta \int_0^{2\pi} d\phi = \tfrac{6}{5}\frac{\pi\,a^5\,\omega^2\,\mathrm{B}^2}{\sigma},$$

Writing for ω, $2\,\pi\,f$ when f is the frequency, we find for the rate of heat production per cubic centimetre.

$$3{\cdot}95\,\frac{a^2 f^2\,(3\,\mathrm{B})^2}{\sigma},$$

when 3 B is the induction when the sphere is stationary.

2. In the case of a cylinder rotating about its axis of figure in a uniform magnetic field at right angles to the axis, we may assume in analogy with the result for a sphere, that the induced currents circulate in planes parallel to the axis and the magnetic force, and that the E.M.F. in any circuit is the same as that which would be induced in the circuit supposed insulated and rotating in the magnetic field which exists in the cylinder at rest. The form of the stream lines in any plane section is unknown. It is reasonable to assume that they are approximately rectangular. Different assumptions may be made regarding the law of formation of the rectangular circuits. We shall assume (1) that in any section the currents flow in rectangles similar to the boundary of the section; (2) that the currents flow on the surfaces of cylinders similar to the cylinder; (3) that the current density in any circuit is constant throughout that circuit. And compare the results obtained for the value of the rate of heat production according as one or other of these hypotheses is adopted.



3. Take axes through the centre of the cylinder, O_z the axis of rotation, O_y parallel to the magnetic induction in the cylinder. Let a centimetres be the radius and $2\,m\,a$ centimetres the length of the cylinder, $2\,\pi\,f$ the angular velocity. In a section P N P′ distant x centimetres from the axis, assume that the currents flow in circuits similar to the boundary of the section.

Let N L $= z$ centimetres, then N Q $= z\,\sqrt{\dfrac{(a^2-x^2)}{m\,a}}$ centimetres.

If B is the magnetic induction, and ρ the specific resistance of the material in ohms, the E.M.F. in the circuit Q L Q′

$$= 2\,\pi\,f\,\mathrm{B}\,.\,4\,z\,\frac{\sqrt{(a^2-x^2)}}{m\,a}\,.\,10^{-8}\ \text{volts},$$

and the resistance

$$= 4\,\rho\left(z\,\frac{\sqrt{(a^2-x^2)}}{m\,a} + z\,\frac{m\,a}{\sqrt{(a^2-x^2)}}\right)\Big/\delta x\ \delta z.$$

Hence the rate of dissipation of energy in watts per cubic centimetre

$$= \frac{16\,\pi\,f^2\,\mathrm{B}^2\,10^{-16}}{\rho\,m^2\,a^4}\int_0^a dx \int_0^{m\,a} dz\,\frac{z^3\,(a^2-x^2)^{\frac{3}{2}}}{[(1+m^2)\,a^2-x^2]}.$$

This may be integrated by substituting $a\sin\theta$ for x, and the result is

$$\frac{f^2\,\mathrm{B}^2\,10^{-16}}{\rho}\,\pi\,a^2\,m^2\left[4 - \frac{2\,m^2}{\sqrt{(m^2+1)}}\log\frac{\sqrt{(m^2+1)}+1}{\sqrt{(m^2+1)}-1}\right].$$

When $m = 1$, this is equal to

$$4{\cdot}694\,\frac{f^2\,\mathrm{B}^2\,10^{-16}\,a^2}{\rho}.$$

When m is small, the expression tends to

$$12{\cdot}6\,\frac{f^2\,\mathrm{B}^2\,10^{-16}\,a^2\,m^2}{\rho}.$$

4. When the currents are assumed to flow in cylindrical

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shells similar to the original, let $2z$ centimetres be the length. The radius of the shell $= z/m$ centimetres.

The thickness of the plane end is δ_2, and of the curved surface $\frac{1}{m}\delta_2$.

Denoting by ϕ the angle x O Q (Fig. 1), the E.M.F. round the elementary circuit

$$= 2\pi f \mathrm{B}\, 10^{-8} \cdot 4\frac{1}{m} z^2 \sin\phi.$$

The resistance of the circuit

$$= \left(\frac{4{\cdot}3\, m^2}{3\,\delta\phi\,\delta z} + \frac{4\, m_3 \sin\phi}{m_3\,\delta\phi\,\delta_3 \sin\phi}\right)\rho = \frac{4\,(m^2+1)}{\delta\phi\,\delta_2}\rho.$$

The dissipation of energy in watts per cubic centimetre is

$$\frac{16\,\pi f^2\,\mathrm{B}^2\,10^{-16}}{m^3\,(m^2+1)\,a^3\,\rho}\int_0^{\frac{1}{2}\pi}\sin^2\phi\, d\phi \int_0^{ma} z^4\, dz$$

$$= \frac{4\pi^2}{5\,(m^2+1)}\, m^2\, a^2\, \frac{f^2\,\mathrm{B}^2\,10^{-16}}{\rho}.$$

When $m=1$, this is equal to

$$\frac{2\pi^2}{5}\, a^2\, \frac{f^2\,\mathrm{B}^2\,10^{-16}}{\rho},$$

or,

$$3{\cdot}95\, a^2\, \frac{f^2\,\mathrm{B}^2\,10^{-16}}{\rho}.$$

When m is very small, the value is approximately

$$7{\cdot}9\, m^2\, a^2\, \frac{f^2\,\mathrm{B}^2\,10^{-16}}{\rho}.$$

5. When the current in any section is assumed to be of uniform density throughout, the rectangular circuit must be such that Q L being this circuit Q P = L R (Fig. 2). The area enclosed by the circuit is

$4z\,(\sqrt{(a^2-x^2)} - ma + z)\,(\alpha)$, or $4y\,(ma - \sqrt{(a^2-x^2)} + y)\,(\beta)$, and the length

$4\,(2z + \sqrt{(a^2-x^2)} - ma)\,(\alpha)$, or $4\,(2y + ma - \sqrt{(a^2-x^2)})\,(\beta)$, the form α or β being taken according as ma is less or greater than $\sqrt{(a^2-x^2)}$. Hence the rate of dissipation of energy in watts per cubic centimetre is A + B, where

$$\mathrm{A} = \frac{16\,\pi f^2\,\mathrm{B}^2}{m\,a^3\,\rho\,10^{16}} \int_0^{a\sqrt{(1-m^2)}} dx \int_0^{ma} \frac{(\sqrt{(a^2-x^2)} - ma + z)^2\, z^2}{(\sqrt{(a^2-x^2)} - ma + 2z}\, dz,$$

and

$$\mathrm{B} = \frac{16\,\pi f^2\,\mathrm{B}^2}{m\,a^3\,\rho\,10^{16}} \int_{a\sqrt{(1-m^2)}}^{a} dx \int_0^{\sqrt{(a^2-x^2)}} \frac{(ma - \sqrt{(a^2-x^2)} + y)^2\, y^2}{(ma - \sqrt{(a^2-x^2)} + 2y)}\, dy.$$

When m is greater than unity the integral B alone is taken, the limits of x being 0 and a. To integrate A with respect to z, let

$$\sqrt{(a^2-x^2)} - ma = 2\mathrm{D}, \text{ and } z + d = \xi.$$

Then

$$\int_0^{ma} \frac{(\sqrt{(a^2-x^2)} - ma + z)^2 z^2}{(\sqrt{(a^2-x^2)} - ma + 2z)}\, dz = \int_{\mathrm{D}}^{ma+\mathrm{D}} \frac{(\xi^2 - \mathrm{D}^2)^2\, d\xi}{2\xi}$$

$$= \tfrac{1}{2}\left[\frac{\xi^4}{4} - \xi^2 d^2 + d^4 \log\xi\right]_{\mathrm{D}}^{ma+\mathrm{D}}$$

or, restoring the values of D and ξ,

$$\frac{1}{2^4}\, ma\,(\sqrt{(a^2-x^2)})\,(4\,ma\sqrt{(a^2-x^2)} - m^2a^2 - (a^2-x^2)) \quad \text{(C)}$$

$$+ \frac{1}{2^5}(\sqrt{(a^2-x^2)} - ma)^4 \log\frac{\sqrt{(a^2-x^2)} + ma}{\sqrt{(a^2-x^2)} - ma} \quad \text{(D)}$$

A similar substitution in B yields as the result of integration, with respect to z,

$$\frac{1}{2^4}\, ma\,\sqrt{(a^2-x^2)}\,(4\,ma\,\sqrt{(a^2-x^2)} - m^2a^2 - (a^2-x^2)) \quad \text{(C')}$$

$$+ \frac{1}{2^5}(ma - \sqrt{(a^2-x^2)})^4 \log\left(\frac{ma + \sqrt{(a^2-x^2)}}{ma - \sqrt{(a^2-x^2)}}\right) \quad \text{(D')}$$

Since (C) and (C') are identical in form we can combine them, and integrate with respect to x from $x = 0$ to $x = a$. Let $x = a\sin\theta$, and denoting $\cos\theta$ by c and $\sin\theta$ by s, we obtain

$$\int_0^a (\mathrm{C} + \mathrm{C'})\, dx = \frac{ma^5}{2^4}\int_0^{\pi/2} c^2\,(4mc - c^2 - m^2)\, d\theta$$

$$= \frac{ma^5}{2^4}\left(\frac{8}{3}m - \frac{(3+4m^2)\pi}{16}\right) \quad \text{(E)}$$

By the same substitution D and D' assume the forms

$$\mathrm{D} = \frac{a^5}{2^5}\int_0^{\cos^{-1}m} c\,(c-m)^4 \log\frac{c+m}{c-m}\, d\theta \quad \text{(F)}$$

$$\mathrm{D'} = \frac{a^5}{2^5}\int_{\cos^{-1}m}^{\pi/2} c\,(m-c)^4 \log\frac{m+c}{m-c}\, d\theta \quad \text{(G)}$$

where the limits in D' when $m > 1$ are 0 and $\pi/2$. Taking this case first and integrating by parts,

$$\mathrm{D'} = \frac{a^5}{2^5}\Big[(s\,m^4 - 2\,(cs+\theta)\,m^3 + 2\,(c^2 s + 2s)\,m^2$$

$$- \tfrac{1}{2}\,(2c^3 s + 3cs + 3\theta)\,m$$

$$+ \tfrac{1}{15}\,(3c^4 s + 4c^2 s + 8s))\log\frac{m+c}{m-c}\Big]_0^{\pi/2} \quad \text{(H)}$$

$$+ \frac{m\,a^5}{2^4}\int_0^{\pi/2} \frac{s}{m^2 - c^2}\,[(m^4 + 4m^2 + \tfrac{8}{15})\,s - m\,(2m^2 + \tfrac{3}{2})\,cs$$

$$+ (2m^2 + \tfrac{4}{15})\,c^2 s - m\,c^3 s + \tfrac{1}{5}\,c^4 s$$

$$- m\,(2m^2 + \tfrac{3}{2})\,\theta]\, d\theta \quad \text{(K)}$$

The integrated part vanishes at the limits, and the remainder on integration becomes

$$\frac{m\,a^5}{2^4}\Big[(m^4 + 4m^2 + \tfrac{8}{15})\,\frac{\pi}{2m}\,(m - \sqrt{(m^2-1)})$$

$$- m\,(2m^2 + \tfrac{3}{2})\left(1 - \sqrt{(m^2-1)}\tan^{-1}\frac{1}{\sqrt{(m^2-1)}}\right)$$

$$+ (2m^2 + \tfrac{4}{15})\,\frac{\pi}{4}\,(m - \sqrt{(m^2-1)})^2$$

$$- m\left(-\tfrac{1}{3} + m^2\left(1 - \sqrt{(m^2-1)}\tan^{-1}\frac{1}{\sqrt{(m^2-1)}}\right)\right)$$

$$+ \frac{\pi}{80}\,([m - \sqrt{(m^2-1)}]^4 + 2\,[m - \sqrt{(m^2-1)^2}])$$

$$- 2\,(2m^2 + \tfrac{3}{2})\left(k - \frac{k^3}{3^2} + \frac{k^5}{5^2} - \ldots\right)\Big] \quad \text{(L)}$$

when $k = m - \sqrt{(m^2-1)}$.

In the particular case when $m=1$, the value is

$$\frac{16\,\pi f^2\,\mathrm{B}^2\,10^{-16}\,a^5}{a^3\,\rho\,2^4}\left[\frac{8}{3} - \frac{7}{16}\pi + \frac{83}{30}\pi - \frac{7}{2} + \frac{17}{30}\pi - \frac{2}{3} + \frac{3}{80}\pi\right.$$

$$\left. - 7\left(1 - \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \ldots\right)\right].$$

The value of the series $1 - \frac{1}{3^2} + \frac{1}{5^2} - \frac{1}{7^2} + \ldots$ can be found to be 0·9160. Hence we obtain for the number of watts

$$4{\cdot}095\, \frac{f^2\,\mathrm{B}^2\,a^2\,10^{-16}}{\rho}.$$

The integration of F and G when $m < 1$ is troublesome, but when m is sufficiently small, we may without much error neglect G, and integrate F from 0 to $\pi/2$.

$$\frac{a^5}{2^5}\int_0^{\pi/2} c\,(c-m)^4 \log\frac{c+m}{c-m}\, d\theta$$

$$= \frac{a^5 m}{2^4}\int_0^{\pi/2} c^4\left(1 - 4\frac{m}{c} + \frac{19}{4}\frac{m^2}{c^2} - \frac{16}{3}\frac{m^3}{c^3} + \ldots\right) d\theta$$

$$= \frac{a^5 m}{2^4}\left[\frac{3}{16}\pi - \frac{8}{3}m + \frac{19}{16}m^2\pi - \frac{16}{3}m^3 - \ldots\right] \quad \text{(M)}$$

Adding (E) and (M) we obtain

$$\frac{9}{8}\pi^2\, a^2\, m^2\, \frac{f^2\,\mathrm{B}^2\,10^{-16}}{\rho} = 11{\cdot}1\, a^2\, m^2\, \frac{f^2\,\mathrm{B}^2\,10^{-16}}{\rho}.$$

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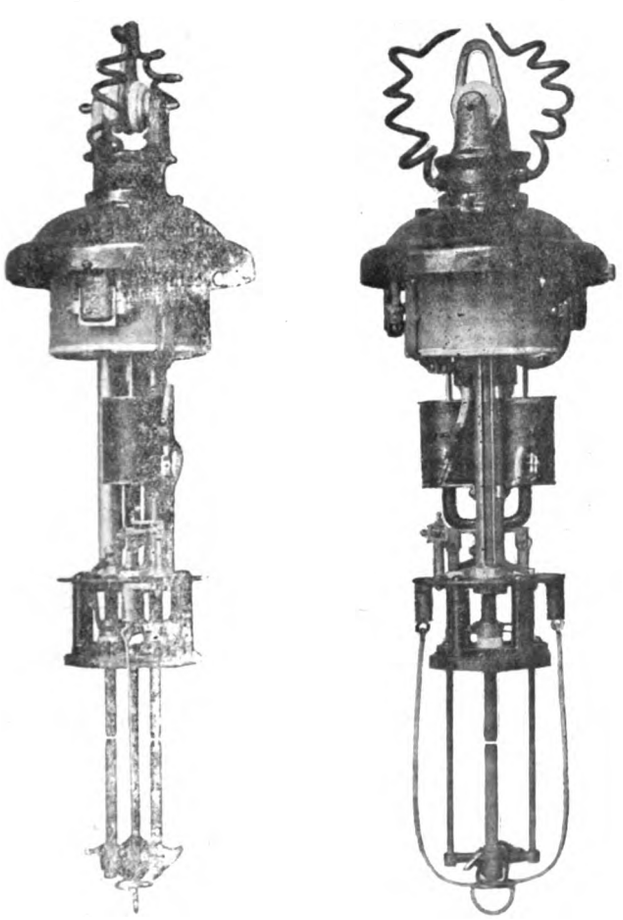
INDUCTANCE COILS FOR TELEPHONE CIRCUITS.

Two patents have been granted to Mr. J. C. Lee in the States relative to inductance coils such as are employed for reducing the distortional and attenuating effect of telephone lines. The specifications state that two main requirements of such coils are that the resistance of the winding shall be low and the inductance high. The latter may be fulfilled by using a core of iron, but when coils containing iron cores are employed in circuits carrying telephone currents the development of eddy currents is thereby facilitated, thus giving rise to adverse effects in telephonic working. The object of the present invention is to provide a practical substitute for iron. This is done by making the core of magnetic oxide or of ferroso-ferric oxide (Fe_3O_4). Thin plates or ribbons or very small wires of iron are assembled, lapped or wound into a loosely-built or partly open-work structure corresponding in form and dimensions to the core desired. This structure is then submitted to the action of heat in an atmosphere capable of yielding oxygen to the iron until the iron is reduced or converted into magnetic oxide. The core thus made is thus composed of artificial magnetic oxide, and while retaining the form in which it was originally built up, has become condensed, continuous, and compact It is stated that such a core possesses in a high degree the desired qualifications of permeability and high specific electrical resistance, and, in consequence of the latter, has no tendency to serve as a circuit for the development of eddy currents.

TRADE NOTICES AND NOVELTIES.

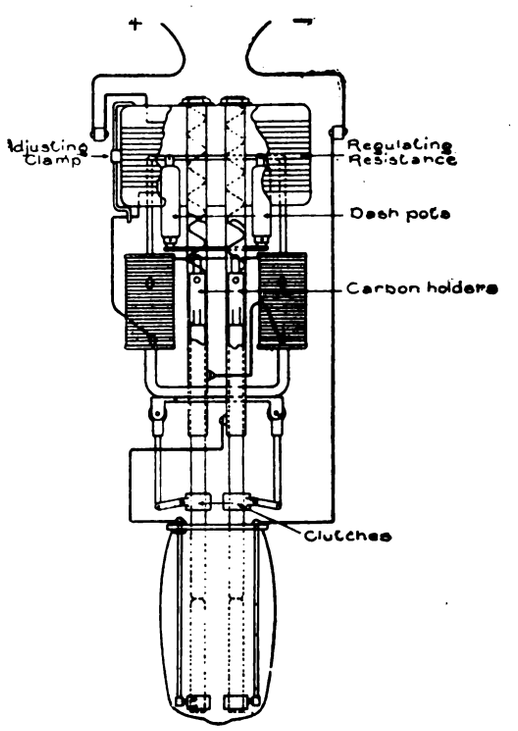
A New Enclosed Arc Lamp.

The present system of operating two direct-current enclosed arc lamps in series on circuits of 200 to 250 volts, although very



Mechanism of B.T.H. "Twin-Carbon" Arc Lamp.

satisfactory, is not an ideal one. For the proper regulation of the arc a differential control requiring two sets of windings is necessary, and if the lamps are to be independent of each other, they must have automatic cut-outs and substitutional resistances—features which make the lamps rather complicated in construction and somewhat difficult to adjust. The wiring for series lamps is apt to be more expensive than for the simple parallel type, and it is often found necessary to operate two lamps when one would give sufficient light. There is undoubtedly a large field for a lamp to operate singly on 200 to 250 volt circuits, giving a quality of light equal to that obtained



Mechanism of B.T.H. "Twin-Carbon" Arc Lamp.

with a series-multiple lamp. A multiple lamp operating singly within these limits of voltage with a small current and an arc of about 150 volts has been used to some extent, and has proved very satisfactory for certain classes of work; but the combination of small current and long arc gives a purple tinge to the light, which is sometimes considered objectionable. The British Thomson-Houston Company, of Rugby, have brought out an enclosed arc lamp for single operation on high-voltage direct-current circuits, which is claimed to be quite as efficient as the long arc multiple lamp, and gives a perfectly white light equal in quality to that from a standard 5-ampere 80-volt arc. To obtain these advantages it is necessary to divide the voltage equally between two arcs, and this is what is done in the British Thomson-Houston "twin carbon" lamp. The standard lamp takes $2\frac{3}{4}$ amperes and the two arcs are in series with 80 volts at each arc. The controlling mechanism is very simple, consisting of a steadying resistance and a pair of magnets connected in series with the two arcs across the 200 to 250 volt line. A single armature operates the clutches of both carbons, so that both feed together, and it is impossible for one arc to rob the other to an appreciable extent. The carbons are placed very close together, so that to the observer the effect is the same as if the light emanated from a single arc; 11mm. carbons are used, and with 12in. upper and 5in. lower the lamp will burn 130 to 150 hours with one trimming. "The twin carbon lamp will be found to offer special advantages in cases where the consumer's supply is being changed from 100 or 200 volts alternating to 200 to 250 volts direct. Alternating lamps operating in multiple can be replaced by twin carbon lamps without changing the wiring or the arrangement of the lamps." An examination of the accompanying illustrations will show that the greatest attention has been paid to the mechanical construction of the twin carbon lamp. It has been designed along the same lines as the other British Thomson-Houston enclosed arc lamps, and is really only a new combination of parts of a standard mechanical design. All lamps are weather-proof, and have solid copper castings. No sliding contacts or springs are used, and all parts of the mechanism are readily accessible for inspection or repair.

Telephone Apparatus.

From Messrs. L. M. Ericsson and Co., Limited, 154-5, Temple-chambers, Temple-avenue, London, E.C., we have received a copy of the 1902 edition of their illustrated catalogue. This catalogue deals with telephone apparatus and testing instruments of Messrs. Ericsson's manufacture, and is the most complete of its kind which we remember having seen. A number of useful diagrams of connections and instructions are included. On referring to the introduction we learn that this new edition of the firm's catalogue is preceding by only a comparatively short period of time the establishment of their

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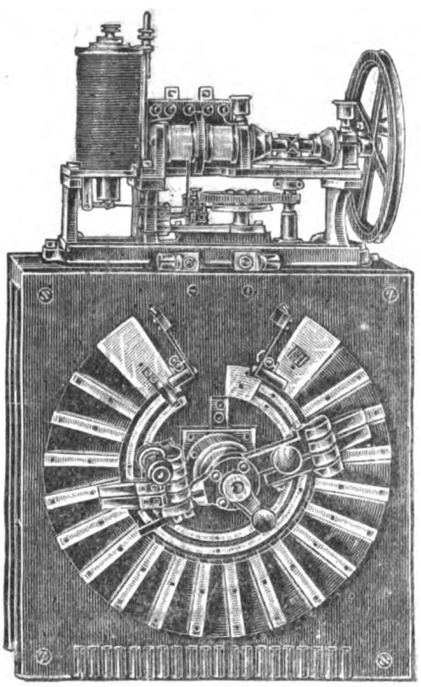
British works. Two acres of freehold building land have been acquired at Broad-lane, Tottenham, and plans for a factory building on the most modern and approved lines are at present in preparation. A special feature of the firm's Tottenham works, we are told, will be the manufacture of their "Municipal" wall and table sets. The particular attention of town corporations intending to manage their own telephones is called to these two instruments in the catalogue under notice.

Automatic Battery Switches.

We illustrate herewith a compact form of automatic combined charge and discharge battery switch, supplied by the



Automatic Battery Switch.

Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C. The mechanism of the switch consists chiefly of a universal cone gear driven mechanically, but controlled electrically by means of electromagnets. The leading spindle carries two friction cones, and is continuously driven in the same direction, either by means of a special motor or from a

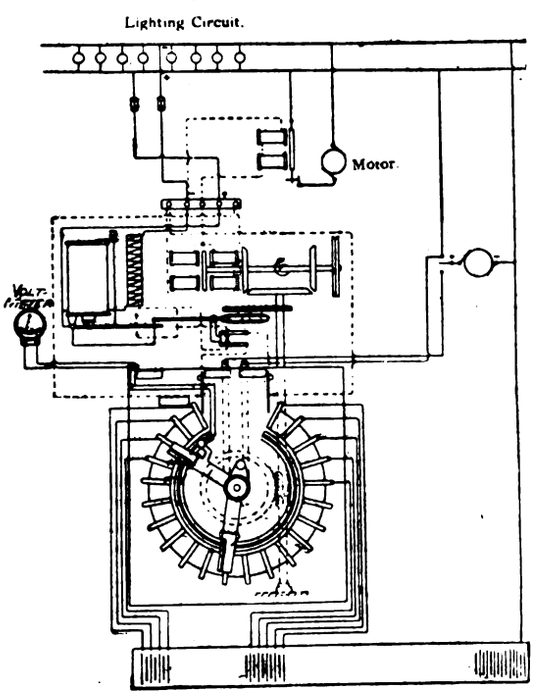


Diagram of Connections for Two-Wire Circuits—Automatic Battery Switch.

suitable transmission shaft. A wrought-iron armature disc is fixed upon the spindle, between two electromagnets acting upon it in such a way that the spindle is moved bodily in either one or the other direction according to which of the two magnets is excited. A third friction cone, situated between the two cones above mentioned, is fixed upon a second shaft at right angles to the leading shaft in such a way that under normal conditions the cones do not touch one another. The moment one of the magnets is excited the armature disc, and with it the leading revolving spindle are moved to one side, thus engaging the centre cone and transmitting the power to the second shaft, the direction of its rotation being dependent upon the lead given by the electromagnet. By means of suitable gearing the motion of the second spindle is transmitted to the switch lever of the battery switch. The controlling or pressure coil consists of a solenoid, whose core carries the contact lever moving between two pillar contacts, thereby controlling the two electromagnets. In this manner the mechanical power imparted to the instrument is practically unlimited, the direction of rotation only being controlled electrically. The apparatus is capable of instant reversal, and the regulation effect is exceedingly accurate. The necessary connections are shown in the accompanying diagram. This particular form of automatic battery switch is made for capacities of from 50 to 200 amperes. A modified form is supplied for capacities from 200 to 1,000 amperes. Additional particulars and illustrations of these switches are given in price list No. 10 recently issued by the Electrical Company, Limited. In the same list will also be found a quantity of information relating to other accumulator apparatus of the firm's standard manufacture, including accumulator charging switches with hand regulation, combined charge and discharge switches with hand regulation, automatic minimum and maximum cut-outs, and various instruments.

"Union V." Motors.

From the Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., we have received a copy of their recently-issued list of standard "Union V." type of direct-current dynamos and motors. This list, we are informed, is one of ten setting out the advantages and varieties of the "Union V." type of machine for various and special purposes. The firm call special attention to their enclosed ventilated type of motor, which is so efficiently ventilated by means of channels through the armature and over the commutator that it is possible to rate it as highly as the open-type motor. Another advantage claimed for this type of machine is the patent adjustable pole-pieces, enabling the brushes to have a fixed position, the adjustment being permanently made in the factory by means of the adjustable laminated pole-shoes. The "Union V." dynamos are usually of the open type, but can be also made enclosed, or enclosed and ventilated, in the same way as the motors. The machines have interchangeable standard parts We notice that the firm in question have standardised a type of dynamo for generating in one armature current for three-wire systems of distribution.

FORTHCOMING EVENTS.

Sanitary Institute.—Sept. 9-13, congress, Manchester. Sept. 27-9, health exhibition.

Waterworks Engineers.—Winter meeting, December, London.

Iron and Steel Institute.—Sept. 2-6, Dusseldorf.

Institution of Civil Engineers.—Birmingham students' visit: Sept. 25, Crewe.

British Association.—Meeting at Belfast commences Sept. 10.

Municipal and County Engineers.—District meetings. Midland: Sept. 27. West Bromwich. Eastern: Oct. 25. King's Lynn.

APPOINTMENTS VACANT.

Resident Electrical Engineer, Hoylake and West Kirby Urban District Council. £250 per annum, Sept. 2.

Draughtsman, experience of high-tension central-station switch-gear, for the estimating department of a firm of electrical engineers. See advertisement.

Works Engineer, to take charge of generating station, running plant, machinery, etc., of large engineering works. See advertisement.

Gentleman to represent in London large electrical engineering company having works situated in the Midlands. See advertisement.

Electrician to work small electric light plant at a country house, 25s. per week and house. See advertisement.

Chief Assistant Engineer, Dewsbury Corporation Electric Light and Power Department. £120 per annum, Sept. 2. See advertisement.

Meter Reader and Battery Room Attendant, Southend, 32s. per week.

Mains Assistant, Southend, 35s. per week.

Assistant Electrical Engineer, Southend, £130 per annum, rising by annual increments of £10 to £200.

Assistant Electrical Engineer, Ilkeston Tramways and Electricity Departments. £110 per annum. Particulars may be obtained from Mr. O. A. Pilcher, engineer and manager, Town Hall, Ilkeston, Aug. 25.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

509. An air-pump driven by an electric motor has to maintain in an air-chamber a pressure of not less than 60lb. nor more than 80lb. per square inch. At present the motor is stopped and started according to the reading of the pressure gauge, which entails frequent attention. Is there any method of automatically controlling the pump?—F. W.

510. Describe the most simple and satisfactory method of testing the efficiency of a lightning conductor.—G.

ANSWERS.

Question No. 503.—Why should it make any difference which way a continuous current should be sent through a "Nernst" lamp filament? The instructions sent out with each lamp by the makers, state they *must* be connected up according to the correct polarity as marked on the terminals.

Best Answer to No. 503 (*awarded* 10*s.*).—A Nernst lamp has a + and – terminal, because during the early tests of the lamp it soon became evident that the passage of a continuous current in one direction had the effect of decomposing the "glower." The exact composition of this "glower" is a trade secret, and, of course, is known only to the manufacturers However, it may be said roughly to consist of porcelain in combination with thorium, yttrium, zirconium, or cerium—probably the first two or three. When a current traverses this "glower" in a wrong direction, its immediate effect is a great liberation of ions at the ends of the rod. This leads to loose connections, also to a decrease in the cross-sectional area. It is curious, however, that the rod's resistance also *decreases*, notwithstanding the decrease in cross-section. It is due to the same reason that a Nernst lamp will not burn satisfactorily in a vacuum, the current by its electrolytic action liberating certain metals which need a supply of oxygen to oxidise them again The Nernst Company have taken the precaution to arrange their plugs of different sizes, so that providing the lamps are wired properly it is impossible to plug them on the wrong poles. The action of an alternating-current Nernst lamp would be an interesting study, but I have never seen such an article, nor am I sure if such is manufactured at all.—J. E. H.

Answer to No. 503 (*awarded* 5*s.*).—The reason why a "Nernst" lamp requires to be connected up according to the polarities marked on the terminals of same by the makers, and why it would not do to connect them in the opposite manner, is entirely owing to the general construction of the lamp. Below, therefore, are details regarding its construction, and diagrammatic sketch of the lamp (Fig. 1), with table of reference. The example taken is a 150-c.p. lamp at 200 volts (and as it might interest your readers), the primary cost of which is £1. The illuminant in question differs from the incandescent in that, after switching on the current, a period of about 40 seconds of time elapses before the lamp is alight. The reason of this will be made clear when reading the following.

Referring to Fig. 1, the current first enters at the + terminal of the lamp and divides itself, part of current going through fine-wire connection to the arm of a magnetic switch, S W, and remainder of current going through the regulating resistance, R. As those who are acquainted with the "Nernst" illuminant well know, the filament proper is composed of some rare earth metals, and a sudden flow of current going through the filament, before it is properly heated, would be both detrimental and undesirable, and in many cases this would permanently destroy it. To prevent this occurring, however, a platinum heater, H, is connected as shown in Fig. 1, and the current passing through arm of magnetic switch, S W, on to platinum heater, H, the heat radiating from the latter, caused through the current passing through it, gradually warms up the filament, F, and so brings about the desired result. By this time the current going through resistance, R, the iron wire, W, has become magnetised, which in turn magnetises the solenoid of switch. The arm of the switch is then attracted to the solenoid, with the result that the current going through this and the platinum heater becomes short-circuited, the whole of the current, therefore now going through the filament, on to the conducting wire, S_1, which also is a support for the filament, and thence to the – terminal of the lamp. The lamp is now alight, and giving out that brilliance which is making the "Nernst" light so formidable a rival to the ordinary incandescent. References: R, regulating resistance; Sw, magnetic switch; H, platinum heater; F, lamp filament; W, iron wire; S_1, support and return circuit.

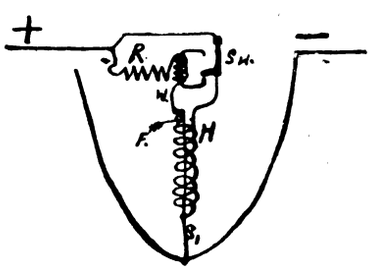

FIG. 1.

The following is a comparison of costs between "incandescent" and "Nernst" lamps, although outside the real question under discussion the writer gives them, as possibly they may excite interest amongst those who are unable to glean much information regarding the latter:

	Incandescent.		Nernst.
Candle-power	16	...	16
Watts per candle-power...	4	...	1·5
Life.....	1,000 hours.	...	1,000 hours.
Kilowatt-hour	64	...	24
Watts	64	...	24
Cost of electricity	32s.	...	12s.

In conclusion, the writer trusts that "O. F. F." now sees the reason and solution of his question.—J. W. M.

Question No. 504.—Is there any satisfactory electrical method of softening hard-steel plates to enable same to be drilled and machined?

Answer to No. 504 (*awarded* 7*s.* 6*d.*).—A method of softening highly tempered steel plates has been in use for 10 or 12 years. It is an application of the well-known Thomson process of electric welding. An alternating current of 2,000 to 6,000 amperes, at a pressure of from four to ten volts, is passed through the two pieces that are required to be welded together, and the joint having the greatest resistance in the circuit is almost immediately brought to welding heat, when the pieces are forced together and thoroughly welded. One of the most ingenious applications of this process is that of locally softening armour plates, and it is largely used for this purpose. An armour plate has its surface made intensely hard, the hardness extending ½in. below the surface, thus rendering it impossible to drill or machine it. This work is, therefore, done before the plate is tempered, but it sometimes happens that a hole has to be drilled or a piece machined off somewhere afterwards, and the makers do not wish to soften the whole plate, but only the exact portion necessary, and are obliged to use electricity for this purpose. The plant necessary to do this by the process mentioned consisted of a 55-h.p. engine driving a 40-kw. alternating dynamo, giving 135 amperes at 300 volts; a small switchboard cables to the spot where the work has to be done; adjustable resistance and a special transformer,

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the secondary winding of which consists of a copper casting, U-shaped, with arrangements for a continuous flow of water through it in order to keep it cool. Suppose a hole 1in. in diameter is required to be drilled in a finished armour plate. The transformer is suspended above the spot, and adjusted so that the two ends of the U-shaped secondary coil are in good contact with the plate on either side of the exact spot. To commence the operation, the resistance in series with the primary coil is so adjusted as to allow about 3,000 amperes at four volts to pass through the secondary circuit. The current is gradually increased up to 6,000 amperes, when the steel becomes visibly red hot, and bulges slightly. This maximum current is left on for two or three minutes, when the current is gradually reduced to minimum again, so that at least 10 or 12 minutes are occupied in reducing the temperature. If the operation is hurried, the mass of cold metal round the heated spot will chill it again, rendering it nearly as hard as before. The annealed spot is elliptical in shape, and measures about 4in. by 2½in. If the plate is heated too quickly the part expands, and cracks appear on the surface. If a part of the plate has to be cut the work is done in the same manner, only in a greater number of operations, according to the length of the piece. There is another electrical process that has recently been invented, which does not need such an expensive plant, but details of this cannot be published at present.—W. A. T.

Answer to No. 504 (*awarded* 7*s.* 6*d.*).—The well-known Thomson process of electric welding has been utilised with considerable success for the purpose mentioned. The electric arc has also been tried, but the difficulty has been in withdrawing the heat sufficiently slowly and preventing the chilling and consequent rehardening of the softened surface. In the Thomson process the annealer proper consists essentially of an alternating-current transformer having a primary coil of many turns excited by a current of about 135 amperes at 300 volts. The secondary consists of a single turn only, and consequently the resulting E.M.F. is very low, being about one or two volts, while the volume of current is correspondingly great. The secondary is U-shaped, and bolted to its ends are copper contact pieces, the design of which depends upon the nature of the work to be done. The current density in these contact pieces at the smallest part is something like 40,000 amperes per square inch cross-section, and in order to prevent the primary coil being damaged by the great heat generated the contacts are hollowed out and cooled by water circulation. The secondary coil consists of a hollow copper casting in two halves, and the primary is completely enclosed within it. The core is of laminated soft iron as usual. The complete transformer is mounted in a yoke suspended by trunnions, to enable it to be swung at any desired angle for convenience in bringing the contact pieces against the required part.

In the operation of annealing, the contact plates are brought up against the surface of the plate on either side of the spot to be annealed. The distance between the contact pieces for a hole ⅞in. diameter is about 1¾in. The primary current is then switched on and gradually increased to its maximum. A bright-red spot then appears under each contact piece. The current is kept on until the plate has become sufficiently heated to char or ignite a stick of wood held against it, and is then gradually decreased until it has again reached the minimum. The first, or heating, period requires about three minutes, during which the secondary current has reached from 3,500 to 6,000 amperes. The second, or cooling, period requires from 10 to 12 minutes in order to prevent the sudden chilling of the spot due to the surrounding mass of metal and to ensure a thorough anneal. The plate, at the spot of annealing, presents a dark-blue colour, oval in shape, and is very readily drilled and tapped At the points where the contact pieces have rested the plate will be scaled and hard, but they can be annealed by shifting the annealer if necessary.—T. F. T.

Answer to No. 504 (*awarded* 5*s.*).—Although the softening may be done by means of electricity, a fire or a blowpipe would be preferable both as regards efficacy and economy. The current required would be very large for the result obtained. The writer had to bore and file square holes in hardened steel strips; the strips were ¼in. in width by $\frac{1}{16}$in. in thickness. The strips were held firmly in grips with a distance between the grips of ½in., and a current passed from grip to grip. A current of 150 amperes made the portion of the strip between the grips red hot; after cooling, holes could be drilled and filed square to suit requirements. This was done more as an experiment than as a practical method. It would have been cheaper to have used the blow-pipe or a pair of red-hot tongs. The sizes of the plates not being mentioned in the question, it is impossible to give a figure for the current that would be required. I think the best way—that is, provided if electricity is to be used—would be to have metal contact pieces on either side of plate where hole is to be drilled, and get the plate hot by means of imperfect contacts. To soften large plates so that the faces could be planed would, I take it, be impracticable, but if the edges only were to be planed the metal contact pieces might be shifted along, and thus softening a little at a time. Whatever method is employed to ensure thorough softening, the heating must be regular and the cooling done very gradually.—M. M.

WORCESTER ELECTRICITY ACCOUNTS.

From the electric lighting accounts of the Corporation for the year ending Dec. 31, 1901, it appears that the total expenditure on capital account at that date amounted to £88,879. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

Dr.	Revenue Account.	£	s.	d.
Coal		2,350	15	7
Oil, waste, and engine-room stores		182	7	7
Wages at generating station		993	18	5
Repairs to buildings, plant, and machinery		445	16	7
Wages of linesmen, fitters, and labourers		16	18	7
Repairs and maintenance and renewal of mains		14	13	1
Repairs and maintenance of transformers, etc.		86	10	8
Attending and maintenance of public lamps		370	0	6
Rents		39	7	0
Rates and taxes		72	6	5
Salaries—engineer's department		504	1	11
Stationery and printing, etc.		69	7	5
General establishment charges		54	12	6
Insurances		49	4	10
Free Wiring Company		56	7	4
Lamps		19	1	2
		5,325	9	7
Balance carried to net revenue account		5,530	14	9
		£10,856	4	4

Cr.	£	s.	d.
Sale of current per meter, less discounts	8,808	12	4
Public lighting	1,583	18	8
Rental of meters and other apparatus	238	14	9
Repairs, carbons, lamps, etc.	13	5	5
Rents—Powick and Tybridge-street	113	0	4
Sale of old copper, iron, casks, etc.	5	17	7
Employés share of premium *re* insurance	2	2	5
Compensation *re* accidents	1	7	6
Damage by self-ignition to field magnets and armature of alternators	77	9	9
Lowering main and altering sub-station	6	13	4
Miscellaneous	5	2	3
	£10,856	4	4

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	74,001	12	6
Sundry creditors	1,566	7	8
Balance at credit of net revenue account	1,479	6	0
Sinking fund account	11,953	0	1
Treasurer	16,083	8	9
	£105,083	15	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	88,879	4	4
Stores on hand	568	4	8
Sundry debtors for current supplied	3,129	18	8
Public lamps	416	1	2
Other debtors	137	6	1
Sinking fund account	11,953	0	1
	£105,083	15	0

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		907,086
Quantity sold { Public lamps	126,878	662,569
Quantity sold { Private consumers by meter	536,691	
Quantity used in works		10,745
Total quantity accounted for		673,314
Quantity not accounted for		233,772
Total maximum supply demanded (kilowatts)		538

Number of public lamps: 57 arc lamps of 600 watts each, 139 incandescent lamps of various candle-power.

LEGAL INTELLIGENCE.

AN INTERRUPTED SUPPLY.

On the 13th inst. Mr. John Troutbeck, high bailiff for Westminster, and a common jury tried the case of the St. James's and Pall Mall Electric Lighting Company, Limited, *v.* His Majesty's Postmaster-General, which was a claim for damages for the flooding of one of the plaintiffs' mains, whereby the supply of electricity was interrupted.

Mr. Llewellyn Davies, for the plaintiffs, stated that in January last the contractors working for the Postmaster-General had opened a trench near the St. James's Theatre for the purpose of laying down telephone wires. The electric lighting company's mains were enclosed in culverts or troughs, which were practically watertight. In the course of the work one of the defendant's workmen struck with his pickaxe a very old 2in. service water-pipe which supplied the Marlborough Club. The result was a heavy rush of water, which quickly filled the trench and got inside the culvert. The water reached boiling point in less than a minute, the consequence being that the supply of electricity was suspended for half an hour throughout the district and for an hour in the locality of the accident. A matinée was in progress at the St. James's Theatre, which, save for a few gas-burners, was in darkness for an hour, and the Trocadero, which was wholly lighted by electricity and had no gas stand-by, was in the same predicament. Under an agreement the company had to pay the Carlton Hotel Company a penalty of £10 for interrupting their supply. The actual loss to the plaintiffs by reason of the accident was £145, but, in addition, he submitted that they were entitled to damages for the injury done to their business.

At the close of the evidence, **Mr. Clavell Slater,** for the defence, contended that inasmuch as the damage was not done by the Postmaster-General "in the exercise of his powers under the Act" the plaintiffs could not recover. The damage to the company's reputation was too remote for consideration.

The jury awarded the plaintiff company £145. 19s. 6d.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Rome.—The Admiralty require tenders for about £4,000 worth of copper in ingots. Tenders by Aug. 30.

Calarasi-Stirbey (Roumania).—The Municipality require tenders for public electric lighting. Tenders by Sept. 3.

Milan.—The Government Tobacco Factory require tenders for 20,506 kilos of lead, estimated at 83,049·30 lire. Tenders by Aug. 30.

Plymouth.—The Corporation invite tenders for overhead line construction, etc., in connection with the tramways. Tenders by Aug. 23. See advertisement.

Madrid.—The Public Works Department require tenders for an electric tramway from Vigo to Bayona. The deposit required is 19,993 pesetas. Tenders by Sept. 29.

Limerick.—The Corporation invite proposals for the wiring of consumers' premises on the "hire-purchase" or any other system. Tenders by Sept. 1. See advertisement.

Maddaloni.—The Municipality invite tenders for the electric lighting of the town for 40 years. Tenders to be addressed to the Syndaco, Maddaloni, Province of Casenta, Italy, by Aug. 26.

Dartford.—The Metropolitan Asylums Board invite tenders for electric fire-alarm installation at the Orchard Small-Pox Hospital, near Dartford. Tenders by Aug. 28. See advertisement.

Edinburgh.—The Corporation invite tenders for cast-iron pillar boxes for street section fuses. Specification, etc., can be obtained from the Resident Engineer, Dewar-place, Edinburgh. Tenders by Aug. 26.

Madrid.—The Post and Telegraph Department, Carretis 10, Madrid, require tenders for 30,000 porcelain insulators. The estimated cost is 8½d. per piece, and the deposit required is 1 per cent. Tenders by Aug. 24.

Poplar.—The Electricity Committee invite tenders for supply of arc lamp carbons. Specification, &c., may be obtained at the offices of the Borough Electrical Engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by 25th inst.

Aberdeen.—The City District Lunacy Board invite tenders for an electric light installation at Kingseat Asylum, Newmachar, Aberdeenshire. Particulars may be obtained from Mr. A. Marshall Mackenzie, 343, Union-street, Aberdeen. Tenders by Aug. 25.

Middlesex.—The County Council will shortly advertise for tenders for the first 16 miles of tramways, which comprise the following three sections: (1) Lordship-lane to Wood Green; (2) Archway-road to Whetstone; and (3) from Archway-road to Edgware.

Bristol.—The Board of Guardians invite tenders for supply of boilers and electric wiring and fittings, etc., for their infirmary proposed to be erected for the accommodation of about 875 sick patients at Stapleton. Tenders by Sept. 10. See advertisement.

Malvern.—The Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work); engines, alternators, exciters, and switchboard; high and low tension concentric cables; and transformers. Tenders by Aug. 23. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1. The Government also propose to lay a cable between Punta-Arenas and Puerto-Montt.

Kirkcaldy.—The Corporation invite tenders for supply and delivery of electricity meters. Specifications may be seen at the office of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, and obtained from Mr. W. L. MacIndoe, town clerk, Town Clerk's Office, Kirkcaldy.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Bexley.—The Electric Lighting and Traction Committee invite tenders for permanent way, bonding, overhead equipment, car bodies, trucks, and electrical equipment. Specification, etc., can be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster. Tenders by Sept. 4.

West Ham.—The Council are inviting tenders for steam, exhaust, feed-water, and drain piping, water softener, steam traps and separators, and circulating and air pumps, discharge piping, water purifier, and vapour pipes for the electricity works. Tenders by Sept. 2. See advertisement.

Manchester.—The Electricity Committee invite tenders for the steelwork in the construction of a high-level railway at their Stuart-street generating station, Bradford, Manchester. Specification, etc., can be obtained on application at the City Surveyor's Office, Town Hall, Manchester. Tenders by Sept. 1.

Bristol.—The Electrical Committee invite tenders for foundations, culverts, subways, etc., at the Avonbank electricity works. Specification, etc., may be seen and obtained at the offices of Mr. H. Faraday Proctor, A.M.I.C.E., M.I.E.E., city electrical engineer, Temple Back, Bristol. Tenders by 12 noon on 28th inst.

Manchester.—The Tramways Committee invite tenders for electrical repairing stores, electrical fitters' tools, oil, and grease. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by 1 p.m. on 30th inst.

Blackpool.—The Electricity and Tramways Committee invite tenders for about 310 yards of 20in. gauge tramway rails and 10 wagons, to be supplied to the electricity works, West Caroline-street. Particulars on application to Mr. Charles Furness, the borough electrical and tramway engineer. Tenders by Aug. 31.

Bury (Lancs.).—The Tramways Committee invite tenders for supply and delivery of rails and fishplates; fishbolts and nuts, tiebars; points and crossings; and sole or anchor plates. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by 28th inst.

Swansea.—The Council invite tenders for the whole or portions of the following: supplying and laying telephone conduits and cables, erecting telephone poles, standards, arms, etc., fixing subscribers' instruments, the supply of creosoted telephone poles, insulators, wooden arms, ironwork, galvanised iron arm bolts, nuts, and washers, wire, batteries, instruments, switchboards, etc. Tenders by Sept. 1. See advertisement.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

Madrid.—The Public Works Department invite tenders for the extension of electric tramways in the east of Madrid, and also for a new line and working of the same for not more than 60 years. A preliminary deposit of 3,368 pesetas and a final deposit of 16,844 pesetas is required, also the repayment of 3,189 pesetas and interest to the Sociedad del Tranvia del Este for preparation of the scheme. Particulars may be obtained from the above. Tenders by Aug. 26.

Lourenco Marques.—Tenders for eight electric hoists of the "Temperley" type are required in connection with the first section of the deep-water pier now in course of construction at that port. The construction of the second section of the pier has not yet been decided upon, but it will eventually require a further 14 electric hoists as above. British firms wishing to supply material should apply for details direct to his Excellency the Governor of the District, Lourenço Marques.

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Doncaster.—The Corporation invite tenders for the supply, delivery, and fixing of an ejector condenser plant, with all necessary pumps, piping, etc., at the Corporation electricity works, Doncaster. Particulars may be obtained from Mr. W. Wyld, borough electrical engineer, Grey Friars-road, Doncaster. Tenders by Aug. 28.

West Ham.—The Corporation invite tenders for the construction of about eight miles of route length of tramways, and the paving of the sides of roads along the entire route, as follows: (Contract No. 1) permanent way and paving, including copper bonding; (1A) paving sides of roads. Specifications, etc., may be obtained for Contract No. 1, at the offices of Mr. J. E. Waller, M.I.C.E., 29, Great George-street, Westminster; for Contract No. 1A, at the office of the borough engineer, Mr. John G. Morley, Town Hall, West Ham. Tenders by Sept. 4.

Amsterdam.—The Board of Trade have received through the Foreign Office copy of a dispatch from H.M. Consul at Amsterdam reporting that on Sept. 8, at 12 noon, the Municipal Council of Amsterdam will receive tenders for the delivery and laying of the entire network of cables for the municipal electric works, consisting of about 150 km. high-tension, 70 km. low-tension, and 25 km. telegraph and telephone cable, with the necessary accessories. Particulars may be obtained from the Municipal Printing Office at a cost of 2·50fr. (4s. 2d). Information will be supplied at the office of the Director of Electrical Works, O. Z. Achterburgwal 213, Amsterdam.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of land-owners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

King's Norton, Birmingham.—The Urban District Council are prepared to lease their powers obtained under their electric lighting order in 1898. The area of supply comprises the whole of the civil parishes of King's Norton and Northfield, in the county of Worcester. The streets scheduled for supply within period limited by the order are all within the wards of Moseley and King's Heath, which together contain a population of 20,400. Prints of the order may be obtained from the Government printers, Messrs. Eyre and Spottiswoode. The engineer is Mr. A. W. Cross, A.M.I.C.E., 23, Valentine-road, King's Heath, Birmingham, to whom enquiries for further particulars should be addressed. Preliminary offers must be addressed to Mr. Edwin Docker, clerk to the Council, 10, Newhall-street, Birmingham, and reach his office by Sept. 18.

Leicester.—The Tramways Committee invite tenders for electric tramway works and materials, under the following sections, each comprising a separate contract. For supply and delivery of steel girder tramway rails and fishplates; supply and delivery of bolts, nuts, and tiebars; supply and delivery of points, crossings, and special track work; supply and delivery of stoneware pipes and conduits; supply and laying of feeder cables, telephone and test wires, and supply and delivery of roadway frames and covers; supply and erection of overhead electrical equipment, and the supply of copper bonds; supply and erection at the power station of steam-raising plant; supply and erection at the power station of engines, generators, battery, boosters, switchboard, overhead travelling crane, etc.; supply and delivery of electric tramcars. Specification, etc., may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., engineer, Town Hall, Leicester. Tenders by Sept. 3.

RESULTS OF TENDERS.

Bahia (South America).—An order has been received by Willans and Robinson, Limited, for one of their 360-i.h.p. compound engines for driving spinning machinery by a rope drive.

Walsall.—The Town Council have accepted the tender of the Walsall Electrical Company, Limited, for wiring the new engine-room and store-room at Wolverhampton-street generating station, at £43. 9d. 9d.

Wrexham.—Willans and Robinson, Limited, have received an order through the Lancashire Dynamo and Motor Company for one of their 575-i.h.p. engines, for direct coupling to a dynamo of the latter company's make, for traction purposes; the engine is a compound.

Sydney.—The City Council have accepted the tender of Dick, Kerr, and Co. for the supply of the generating plant for lighting Sydney by electricity. With plant entirely satisfactory, the respective prices were: Dick, Kerr, and Co., Limited, £49,072; Mather and Platt, Limited, £50,528; British Thomson-Houston Company, £51,588; and J. G. White and Co., £52,444.

Lowestoft.—The Corporation have received the following tenders for the construction of tramway rails, fishplates, and bolts:

Rails, fishplates, and bolts.

English rails.

P. and W. Maclellan, 129, Trongate, Glasgow	£7,431	10	0
W. Scott and Co., 71, Finsbury-pavement, E.C.	7,454	15	0
A. Faulks, Sparrow-hill, Loughborough	7,466	12	6
Mccartney, McElroy, and Co., 53, Victoria-street, Westminster	7,882	5	6
W. Griffiths and Co., 35 to 39, Hamilton House, Bishopsgate-street Without, E.C.	8,091	5	0
E. Nuttall and Co., Trafford Park, Manchester	8,115	5	0
Macleod and Co., 57, Tower-buildings, Liverpool	8,365	7	3
Barrow Hematite Steel Company, Barrow-in-Furness (tender incomplete)	7,509	0	0

Foreign rails.

A. Penney and Co., 107, Fenchurch-street, E.C. (accepted)	6,053	0	0
J. G. White and Co., 22A, College-hill, Cannon-street, E.C.	6,467	7	0
P. and W. Maclellan. 129, Trongate, Glasgow	6,743	10	0
A. Faulks, Sparrow-hill, Loughborough	7,029	0	0
E. Nuttall and Co., Trafford Park, Manchester	6,474	0	0
Dick, Kerr, and Co., 110, Cannon-street (not to specification)	6,164	9	9
E. Le Bas and Co., 18, Billiter-street, E.C. (not to specification)	—		
Ibbotson Bros., Globe Steelworks, Sheffield (tender incomplete)	—		

Permanent-way construction.

G. Wimpey and Co., The Grove, Hammersmith (accepted)	33,136	3	4
A. Faulks, Sparrow-hill, Loughborough	33,541	17	4
Dick, Kerr, and Co., 110, Cannon-street, E.C.	34,118	5	6
W. Griffiths and Co., 35 to 39, Hamilton House, Bishopsgate-street Without, E.C.	34,366	18	9
J. Brunton, Dock Office-chambers, New Cross-street, Hull	35,169	5	10
J. G. White and Co., 22A, College-hill, Cannon-street, E.C.	35,599	13	0
E. Nuttall and Co., Trafford Park, Manchester	36,827	13	0
Macartney, McElroy, and Co., 53, Victoria-street, Westminster	40,063	5	2
J. J. Robson, Sheffield-lane, Newcastle-on-Tyne	40,084	0	10
R. C. Brebner and Co., 4A, St. Andrew-square, Edinburgh	51,804	10	5

Warrington.—The Board of Guardians have accepted the tender of Morton and Sampson for the extension of the electric light in the workhouse, at £59. 10s.

BUSINESS NOTES.

TRACTION.

Caerleon.—It is proposed to establish a service of motors and electric cars between Newport and Caerleon.

Greasborough.—Plans are being prepared for the laying down of a system of electric tramways in the district.

Sheffield.—A prize of £5 is offered by the Sheffield Tramways Committee for the best destination indicator.

Worsborough.—The Board of Trade have extended the time for completion of the tramways for three months.

Glasgow.—Colonel Yorke visited Glasgow yesterday, and inspected further extensions of the electric tramway system.

Deal.—The Town Council have been informed that the Kent Electric Power Company are preparing a tramway scheme for this place.

Cheadle.—Negotiations are proceeding with landowners with respect to widening the roads for the tramways as required by the provisional order.

Farsley.—At a meeting of the Urban District Council on Monday the members were strongly in favour of the Bradford electric tramcars being run to Farsley.

Sandwich.—The Kent Electric Power Company's Tramways Bill has now received the Royal assent, and active steps are being taken to carry out the scheme.

Dundee.—The estimates for the current year of the Dundee tramways provide for an income of £41,800, compared with an actual income last year of £37,874.

Torquay.—The tramway scheme here is now beginning to take shape. In order to keep out private companies the Corporation are themselves applying for powers.

Burton.—The Town Council have decided to send experts to Wolverhampton to examine the system of surface-contact tramways in operation there and to report.

Brierley Hill.—The District Council have passed a resolution in favour of a joint scheme for the promotion of a light railway through Quarry Bank from Brierley Hill to Cradley Heath.

Plymouth.—The electrical engineer has been authorised to invite tenders for the necessary overhead electrical equipment of the tramways in course of construction through the Pounds Estate.

Northampton.—The Town Council have agreed upon a site for tram-sheds, workshops, and, if necessary, a generating station, etc., in connection with the proposed new electric system of tramways.

Doncaster.—In consequence of the overhead trolley system having been adopted at this place, the Post Office have been compelled to place some of the telegraph wires on the line of route underground.

Rochester.—The City Council have agreed to promote a Bill in Parliament for a series of public improvements, which will include a scheme of municipal electric tramways for the city and its suburbs.

Llanelly.—At the last meeting of the Borough Council the scheme for electric light and traction again came up. The Estate Committee recommended that certain steps be taken in the negotiations with the Insulated Wire Company, and the Council unanimously decided to do this.

Lowestoft.—The Board of Trade have sanctioned the detail alterations in the tramway route, the construction of Tramway No. 9, and the borrowing by the Corporation of £6,000 for carrying out the work.

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Gateshead.—An electric car was proceeding down High-street on Wednesday when it left the rails and dashed into the walls of an hotel. No passengers were aboard, and not much damage was done to the car.

Dewsbury.—The work of laying the electric tramway in Dewsbury is rapidly nearing completion. Before the lines can be opened, however, several of the National Telephone Company's posts and wires will have to be removed.

Rotherham.—Good progress is being made with the construction of the electric tramways. All the contracts have now been let. The whole of the work will proceed almost simultaneously, and is to be completed within 12 months.

Dover.—The Light Railway Commissioners have intimated to the Corporation that they will be given powers to purchase any portion within the borough of the new electric cliff railway which is to connect Dover with St. Margaret's Bay.

Hindley.—After considering the question of purchasing the tramways in Ince and Hindley, the Tramways Committee have agreed that the first question to be settled is the purchase price. Negotiations with the company are proceeding.

Korea.—The electric tramway at Seoul, the capital of far-away Korea, embraces a large portion of the city and suburbs. The principal thoroughfares are now lit with electric light, which is installed also in the palace and many private houses.

Loughborough.—The time limit in respect to the electric light railway powers of the Corporation has been extended. The Corporation are now in negotiation with the Brush Company as to their undertaking the construction of the lines.

Swadlincote.—The light railway scheme promoted by the Midland Railway Company has been considered by the Urban District Council, but with regard to the draft order the Council are advised to urge the promoters to make numerous amendments.

London United Tramways (1901).—The directors have declared an interim dividend on the £10 ordinary shares of this Company for the half-year to June 30 last at the rate of 8 per cent. per annum. The dividend warrants will be payable on the 23rd inst.

Imperial Tramways Co.—The directors have declared an interim dividend on the £10 ordinary shares of this Company for the half-year to June 30 last at the rate of 10 per cent. per annum. The warrants will be payable on and after the 23rd inst.

Bradford.—A deputation has waited upon the Tramways Committee from Greengates urging the extension of the city tramways to that district. The committee have resolved that the work of laying the line should be begun early in the ensuing spring.

Newcastle.—New car-sheds are to be erected on land in the west end of the town. The committee are recommending the Council to proceed with the extension of the tramways to Walker at once. The Spital Tongues section will probably be opened for traffic in a day or two.

Prestwich.—The agreement with the Salford Corporation for the working of electric tramways in the Prestwich district has been unanimously approved by the District Council, and application will be made for a loan of £21,000 for the construction of tramways in Bury New-road.

Belfast.—At the half-yearly meeting of the shareholders in the Belfast Street Tramways Company, on Friday, it was decided to reject the offer of the Corporation to purchase their system for a sum of £380,000, the company to retain the amount of their invested sinking fund, £28,600.

Drighlington.—In reply to the representations made by the District Council that the Bradford tramway system should be extended to this place, the Tramways Committee of the Corporation have agreed to recommend the Council to proceed with the construction of the line early next year.

Liverpool.—A deputation consisting of the general manager of the tramways, the city engineer, the electrical engineer, and two members of the Tramways Committee, will shortly proceed to the United States and Canada for the purpose of inspecting the various tramway systems in operation there.

Ashton-under-Lyne.—We are informed that the Board of Trade officials made an inspection of the electric tramway system at this place on Friday and Saturday last, and expressed themselves satisfied with the equipment. Mr. A. Coveney has been formally appointed manager of the undertaking.

Stroud. The light railway scheme for this district was rejected by the Light Railway Commissioners at the enquiry held by them recently, on the ground that the proposed lines would compete with the existing railways. The merits of the scheme were therefore not gone into or considered by the Commissioners.

Llandudno.—The Board of Trade certificate for the Great Orme tramway has been received, and the engineers hope to complete the second stage of the line by next week, when it will be opened to the summit. At present passengers are conveyed to the plateau, whence it is an easy walk to the highest point.

Surrey Electric Railway.—At a recent meeting of the shareholders of the City and Surrey Electric Railway it was unanimously resolved to amalgamate with the National Electric Traction Company. The National Electric Traction Company were the guarantors of an issue which recently appeared of City and Surrey shares.

Shipley.—The Shipley Tradesmen's Association is urging the District Council to carry out an extension of their electric tramways with a view to securing a service of cars through the centre of the town. A deputation who waited upon the Electricity Committee were informed that it was intended to carry out the extension referred to in the near future.

Motor Buses.—At the meeting of the London General Omnibus Company on Wednesday the Chairman stated that motor vehicles are being built for the company by several makers, and that one is to be delivered within the next few weeks. He, however, added that the directors had seen none which fully answered their requirements.

Poole.—A Branksome dealer has been awarded £40 damages against the Poole and District Tramcar Company for a dislocated shoulder. The rope used to place the trolley to the wire was hanging loosely by the side of an electric tramcar and caught the trap in which the plaintiff was riding, overturning it, and throwing him out on the road.

Twickenham.—The London United Tramways Company are now proceeding with the reconstruction work and the laying down of the electric tramrails on the Twickenham section of their system. By working continuously day and night it is expected that the line to Teddington and Richmond will be opened for traffic by the end of the current month.

Middlesex.—Altogether the County Council have under consideration the construction of nearly 50 miles of light railways in Middlesex, involving a probable outlay of some £2,000,000. The first 16 miles comprise the following three sections: first, Lordship-lane to Wood Green; second, Archway-road to Whetstone; and third, from Archway-road to Edgware.

Withington.—An order from the Board of Trade has been received by the District Council prolonging for 12 months the period limited for the completion and opening for public traffic of the tramways in the Withington district. The Board of Trade have also given their consent to the handing over of the Council's electric lighting order to the Manchester Corporation.

Directory.—We have received a copy of the "Universal Directory of Railway Officials for 1902," which is issued from 3, Ludgate-circus-buildings, E.C. Information appertaining to railway officials is given from all parts of the globe, and we notice that in the first pages of the volume an alphabetical list of the various tramway and light railways in the United Kingdom is presented.

Cardiff.—A meeting of the local Property Owners' and Ratepayers Association has passed a resolution recording its most emphatic protest against the extravagant methods adopted by the Corporation in working the tramways at Cardiff. As a result of negotiations, the Town Council have decided to offer the Cardiff District and Penarth Harbour Company £10,000 for their lines.

Sunderland.—The tramway men, says a local paper, are determined to carry out their intention of refusing to go on duty on Sunday should the Corporation, through their manager (Mr. England), insist upon one of the men paying for damages sustained by the car he was driving, and in the event of his not doing so, dismissing him. The first instalment towards the damage is due on Saturday.

Southend.—A communication has been received by the Shoeburyness District Council from the Light Railways Commission, stating that the application of the Southend Corporation to construct a tramway along the cliffs to the Cambridge Estate would be approved by that body subject to the quashing by the Board of Trade of the London, Tilbury, and Southend Railway Company's objection.

North Shields.—The threatened strike of tramway men at North Shields has been averted, the directors of the company having consented to advance the wages of the conductors ½d. per hour and motormen ¼d. per hour, which is equivalent to an increase of about 2s. 6d. and 1s. 3d. per week respectively. The men have agreed to accept the company's offer. They asked for 1d. an hour increase all round.

Yarmouth.—A report just issued shows that the total receipts from the tramways from June 19 to Aug. 7 were £2,042. 15s. 11d.; total receipts per car mile, 14·24d.; total passengers carried, 395,992; passengers carried per car mile, 11·5; average fare per passenger, 1·23d. The receipts on Bank Holiday realised £118. 0s. 2d., being 2s. 5¼d. per car mile, and the number of passengers carried was 21,417

Johannesburg.—On July 16 the Town Council passed the following resolution: "That a special committee be now appointed for the purpose of considering the establishment of municipal tramways. That it shall be an instruction to such committee to bring up a full report at an early date with the view of providing for the establishment and working of municipal electric tramways in Johannesburg." A committee was accordingly appointed.

Keighley.—The Town Council met again on the 14th inst. to consider the question of adopting electric traction on the local tramways, and whether application should be made for an order to extend within the next few years as far as Stockbridge. In view of Keighley's high rates, it was agreed that the matter should stand over for a year, unless the November elections show a decided feeling in favour of an earlier dealing with the matter.

London County Council Tramways.—The conversion of the London County Council tramway between Tooting and Clapham for electric traction has been completed, and a commencement has been made with the conversion of the track between Clapham Common and Kennington Gate; and the hope is that the new system may be got to work soon after the turn of the year, though there does not at present seem much prospect of this hope being realised.

Isle of Man Tramways.—The sale of the electric line running from Douglas to Ramsey for £252,000 to Mr. Ernest Schenk has received the official sanction. A forfeitable deposit of £50 200 has already been paid, and completion of the purchase has to be made on or before Nov. 14. The lines have a total length of 22½ miles of double track, the permanent way being freehold. It is understood that the property has been taken over by a syndicate formed by Mr. Schenk, chairman of the Crystal Palace Company.

Great Northern and Strand Railway.—An application for a certificate under the Lands Clauses Consolidation Act was on Tuesday made by Mr. Barker, on behalf of the Great Northern and Strand

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Railway Company, before Mr. Alderman Truscott, at the Mansion House. This certificate is to enable the railway to purchase sites for their stations. It was stated that the Underground Electric Railways Company is to construct the "tube" in consideration of the unallotted shares being made over to them. The alderman granted the certificate.

Airdrie.—Both the Airdrie and the Coatbridge Town Councils have decided to oppose the application of the Airdrie and Coatbridge Tramways Company for an extension of the time allowed for laying and completing the tramways in Coatbridge. The company have allowed two years to pass in the case of the Airdrie lines and one year in the case of the Coatbridge lines without having made any sign of beginning to lay down the tramways. The period for laying both tramways expires in July of next year; hence the application for an extension of time.

Parkstone.—With reference to the application recently made by the Poole and District Electric Traction Company for an order giving them power to construct a line through Parkstone, the town clerk of Poole has received an intimation from the Light Railway Commissioners that they propose to accede to the application upon terms which are subject to alteration by them upon further consideration. By the granting of this order the company will have powers to extend their tramlines from Park Gates East right through the village of Parkstone to Bourne Valley Pottery.

Aberdeen.—The Town Council Tramways Committee have had under consideration various proposals for the readjustment of fares. Among these are the suggestions that ½d. fares should be introduced into Union-street, that a uniform rate of 1d. should be charged, and that ½d. fares should be provided all over the system. It was ultimately agreed at their last meeting, however, to recommend that no change be made on the fares until they had a full year's working of the electric system. At present ½d. fares only exist on the Woodside route. The Royal assent has been given to the Aberdeen Suburban Tramways Bill.

Wakefield.—A parliamentary paper has been issued giving the particulars of the order approved by the Board of Trade for the construction of light railways in the city of Wakefield and the townships of Horbury, Alverthorpe, Sandal Magna, and Outwood, in the West Riding of the county of York. The authorised capital is fixed at £120,000, of which £40,000 may be issued as preference capital. A similar order has been issued for the construction of a light railway from Bury St. Edmunds to Stanton, Walsham Le Willows, and Diss, with an authorised capital of £170,000, and allowing £85,000 to be classed as preference capital.

Dundee.—The tramway accounts show that the tramway receipts for the year ending May 15 were £35,874. 0s. 9d. and the working expenses £24,042. 7s. 6d., leaving £11,831. 13s. 3d. This sum has been disposed of thus: interest on capital, £5,076. 7s. 4d.; sinking fund, £3,415; annual payment to the tramway company, £2,100; depreciation on plant, £903. 13s. 3d.; fund for renewal of rails, £300—leaving a net surplus of £36. 12s. 8d., which is carried to the credit of the suspense account. The capital has been added to during the year to the extent of £66,187. 16s. 10d., and thus increases the capital account to £232,313. 0s. 11d.

Electricity Supersedes the Horse.—A curious and interesting fact, illustrating the remarkable change which is coming over transit in London, is given by a *Daily Telegraph* correspondent, who was a passenger on Wednesday afternoon on one of the electric cars running from Kew to Chiswick. At one part of the journey, where a good stretch of road was in view, not a single horse could be seen, but there were two or three electrically-propelled tramcars, several motors, and a number of cyclists. A year or two ago horses and horse-drawn carriages were there in plenty; now they are supplanted by electricity, petroleum, and the pedal—much to the convenience, pleasure, and speed of the public.

Cheshire Railways.—The suggestion was thrown out by Sir Ernest Paget at the half-yearly meeting of the Midland Railway Company that the three railway companies owning the Cheshire Lines should arrange to electrify the portion of their joint railways which forms the popular express route between Liverpool and Manchester. It is, however, stated by Mr. Oliver Bury, the general manager of the Great Northern, that the question of electrification in the form suggested by Sir E. Paget could not be said to be officially under the consideration of the Cheshire Lines Committee, but that the possibilities of electric traction were at the present time in the minds of all railway directors and managers.

Leeds.—The City Council are proposing an extension of the tramways from Park-lane to Hyde Park Corner, *viâ* Belle Vue-road and Moorland-road. The chairman and members of the Tramways Committee have gone over the proposed route, and although no resolution has been passed, the general opinion is that the project should be carried out. Extensions in East and West Leeds are also contemplated. A proportion of the Bramley residents are not directly served by the existing Bramley and Stanningley tramways. To cover this deficiency, it is proposed to construct a branch through Town-street and onwards in the direction of Rodley. The other suggestion is to extend the Beckett-street lines in the direction of Ashley-road.

Furness.—At the half-yearly meeting of the shareholders of the Furness Railway Company a shareholder called attention to the use of electricity, which he looked upon as the motive power of the future. Of course, the cost would be great, but it might be tried on, say, the Lake Side branch, the power for which could be obtained from the fall of water at Newby Bridge from Windermere. The Chairman said the question of electricity would have the attention of the directors. They could not expect the Furness Railway Company to lead the way, but they would not be behindhand, and, indeed, at the present time they were experimenting with oil as fuel for locomotives, and if it led to good results, they would not be behind in making use of it.

North-Eastern Railway.—Sir Joseph Pease at the half-yearly meeting of the shareholders of the company referred to the fact that in consequence of the increasing competition of electric tramways the Board had decided, as an experiment, to equip 37 miles of their line in the neighbourhood of Newcastle for electric traction. In addition to this enterprise, it is stated that the North-Eastern Company are completing arrangements for the early installation on their main line near York of the "Hall" electro-automatic track signals. The sanction of the Board of Trade will shortly be asked for the adoption of this system. Mr. Philip Burtt, chief traffic manager, and other officials of the company are about to visit America to inspect the latest railway improvements and methods of transit.

Rowley.—At a meeting of the Rural District Council on Monday the General Purposes Committee reported that a further conference had taken place with reference to the proposed new light railway from Brierley Hill, Quarry Bank, and Cradley Heath, and a loop line to Rowley. It was agreed to construct the light railway on the basis that the cost of application, construction, and maintenance, also the matter of representation, profits, losses, and proceeds of sale, be apportioned in accordance with the mileage of the railway within the respective areas of the authorities. The Council adopted a recommendation appointing representatives on the joint committee for procuring the provisional order, and making provision for a branch line from Blackheath to the Knowle, Rowley, to be included in the order.

Rail Scraper.—A tramway rail scraper has just been patented by Messrs. R. B. Smith and J. M. Hamilton, both of Dundee. The device consists of an iron bar fixed to the weather-board of the car in front of the wheels. To the bar are attached scoops or scrapers proper, which when in operation fit into the grooves and clean them out as the car makes its ordinary journey. By the movement of a handle on the car platform the conductor can put the mechanism out of gear by raising the scoops from the grooves. Each scoop is held in position by means of a volute spring, which is strong enough to resist all loose obstructions in the grooves. Should a fixed obstruction be met, however, which the metal is not able to remove, the spring yields after a certain resistance is reached, and the scoop rises, passes over the obstruction, and then falls into its original position.

King's Norton.—A year ago the District Council obtained parliamentary powers for the municipalisation of tramways for the district and the installation of the electric light, but so far nothing definite has been accomplished. Now, however, there seems a probability that King's Norton, which has long desired better means of communication with Birmingham, will be brought into closer touch with the city It is reported that the City Tramways Company have made an important offer to the District Council, and negotiations on the subject are proceeding between the two bodies. The proposal is to run a branch line from the Bristol-road route at Pebble Mill-road to the Cotteridge, and the tramway in length would extend a little over three miles. The District Council would bear the cost of equipment and laying, and the company would provide the cars. At the expiration of the existing Bristol-road lease in 1911 the District Council would be required to buy the cars. The electric power for working the trams would be obtained from the company's generating station at Bournbrook.

Huddersfield.—Mr. K. F. Campbell, the borough engineer, has issued a report on the electric tramcars. Some misapprehension is stated to have prevailed as to the suitability of the four-wheeled cars, and people have shown their preference for the eight-wheeled or bogie cars. The evidence collected from Bradford, Halifax, Glasgow, and other towns and cities, and the opinions of experts, appears to be in favour of the four-wheelers, and Mr. Campbell reassures the public on the score of their safety. At the meeting of the Town Council on Wednesday it was decided to inform the Brighouse Corporation that the Council could not see their way at present to extend the local tramway system to Brighouse. Another resolution was adopted in favour of meeting the British Electric Traction Company and the Mirfield District Council, to consider the suggestion by the latter authority as to the construction of a tramway from the terminus on the Corporation system at Bradley to Mirfield. Subject to the Newsome District Committee of the Town Council improving the gradients, it was agreed to make application to the Board of Trade for power to construct a line of tramway to Newsome.

Mitcham.—The Board of Trade have confirmed an order authorising the construction of light railways in the parish of Mitcham, in Surrey. It empowers the Rural District Council of Croydon to construct and maintain three lines. The first, a mile in length, runs along the London-road from the boundary of Tooting Graveney to Upper Green at Upper Mitcham, near the Jubilee clock; the second, of half a mile, runs from here in a southerly direction along London-road to a little south of the junction with the Causeway; and the third, of 1¾ miles, extends from Upper Green along Commonside West over Blue Houses railway bridge and through the Croydon and Mitcham road to the Croydon borough boundary near the Jolly Gardeners' public-house. Before the lines are built the Council has to widen parts of the route, the widenings being dedicated to the public as a highway. The order also gives power to the Council to construct a generating station to supply electrical energy for the line. The whole of the lines must be completed within three years. The system may be used for carrying goods, minerals, and animals as well as passengers, and special provision is made for workmen's trains at cheap fares.

New Issue.—The Tynemouth and District Electric Traction Company, Limited, are making an issue of £20,000 4 per cent. debenture stock at par. This company, which was formed in January, 1890, with a capital of £80,000, as the North Shields and Tynemouth District Tramways Company, Limited, owns the tramways and light railways from New Quay, North Shields, to Whitley Bay, of an approximate route length of four miles, these lines, as constructed and equipped for electric traction, being opened for traffic on March 18,

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1901. The company recently applied for a light railway order to construct a light railway extension from the present terminus at Whitley to Whitley Sands, a distance of about half a mile, and the order, which was unopposed, has been passed by the Light Railway Commissioners, subject to confirmation by the Board of Trade. The districts served by the company's lines have a rapidly increasing residential population, estimated at 70,000, and include the borough of Tynemouth and the urban districts of Whitley and Monkseaton. The present issue is made in order to provide for increased services, the doubling of the track along the Grand-parade, Tynemouth, for the light railway extension to Whitley Bay, and to pay off the liabilities of the company.

Rothesay.—The new electric car system between Rothesay and Port-Bannatyne was formally inaugurated on the 13th inst. The contractors for the laying of the line and overhead traction were Messrs. Dick, Kerr, and Co., London. The power station is at Point-house, Ardbeg, the site of the tramway stables, and so far as completed there is one engine, made by M'Intosh and Seymour, of New York, coupled direct to a Westinghouse generator, made at Pittsburg, Philadelphia. There are two boilers by Babcock and Wilcox, each of 250 n.h.p., and the engine is capable of dealing with a load of 400 n.h.p. When the station is completely finished there will be two more engines of 250 h.p. each, and there will also be a battery, not yet quite finished, which will be capable of running the cars for a considerable time. The car-shed is very spacious, high-roofed, brick building next the roadway, and is capable of storing 15 cars, and there is a further space reserved for the erection of a second car-shed to accommodate other 12 cars. The engines and boilers are in a corrugated iron building, while the storage batteries are in a large brick building. Messrs. Alex. Whitelaw and Co., Greenock, are the contractors for all the buildings within the power station. The blasting and excavation required on the site have been very considerable, and the delay in getting the work forward in time for the early part of the season is attributed to this, as so much of it had not been anticipated.

Leighton.—The Highways Committee of the Herts County Council report, with regard to the construction of the Leighton Buzzard and Hitchin light railway, that the proposal appears to be for a light railway running not along the roads, but in all cases across private lands. The railway starts by a junction with the London and North-Western Railway at Leighton Buzzard, and passes through Hockliffe, Harlington, Barton-in-the-Clay, and near Shillington, all in Bedfordshire; it then enters Hertfordshire near Aspley End, Shillington, and passes through the parishes of Pirton and Ickleford, joining the Hitchin and Bedford branch of the Midland Railway, just north of Ickleford village. The total length of the railway is little over 19 miles, of which about 3½ miles are in Hertfordshire. The railway will cross two main roads, one of first-class importance. The first is the road between Pirton and Holwell, which is crossed near Pirton, and the second the road from Hitchin to Bedford. The gauge of the railway is the ordinary standard gauge of 48½in., and it may be assumed that the railway is intended to be a connecting link between the London and North-Western Railway at Leighton Buzzard and the Great Northern Railway at Hitchin. The committee see no serious objection to the proposal, and they recommend that the county solicitor be instructed to take steps to obtain the insertion of the necessary clauses in the order for the protection of main roads and bridges within the county of Hertford. The report has been adopted by the Council.

Light Railways.—The Board of Trade have recently confirmed the following light railway orders: Halesowen Light Railways (Extension), authorising the construction of light railways in the rural district of Halesowen, in the county of Worcester; Darlington Light Railways, authorising the construction in the county of Durham of light railways in the borough of Darlington, and thence to Cockerton and Haughton-le-Skerne in the rural district of Darlington; Colne and Trawden Light Railways (Capital and Further Powers Amendment), amending the Colne and Trawden Light Railways Order, 1901; Barnsley and District Light Railways (Extensions), authorising the construction of light railways in the urban districts of Worsborough and Hoyland Nether, and in the parish of Tankersley in the rural district of Wortley, in the West Riding of the county of York; Doncaster Corporation Light Railways (Deviation, etc.), authorising the deviation and extension of light railways authorised by the Doncaster Corporation Light Railways Order, 1899, and for other purposes; Llanelly and District Light Railway, authorising the construction of light railways in the urban district of Llanelly and in the rural district of Llanelly, in the county of Carmarthen; Derwent Valley Light Railway, authorising the construction of light railways in the city of York and in the North and East Ridings of the county of York, from Foss Islands to Cliffe Common; Cromarty and Dingwall Light Railway, authorising the construction of light railways in the county of Ross and Cromarty at Dingwall, and between Conan Station n the Highland Railway and Cromarty.

Liverpool Overhead Railway.—At the last meeting of the shareholders of the Liverpool Overhead Railway Company, Sir William Forwood, the chairman, spoke of a new departure in the shape of an acceleration of the service—that is to say, the journey from Seaforth to the Dingle, or from end to end of the long line of docks, will be accomplished in 20 minutes instead of 32 minutes as at present. The *Times* says that the development of the Liverpool Corporation's electrical tramway system has proved a very serious competition. The cars do not run along the line of docks, but they run on other routes to identical points from the pierhead with a system of long 1d. stages, which make the invariable through fares of the overhead railway seem large. At the meeting it was suggested that the municipal competition might be met by the adoption of a system of fares for stages instead of the full through fares. It was explained that there was some difficulty in the way of doing this, but the competition would be met by accelerating the service. When the line was originally opened each train was supplied with two motors to secure a scheduled speed of 12½ miles an hour, including stoppages at the stations, of which there are 16. Now it has been decided to supply each train with four 100-h.p. motors of the iron-clad type, and the scheduled speed will be 19½ miles an hour, including the stoppages, in comparison with which it may be noted that the speed on the City and South London line is 12½ miles and the Central London 14 miles, including stoppages in each case. The speed on the Manhattan Elevated Railway is 13½ miles, on the Metropolitan 14·1 miles, on the South Side (Chicago) Elevated Railway 14·6 miles, and on the Lake-street (Chicago) Elevated Railway 12½ miles. The new service on the Liverpool Overhead Railway is expected to come into operation early next month.

LIGHTING AND GENERAL.

Southend.—Mr. Jeffries, assistant electrical engineer, has resigned.

Brecon.—The Town Council have decided not to adopt electric lighting.

Knaresborough.—An extension of mains is to be made to Franklin Mount.

Dumbarton.—The burgh electric power provisional order has now become law.

Croydon.—Mr. A. F. Dowden, of Southampton, has been appointed junior shift engineer.

Ashby.—The Leicestershire and Warwickshire Electric Power Bill has received the Royal assent.

King's Norton.—The District Council have decided to transfer their electric lighting order.

Govan.—The Watching and Lighting Committee are discussing a proposal to light Copland-road with electric arc lamps.

Hoylake.—Mr. Marples, resident engineer, has resigned. The vacancy is being advertised at a salary of £250 per annum.

Brownhills.—No decisive step has yet been taken with regard to the proposal to obtain an electric lighting provisional order.

Dungannon.—The Board of Works have approved of the scheme for the supply of energy for the proposed electric lighting of the town.

Whitehaven.—Nearly all of the consumers have been changed over to the high voltage, and it will take only a few days to complete the work.

Oban.—The National Telephone Company, being unable to agree to the terms proposed for wayleaves, have removed their poles from the burgh ground.

Wombwell.—The Provisional Electric Power Company, Limited, intend to apply for powers to supply electric power within the District Council's area.

Dundee.—The estimates for the lighting of the city for the current year is put down at £9,180, which includes £1,050 as the cost of electric lighting.

Midsomer Norton.—The surveyor's report on the Electric Power Company's scheme will come before the next meeting of the Urban District Council.

Bristol Telegraph Messengers.—The Bristol telegraph messengers were entertained on Saturday afternoon at Old Sneed Park by Mr. Francis Tagart.

Removal.—Messrs. G. A. Vaudervell and Co. have removed from South Kensington to larger works at Chapter Works, Chapter-road, Willesden Green, N.W.

Perthshire Telephones.—The General Post Office are making enquiries with the object of granting telephone facilities to Pitlochry, Dunkeld, and Aberfeldy.

Burton.—Preparations for the scheme for the extension of their electric lighting works are proceeding, property having recently been purchased near the works.

Taunton.—The Electric Lighting Committee in their last report state that the connections with the mains during the past quarter were equivalent to 210 8-c.p. lamps.

Newcastle.—The Corporation have decided to obtain the cost of the electric light per lamp in other towns, as there is an opinion that the charge is rather heavy in this city.

Dewsbury Infirmary.—The House Committee will shortly consider a report by Mr. R. H. Campion, borough engineer, with a view to lighting the infirmary with electricity.

Charing Cross and Strand Electricity Supply Co.—Warrant for the dividend on the preference and ordinary shares of this Corporation have been posted to the shareholders.

Dover.—It is proposed to lay a main from the works to the Admiralty Pier *via* Ladywell, Biggin-street, Priory-road, York-street, Queen-street, King-street, Northampton-street, etc.

Erith.—Mr. G. E. Heath, chief assistant electrical engineer to the York Corporation, has been appointed out of some 44 applicants to the position of chief electrical engineer to the Urban District Council.

Prestwich.—The Council are enquiring as to the terms upon which the Salford Corporation would be prepared to take over the Council's electric lighting order and to supply electricity to the district in bulk.

Swadlincote.—The Electric Supply and Traction Company intend to apply for a provisional order to supply electricity for public and private purposes in the district. The Council will oppose the application.

Dorchester.—The Town Council have decided to keep the electric lighting in the hands of the Corporation, and to ascertain, as far as possible, what demand there is likely to be for the light, the charge for which would be 7d. per unit.

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Stapleford.—At the last meeting of the Rural District Council a committee was appointed to meet the Sandiacre representatives on the Shardlow Rural District Council, with a view to arranging the details of an official canvass of the district.

Manchester.—A report is to be prepared upon the cost of electric current purchased from the Corporation with a view to a reduction of prices. It is understood that at first the reduction will only apply to cases where the current is used for power.

Linlithgow.—The Nobel Explosives Company, Limited, are about to construct a large magazine in connection with the new works being erected by them at the east end of Linlithgow. The company also contemplate the installation of an electric lighting plant.

Dunfermline.—The Dunfermline Co-operative Society have just had the electric plant laid down in their new buildings in Queen Anne-street, and on Monday evening the new light was successfully turned on in the presence of the members of committee and others.

Rishton.—The Urban District Council have informed the promoters under the Rishton, Great Harwood, and Clayton-le-Moors electric lighting order that they are not prepared to take over the powers of the order and purchase the undertaking (Rishton portion).

Clacton.—The Urban District Council have decided to exercise the powers conferred upon them by their electric lighting order, and Mr. Trentham has been instructed to proceed with a preparation of plans and estimates for supplying current within the compulsory area.

Stafford.—The Council have decided to apply for a provisional order for power to supply electric current out of the borough in certain specified districts, Rowley Park being named as the suggested compulsory area. An increased charge will be made for the current outside the borough.

Lowestoft.—The Electric Lighting Committee's recommendation that consumers of over 500 and less than 1,000 units be allowed a discount of 5 per cent., and that consumers of over 1,000 units be allowed a discount of 10 per cent. on the total quarterly bill, has been referred back.

Dublin.—The Council have entered into an agreement with Trinity College giving authority to the Corporation to erect a sub station on the college grounds, and a further agreement with the Port and Docks Board regarding the erection of a sub-station on the quay opposite Creighton-street.

Ayr.—The question of the extra sum payable to the lighting department in respect of the current supplied to the tramways and under registered has been settled by payment of £20 to the lighting department, which sum will be applied in purchasing an additional meter for testing purposes.

Surbiton.—The District Council have asked Mr. Armitage, architect to the firm of Messrs. Edmundson, to act as architect and prepare plans for the electric lighting station, in consultation with Mr. Mather, the Council's surveyor, the entire cost of Mr. Armitage's fees being paid by Messrs. Callender.

Mansfield.—The Electric Lighting Committee are about to lay a main in Park-avenue and the Park, at an estimated cost of £285, upon the applicants guaranteeing to take a supply of energy for three years of such amount as will produce annually 20 per cent. upon the expense of laying the main.

Beverley.—The question as to whether the Corporation should themselves instal electricity in the borough, or whether it should be done by a private company, was debated at considerable length by the Town Council at the last monthly meeting. It was finally decided to ascertain the exact terms on which a company would undertake the work.

Ipswich.—The Electric Supply and Tramways Committee in their last report state that the plans, elevations, and other details of the proposed light and power station buildings had been open for inspection in the library of the town hall for more than a week, and that advertisements had been issued inviting tenders for carrying out the works.

Gainsborough.—In consequence of notices received from the Electric Supply and Traction Company and the United Electric Light and Power Company of their intention to apply for orders to supply electricity for lighting and power within the urban district, the Council have decided to take the necessary steps to obtain an order themselves.

Newton.—An amended estimate has been submitted by the Electric Supply Company, Limited, for public street lighting at a total cost of £975, the company stating that they had increased the candle-power of the incandescent lamps from 25 to 30, and that they proposed to give a special kind of lamp, the nominal candle-power of which was between 30 and 40.

Annual Sports.—The sixth annual sports of the employés at Peel Works of the General Electric Company (1900), Limited, came off successfully at the Belle Vue Gardens, Manchester, last Saturday. The number of entries was over 300, and the competition in all the events was very keen. The prizes included a cup presented by Mr. Eckstein, the managing director of the company.

Aylesbury.—Advertisements are to be issued asking for terms from electrical supply companies to take over the Aylesbury provisional order to supply electricity to the town, erecting the works upon, and paying a rent for land belonging to the Council, and for the town's option to take over the whole by arbitration or otherwise at the end of seven, fourteen, or twenty-one years.

Newport (Mon.).—The National Telephone Company are moving into offices specially built for them in the upper end of Dock-street by Mr. J. Linton, contractor, Newport, from designs by Messrs. Edmexton and Gabriel, of Old Broad-street, London, at a cost of just over £5,000. The whole work of construction has been carried out under the superintendence of the clerk of the works, Mr. D. Reid.

Bexhill.—The Urban District Council have referred back to committee a report by the Electric Light Committee, stating that they had under under their consideration the question as to whether the extension of the electric light works was to be of a permanent or of a temporary character, and advised that the additions to the building required for additional plant should be permanent.

Oswestry.—The Oswestry Electric Lighting and Power Company have decided to increase their plant by the following, and contracts have been entered into for the supply of same: 80-kw. set (Belliss engine, Maclure and Whitfield multipolar dynamo), Babcock boiler with chain stoker, new and enlarged steam-mains. They have been advised by, and the works are being carried out under the superintendence of, Messrs. E. Bremner-Smith and Bremner, 10, Warwick-court, Gray's-inn.

Fires.—An explosion occurred on Monday in Drury-lane, and which did considerable damage to the property adjoining the inspection trap, whence the flames had issued; the accident is attributed to the fusion of underground electric wires. Some damage was also done in Wolverhampton by a fire originating owing to a similar cause. A serious fire occurred at Ipswich (cause at present unknown) on premises belonging to Messrs. Turner, engineers; the fire brigade succeeded in saving Turner's pattern shop, with its valuable contents.

London Gazette.—The partnership existing between J. G. Irving and J. S. Plumtree (trading as Irving and Plumtree), electrical engineers, 12, Canal-street, Nottingham, has been dissolved by mutual consent. A receiving order has been made out in the estate of J. W. Worthington and G. Nuttall (trading as J. Worthington and Co.), electrical engineers, Foundry Works, Foundry-street, Hanley, Staffs, on creditors' petition. The last day for receiving proofs in the estate of G. H. Bentley, 8, Grafton-street, Earlestown, Lancs., is Aug. 30. Mr. C. J. Dibb, official receiver, Byrom-street, Manchester, is trustee.

Huddersfield.—Application is to be made for sanction to borrow £5,000 for the purchase of electric motors and appliances. A deadlock has occurred with regard to the telephone question. The National Telephone Company have declined the proposed agreement on the basis of a consent terminating in 1911 with regard to the laying of their wires underground, which was the subject of a long discussion at the last Council meeting in connection with the question of the establishment of a municipal telephone exchange. The resolutions which the Council then adopted have since been before the committee and discussed, but no proposal has been made.

Perth.—The first year's working of the Corporation electricity department has been attended with success, and there is a profit of £12. The amount received for current during the year was £3,131. 1s. 4½d. Extensions have been carried out in the Scone-road, Balhousie, and Glasgow-road districts within the borrowing powers of the Corporation for this special purpose, the total borrowing powers amounting to £45,000. It has not yet been decided whether a decrease can be made in the price for current, but should an increase be granted in the rate for street-lighting, the current for which is supplied at cheaper than actual cost, it is possible that consumers will receive a reduction in rates.

Nantwich.—Colonel Langton Coke has held an enquiry into an application of the Urban District Council for sanction to borrow £12,505 for electric lighting purposes, and £1,275 for the erection of a refuse destructor. We understand that Mr. Peers, Manchester, is responsible for the scheme, which provides for the erection of generating works and a refuse destructor on the Council's sewage farm close to the town, and for the same motive power to be used for both purposes. A memorial from manufacturers and tradesmen complaining that they were unable to compete with manufacturers and tradesmen in other towns owing to the excessive price charged for gas was read in favour of the scheme. The annual payments were estimated at £1,932, and the income at £2,440, this sum including £2,250 which it was anticipated would be derived from the sale of electricity to the public at a charge of 6d. per unit.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Calcutta Tramways Company's further issue of 35,000 shares of £5 each, £2. 10s. paid. The committee has been asked to allow the following securities to be quoted in the official list: National Electric Wiring Company's 100,000 ordinary shares of £1 each; National Telephone Company's £1,000,000 preferred stock, in lieu of the 200,000 preferred shares of £5 each, Nos. 590,001 to 790,000, now quoted. The Stock Exchange Committee has ordered the undermentioned securities to be quoted in the official list: Calcutta Electric Supply Corporation's further issue of 10,000 shares of £5 each, fully paid, Nos. 30,001 to 40,000; Urban Electric Supply Company's 30,000 5 per cent. cumulative preference shares of £5 each, £3 paid, Nos. 50,001 to 80,000, and 30,000 ordinary shares of £5 each, £3 paid, Nos. 8 to 30,007.

Greenock.—The balance-sheet of the electricity department for the period from Jan. 1, 1901, to June 30, 1902, shows that the total revenue was £11,022. 3s. 1d., which includes £5,866. 9s. (less £41. 17s. 3d. for free wiring) derived from private lighting and motive power; £1,335. 16s. 8d. from public lighting; £2,949. 11s. 10d. for sale under contract to Greenock and Port Glasgow Tramways Company; £150 for rent and maintenance of cableways; £741 from the tramways company for minimum supply, as in terms of the agreement. The expenditure includes £4,050. 10s. 6d. for cost of generation; £312. 16s. 5d. for distribution; £349. 7s. 6d. for lamps; £474. 9s. 5d. for rents, rates, and taxes; £712. 6s. 9d. for management expenses—the total expenditure amounting to £6,817. 0s. 4d., leaving a debit balance of £1,390. 3s. 1½d. Since then the position has so far improved that a surplus is confidently expected at the end of the current year. Several large firms are considering the question of lighting their works by means of arc lamps. A special rate will be allowed, with a minimum of 4½d. per unit.

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Marriage.—We have been asked to make the following announcement: "Bentham-Harrison, on Aug. 18, at the parish church, Brighton, by the Rev. R. F. Scott, M.A. Harold Bentham, resident engineer, Birkdale Electricity Works, to Annie Alicia Agnes, daughter of the late J. W. Harrison, of Brighton."

Schuckert Rock Drills.—We are informed that at the recent official competing tests made at the Düsseldorf Exhibition between the different rock-boring machines, the Schuckert combined electric compressed-air percussion drill was able to show better results than those of any other of the competing firms.

Turin.—At the foot of Mont Cenis, 34 miles distant from the city, a power station is being constructed to control a fall from Lake Cenis equal to from 9,000 h.p. to 12,000 h.p. By the use of 16,000 h.p. a permanent current of 3,000 volts will be obtained. The intensity during transit over the 34 miles of route will be equal to 30,000 volts.

Hastings.—The Sub-Telephone Consultative Committee have reported that they could not recommend the Corporation to carry out the municipal telephone scheme outlined in the report prepared by Mr. Bennett, and, moreover, the terms upon which the National Telephone Company is prepared to sell its plant and rights to the town were not such as they can advise the Council to accept.

W. T. Henley's Telegraph Works Co.—An interim dividend at the rate of 12 per cent. per annum for the half-year ending June 30, 1902, will be paid on the ordinary shares of this Company on Sept. 1 next, the rate for the same period last year being 10 per cent. The half-year's dividend on the preference shares, at the rate of 4½ per cent. per annum, will also be paid on the same date as usual.

Devonport.—A plan submitted by the National Telephone Company for placing their wires underground has been referred to the town clerk, borough surveyor, and borough electrical engineer for consideration and report. The Mercantile Association are interesting themselves with the idea of the municipalisation of the local telephones, and they propose to arrange for a meeting with adjoining towns to consider certain points in connection with the matter.

Catalogues.—We have received from the Sun Fan Company, Limited, Bradford, two illustrated catalogues of belt driven and electrically-driven fans. The company claim a combination of high efficiency and moderate prices. The thoroughness of the specification written and illustrated. The catalogues are remarkable for their comprehensiveness in tables of speeds, volumes and powers, prices, weights, etc., and the completeness of the testing arrangements described.

Stonehouse.—The Works Committee have deferred consideration of a letter from the National Telephone Company, Limited, asking the Council to reconsider their proposal to charge £100 for the facilities, expressing the fear that if the charge was insisted upon it would be impossible for the company to adopt the underground system in Stonehouse. The Council will oppose the Provincial Electric Supply and Traction Company's intended application for a provisional order before December for the supply of electricity for Stonehouse.

Middlesbrough.—The Chamber of Commerce last week discussed the question of underground telegraphs. A letter was read from the Marquis of Londonderry intimating that progress was being made with underground wires, and that next year it was hoped to obtain from Parliament a larger sum of money for the extension of underground work. Colonel S. A. Sadler, M.P., said the matter had been mentioned in the House of Commons once or twice, and the general feeling there was that they must go on with underground construction to prevent trouble arising from storms.

Walsall.—The engineer is preparing a report as to the probable cost of extending the electric mains to Mellish-road, Foden-road, and Caldmore. The Electric Lighting Committee state in their last report that the total number of consumers supplied on July 31 last was 230. During the past month the total units generated at the station was 44,581. The total output from the main generators was 42,093 units. The total units from the transformers was 32,795 (estimated). The total units registered on the meters was 28,141. The machinery was run for 652 hours. The wages paid amount to £94.

The E.L.B. System.—We are informed that the Electric Lighting Boards (British Manufacturing Company), Limited, have unanimously decided to go into voluntary liquidation, and a reconstruction scheme is now on foot in which both the creditors and the shareholders in this concern will be protected. The original Electric Lighting Boards Syndicate, who were the debenture holders of the British company, have appointed a receiver to protect the assets and carry on the business in Great Britain for the present. The position of the British company in no way affects the foreign concerns dealing in the same system.

Sandwich.—Three notices of intention to apply for provisional orders granting power to supply electricity within the borough have been received, and the town clerk has submitted a report dealing with the question of these and other applications. In this he mentions that the Kent Electric Power Company, by their recently passed Act, had now the powers of a gas company in the borough in regard to the taking up of roads for the laying of mains. As the nearest generating station, according to the schedule, would be at Sturry, in the event of their wishing to supply the district they might want to erect another in the vicinity, when they would have to apply for a provisional order.

York.—We understand that Mr. C. A. Midgley, the city electrical engineer, is, owing to the great progress made in his department, unlikely to be able to connect all the consumers who have applied, as the new plant cannot be erected in time for the coming winter. During the last year 423,000 units were sold as against 322,369 in 1900-1. The maximum load was 420 units; the total works cost came to 1·98d., as compared with 2·456d. in the preceding year, while the equivalent in 8-c.p. lamps connected exactly doubled itself. Already there are 36,000 8-c.p. lamps connected and 8,000 8-c.p. lamps are waiting, while the capacity of the plant is but 20,000 8 c.p.

London Electric Supply Corporation.—The interim statement for half-year ended June 30, 1902, gives the units sold for the first six months of 1901 as 1,648,065, as compared with 1,971,106 for the first six months of 1902, this being an increase of 323,041. The gross revenue was £33,587. 13s. 11d. (£38,455. 16s.), increase, £4,868. 2s. 1d.; and the net revenue £10,826. 1s. 6d. (£16,466. 19s. 7d.), increase, £5,640. 18s. 1d. After payment of interest there remains a balance (including the amount of £1,489. 19s. brought forward) of £10,816. 2s. 8d., applicable to reserve and to dividends on the share capital. The directors have declared an interim dividend on the preference share capital payable Sept. 1, at the rate of 5 per cent. per annum, which will absorb £6,230.

Inverurie.—The lighting of the railway station has now been completed. Lately several engineers have been busily occupied erecting electric plant, and last week the light was switched on, when 16-c.p. lamps were tried; 32-c.p. lamps have been substituted, giving a splendid light. In all there are 75 incandescent lamps, and shortly there will be a number of arc lamps erected along the station avenue, giving a candle-power of 2,000 each. The erection of the electric plant was in the hands of Mr. William Paterson, chief electrical engineer, Inverurie Railway Works. All the railway houses, numbering over 100, are now fully lighted with electric light, which is giving every satisfaction. Electric light will also be introduced to the goods station in the course of a few weeks.

Manchester.—A party of influential gentlemen from South Australia, including Sir Edwin T. Smith, K.C.M.G., M.P., and Mr. Arthur W. Ware, ex-mayors of Adelaide, visited the Westinghouse Works, Trafford Park) on the 17th inst. and made a thorough tour through the immense modern workshops. It seems that before returning home several of the party intend to visit America, and purpose to study the principal electrical manufacturing works there, including those of the American Westinghouse Company in Pittsburg. It will be remembered that quite recently Adelaide has embarked on a very large scheme for the conversion of its existing horse tramways to electrical power, and for the construction of long lengths of new lines, the contract for the whole of which work has been placed with the British Westinghouse Company.

Brighton.—The borough surveyor has submitted a report with reference to the alterations necessary to be made for the enlargement of the electricity premises in Bread-street, so as to enable the additional plant ordered for tramway purposes to be installed. The estimated cost is about £800. The sanction to the loan for this work has already been given. A report has also been submitted recommending that, in order that Brighton's telephone scheme may not be abandoned altogether, Hove be cut out of the scheme, and that an installation of telephone exchanges as revised be proceeded with as soon as possible. The preliminaries in connection with the proposed electrical exhibition in the aquarium have met with a most satisfactory reception. The resident electrical engineer, in a recent report, says: "Leaving the concert hall out of the area at his disposal for the erection of stalls, almost the whole of the available floor space has been allotted. This would, up to the present, yield a rental of over £91. The engineer offers several suggestions for making the exhibition attractive, and has obtained permission to lay a trolley wire to supply electricity for all the stalls at an approximate cost of £30. He also desires to purchase 20 large wooden letters, 2ft. 6in. high, at an estimated cost of £2, to form the words "Electrical Exhibition." The report was approved by the committee.

South Wales Electrical Power Co.—The Bridgend generating station of this Company, which will be the first to commence the supply of electrical energy for power and other purposes, is progressing rapidly, and will be in working order by November next. The station, which was originally designed to supply the Bridgend Council with energy in bulk, and the Parc Gwyllt and Angelton asylums of the Glamorgan Council with light and power, is now being put down of a considerably larger size than was at first intended. This is in order to meet the large demand for power which has been made by the works and collieries in the surrounding districts. At present 720 h.p. in engines, generators, and boilers are being installed, and the Company are considering the advisability of putting down a further 1,250 h.p. in order to cope with the demand for power that has arisen. The works and collieries round about Bridgend are responding to the power company's offer, and by the time the station begins the supply of electrical energy the Company expects to have a substantial power and lighting load on their mains. The mains throughout the district, which are in duplicate, and in some parts in triplicate, will all be laid by the end of October next. Motors and other electrical machinery are being let out on hire in order to make it possible for works to avail themselves of the new form of power without incurring a heavy capital outlay.

Coatbridge.—The summary of the report by Judge Lavell and the town chamberlain on the electricity company's accounts is as follows: (1) Capital account: During the year the first mortgage has been increased by a further sum of £16,350. There has been expended on plant, etc., £9,623. 13s. 4d., as compared with £2,677. 18s. 2d. of the previous year, making the total expenditure on capital account, as at Dec. 31, 1901, £34,514. 12s. 9d. (2) Revenue account: The expenditure for the year amounted to £1,791. 14s., as compared with £1,492. 15s. 2d. in the preceding year. The loss on the year's working is £142. 3s. 3d., which, with the interest paid on mortgages and loans of £1,606. 19s. 1d., amounts in all to £1,749. 2s. 4d., as compared with £1,599. 17s. 11d. of the previous year. This loss has been carried to a suspense account, and the total losses, etc., at the debit of this account, as at Dec. 31, 1901, amounts to £13,081. 3s. 6d. The offer of the Scottish House-to-House Electricity Company for street-lighting during the next year has been accepted. Additional arc lamps will be erected. The charges are as follows: 10 arc lamps, all night, £22. 10s. each; incandescent lamps of two 8 c.p. each, all night, £3; incandescent lamps of one 8 c.p. each, to 11 p.m.,

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£1. 10s. 6d. The company to be allowed a margin of 15 minutes on the above-mentioned times for switching on and off. Also for extra 15 days' incandescent lighting would be as follows: half night, an extra 1s. 11d. per lamp; all night, an extra 3s. 9d. per lamp. Current for an extra five arc lamps of the enclosed type at the same price as the open type—viz., £23. 15s.

King's Lynn.—The Electricity Enquiry Committee have presented a report, from which we extract as follows: "We find that street-lighting costs £1,911 a year, although current is charged at only 2·06d. per Board of Trade unit, with attendance and repairs at 0·28d., or at a total price of 2·34d. The charge for private current averages 4·73d. per Board of Trade unit. There was delivered last year to private consumers 93,274 units, and to street-lighting 193,405 units, making the total amount distributed 286,679 units. Thus street-lighting absorbs more than two thirds of the whole production. We find that the works cost is 1·96d. per Board of Trade unit, and that the total cost, inclusive of rates, salaries, etc., is only 2·41d. per unit. When one considers that King's Lynn is one of the smallest installations in the kingdom, and that coals are much dearer per ton here than in the manufacturing districts, this total cost price must be deemed a satisfactory figure. The most important features in the returns for a number of towns supplying 500,000 units per year and over, and those that we think should receive your most serious attention, are: (1) that whilst the average price per unit supplied by the King's Lynn installation is only 3·14d. per unit, the average price of 54 towns, with a population of about or under 60,000 inhabitants, amounts to 4·16d. per unit; (2) that of these 54 towns 20 made profits, and their average price is found to be 4·41d. per unit; 33 of these towns made losses, and their average price is 3·94d. per unit; (3) that the average price charged by the 45 large towns of the country owning electricity works is 3·62d. per unit; (4) and that the price of 43 installations in the hands of companies averages 4·93d. per unit. All these average prices are calculated excluding meter rents. This great difference in the average price of current in King's Lynn and the average price of these other towns is, in our opinion, due to the low price of public lighting, and not to an unduly low price for private lighting. If a loss is made on the year's working, it must be because current has been sold at a less price than it cost to generate—that is, the average price obtained for the units generated has been too low. King's Lynn is not in every respect comparable with any other town. The 193,405 units supplied to the street lamps are more than two thirds of the whole distributed. There is no other town that delivers two-thirds of its total generation in street-lighting. (Londonderry is not comparable with King's Lynn, as it has supplied only public lighting). Hence it is more important that the charge per unit of this branch of the service should not be so unduly low as to make it impossible for the other branches to make the business profitable. The average price of the 54 towns comparable with King's Lynn is 4·67d. for private and 3 10d. for street-lighting, or an average per unit of 4·16d., the 3·10d. per unit for street-lighting being 2·86d. for current and 0·24d. for maintenance of lamps, etc. From a careful consideration of such features of the case we have been able to examine, we beg to suggest: (1) That, if it be possible, it would be wise to dispose of the gas plant. If this is not practicable, then we suggest that it be used solely as a stand-by. (2) That strict economy be used in the public lighting. It is very questionable if all the lights on the Walks are necessary. We find their maintenance costs £45. 10s. We advise that incandescent lights replace the eight arc lights on the Boal and Shores. These lamps cost £128 per year, and there seems no reason for this expense. Could not the police switch the street lights on and off? (3) We suggest that the price of private lighting be made to average 5d. per unit, and that current for public lighting be charged not less than 3d. per unit, including expenses of maintenance. We are informed that the expenses of the current year may be assumed to amount to £2,336 for maintenance, £1,580 payment of principal on loans, £1,086 interest on loans, £280 interest on bank overdraft—total, £5,282. If our suggestions are followed the income may be expected to be: 120,000 units at 5d., £2,500; 175,000 units at 3d., £2,187. 10s.; power, £250; meter rents, £120; profits, £150—total, £5,227. 10s., which approximately balances the expenditure. It cannot be doubted that it is a necessary canon of commercial procedure to make each year support itself. In municipal affairs the ratepayer is ever coming and going, and each one occupying rateable premises ought to bear all the lawful burdens that arise during the year, and also benefit by any economy that he may be the means of aiding. The loss incurred up to March 31, 1902, amounting to £1,861. 8s. 11d., we recommend should be placed to a suspense account, and that the Finance Committee should arrange with the Electricity Committee means of paying this off by six yearly payments, either out of the district rate or by an increase in the price charged for public lighting as those committees from time to time consider most convenient. We suggest that the Local Government Board be asked to allow of an additional loan of £5,000 to pay off the indebtedness to the treasurer on capital account." The report has been referred to the whole Council in committee. The engineer's last report states that since the last meeting applications had been received for 101 additional lamps of 8 c.p. or equivalent, making a total of 12,621 from private consumers. The working cost for the month of July, compared with the same month last year, was as follows: units generated, 12,796, last year 11,578; units sold to private consumers, 3,998, last year 2,486; units sold at power rate, 1,245, last year 21; cost of fuel, stores, repairs, and wages in station, £104. 10s. 5d. (including £20. 5s. for repairs of batteries), last year £77. 5s.; cost per unit generated, 1·96d., last year 1·60d.; wages of lamplighters and outside staff, £16. 7s. 3d., last year £12. 5s. 2d. A plan for the improved lighting of Railway-road, the lamp-posts being placed at the sides instead of in the centre of the road as at present, has been approved. Nernst lamps will be used if practicable. An application had been received for the supply of current to a 2½-h.p. motor in Hockham-street, but on application for permission to lay the necessary main (Hockham-street being still a private street) the owners refused such permission. The matter is in the hands of the town clerk. The engineer has also submitted a further report on the proposed lighting of the docks, and the matter is in the hands of Messrs. Floyd and Gemmell to make a formal offer of terms to the dock company.

PROVISIONAL PATENTS, 1902.

AUG. 11.

17534. Improvements in electric locomotives. Bertram Hopkinson, 26, Victoria-street, Westminster, London.

17538. Automatic guard for electric trams. William Jones and James Henry Howell, 9, Rudgeway-road, Fishponds, Bristol.

17587. Improvements in and relating to electrolytic incandescent bodies, particularly applicable to Nernst lamps. Heinz Bauer, 1, Queen Victoria-street, London.

17589. A movable electric contact for switches and other electrical connections. Sir Henry Edward Colvile, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

17611. Improvements in electric clocks. Carl Joseph Moberg, 19, Holborn-viaduct, London. Complete specification.)

17624. Improvements in or relating to wireless telegraphy. Louis Heathcote Walter and James Alfred Ewing, 111, Hatton-garden, London.

AUG. 12.

17633. Improvements in the method of and means for securing shades, reflecters, or the like, used in connection with incandescent electric lamps. Alexander Morrison and John Wilfred Butterworth, 5, John Dalton-street, Manchester.

17667. A new or improved maximum-demand indicator for alternating electric currents. Charles John Evans, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

17676. An improved stopping device for electric motor vehicles. Ronald Burnett Beattie, 99, Cannon-street, London.

17678. Improvements in or relating to electric lamp globes. Richard Böhm and Ernest Böhm, 99, Cannon-street, London.

17685. Improvements in electrical motor counters. Otto Titus Bláthy, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17687. Improvements in maximum-demand electrical indicators. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17688. Improvements in commutator brushes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17689. Improvements in or relating to electric arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17690. Improvements in electric arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

17691. Improvements relating to armature windings for induction motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.) (Complete specification.)

17703. Signalling by electromagnetic waves. Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17704. Improvements in wireless signalling. Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17705. Improvements in wireless signalling. Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17706. Improvements in wireless signalling. Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17707. Improvements in transmitting and receiving signals. Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17708. Improvements in signalling by electromagnetic waves. Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17712. Improvements in hot-wire electric meters. Robert Stuart Stewart, 53, Chancery-lane, London. (Complete specification.)

17744. Improvements in insulating compositions for metallic surfaces or wires. John Allen Heany, Norfolk House, Victoria-embankment, London. (Complete specification.)

17745. Improvements in water, acid, and fireproof insulating compositions and method of making the same. John Allen Heany, Norfolk House, Victoria-embankment, London. (Date applied for under Patents Act, 1901, June 24, 1902, being date of application in France.) (Complete specification.)

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17746. Improvements in insulating metallic surfaces or wires and method of preparing asbestos for insulating metallic surfaces or wires. John Allen Heany, Norfolk House, Victoria-embankment, London. (Date applied for under Patents Act, 1901, June 24, 1902, being date of application in France.) (Complete specification.)

17747. Improvements in the manufacture of insulated wire. John Allen Heany, Norfolk House, Victoria-embankment, London. (Date applied for under Patents Act, 1901, June 24, 1902, being date of application in France.) (Complete specification.)

17748. Improvements in insulated wire. John Allen Heany, Norfolk House, Victoria-embankment, London. (Date applied for under Patents Act, 1901, June 24, 1902, being date of application in France.) (Complete specification.)

AUG. 13.

17755. An improvement in trolley poles. Alfred Edwin Hardaker, 12, Mayfield-road, Eccles, Lancashire.

17757. Electric automatic switches. Reginald Charles Harpur and Alfred Allen Whitlock, 86, East-hill, Wandsworth, London.

17762. The automatic catch-point trolley for use on electric cars working on overhead wires. Joshua Reynolds, 29, Cedar-road, Aintree, Liverpool.

17784. Automatic point-shifting gear for trolley wires. James Langmuir Napier, 55, West Regent-street, Glasgow.

17794. Improvements in apparatus for actuating the electrical controlling appliances of the motors of electric railway cars. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

17811. Improvements in insulating apparatus for electric currents of high tension. Karl Selim Lemström, 43, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17812. Improvements in receiving and recording apparatus for wireless telegraphy. Marchese Luigi Solari, 24, Southampton-buildings, Chancery-lane, London.

AUG. 14.

17841. Improvements in methods of and means for producing and shaping electric current pulses. Frederick Henry Loring, 18, Southampton-buildings, Chancery-lane, London.

17847. Improvements in telemotor apparatus for working steering, telegraphing, indicating, and other apparatus from a distance. Andrew Betts Brown, 121, West George-street, Glasgow.

17867. Moisture and water proof fixture and guard for electrical attachments, such as incandescent lamps, plug attachments, and the like. Albert Frederick Hauss, 52, Chancery-lane, London. (Complete specification.)

17886. Improvements relating to electric arc lamps. Hugo Bremer, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

17913. An improvement in arc electric lamps. Frederick James Green, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17923. Electric arc lamp. Joseph Albert Rignon, 40, Chancery-lane, London. (Complete specification.)

17924. An improved electric igniting candle for explosion motors. Herman Luthy, 40, Chancery-lane, London. (Complete specification.)

17927. Improvements in electricity meters. Guy Carey Fricker and William Morris Mordey, 46, Lincoln's-inn-fields, London.

AUG. 15.

17952. Improvements in and connected with electricity meters. Barker North, 6, Lord-street, Liverpool.

17953. Improvements in marine electric light fixtures. George Lincoln Martin, 92, Liberty-street, New York City. (Complete specification.)

17994. Improvements in electric interrupters. Lars Gustav Nilson, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 14, 1902, being date of application in United States.) (Complete specification.)

17995. Improvements in driving mechanism for electric road vehicles. Lars Gustaf Nilson, 53, Chancery-lane, London. Date applied for under Patents Act, 1901, May 14, 1902, being date of application in United States.) Complete specification.)

17997. Improvements in controllers for electric motors. Lars Gustaf Nilson, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 15, 1902, being date of application in United States.) (Complete specification.)

17998. Improvements in electro-gasoline vehicles. Lars Gustaf Nilson, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 15, 1902, being date of application in United States.) (Complete specification.)

18009. Improvements in devices for electric ignition of flammable gases. Edmund Hugh Pryce, 22, Southampton-buildings, Chancery-lane, London.

AUG. 16.

18021. Improved adjustable electric switches or circuit breakers. Frank Down Emery and Archibald James Hallam, Falcon Electrical Works, Poland-street, Oldham-road, Manchester.

18048. Improvements in or connected with storage or secondary batteries. John Crisp Fuller, George Fuller, and Leonard Fuller, 33, Chancery-lane, London.

18055. Continuous action electric bell. Bertil Brander, 36, Chancery-lane, London.

18076 Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Matthew O. Troy, United States.)

18077. Improvements in electric current collectors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward D. Priest, United States.)

18078. Improvements in current-limiting switches for electric lights. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Harry W. Brown, United States.)

18079. Improvements in protective devices for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.)

18080. Improvements in electric current regulators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.)

18081. Improvements in telltales for ships' running lights. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John L. Hall, United States.)

18082. Improvements in charging devices for storage batteries. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Hermann Lemp, United States.)

18083. Improvements in means for changing the colour of artificial light. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.)

18084. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Howard R. Sargent, United States.)

18085. Improvements in taping machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis, United States.)

18086. Improvements in charging devices for electromobiles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank P. Cox, United States.)

18087. Improvements in alternating electric current generators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry G. Reist, United States.)

18088. Improvements in electric transformers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Augustine R. Everest, United States.)

18089. Improvements in magnetic separators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles M. Green, United States.)

18090. Improvements in electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elton J. King, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 4.

1901.

14423. Combined telephone, telegraph, electric light, and power system. Stark.

16150. Arc lamp safety winch. Lawrence.

16615. Controlling apparatus for electric motors. Boult. (Christensen.)

16710. Electrical switches. Cox.

16847. Cord grip for electric pendant lamps. Wright.

17349. Electric locomotives operated by accumulator batteries. Böhm and Menckhoff.

18125. Electrical controlling switches. Hickley.

18600. Treatment or manufacture of paper applicable for use in electric insulation. Tayler.

18947. Electric current controllers. Von Zweigbergk.

20476. Electric incandescence lamps. Phelps.

22477. Electric meters. Johnson. (Hartmann and Braun.)

22898. Lapping heads used in electric cable-making machines. Claremont and Hyde.

23756. Mechanical converters of electric current. Joseph.

26474. Electrical valve apparatus for actuating the air brakes of railway trains. Abel. (Siemens und Halske Aktien-Gesellschaft.)

1902.

9317. Electric quantity meters. Gowlland.

9825. Electric fuse boxes for street mains and analogous uses. Hall.

11062. Third-rail insulators for electric railways. British Thomson-Houston Company, Limited. (Stewart.)

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11994. Circuit-closing devices for the line selecters of telephones. Graetzer.

14136. Telephones for diving and like purposes. Gorman and Graham.

14788. Automatic switches for telephones. Schneider.

15435. Secondary or storage batteries. Lake. (Consolidated Storage Batteries Company.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	Aug. 16	4,743	4,495	+ 248	158,794	146,747
Blackburn Corporation	,, 8	819	698	+ 121	16,408	13,258
Blackpool Corporation	,, 14	2,523	2,254	+ 269	20,316	21,095
Blackpool-Fleetwood Tramways	,, 16	2,132	1,720	+ 412	8,649	9,403
Bolton Corporation	,, 17	1,664	1,593	+ 71	51,660	47,303
Bradford Corporation	,, 17	3,441	1,243	+ 2,198	90,573	29,902
Bristol Tramways Company	,, 15	5,425	3,645	+ 1,780	—	—
Carlisle Tramways Company	,, 16	213	201	+ 12	5,724	5,325
Central London Railway	,, 16	6,669	5,305	+ 1,364	46,100	41,207
City and South London Railway	,, 17	3,222	1,863	+ 1,359	19,496	12,912
Cork E. T. and L. Company	,, 14	885	549	+ 336	17,337	15,128
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 16	311	328	- 17	7,053	6,935
Dublin & Lucan Electric Railway	,, 17	138	157	- 19	937	1,050
Dublin U. T., electric cars	,, 15	4,116	4,030	+ 86	—	—
Dublin S. District, Electric	,, 15	1,113	1,068	+ 45	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 16	12,442	12,516	- 74	—	—
Halifax Corporation	July 30	2,573	2,600	- 27	21,516	—
Huddersfield Corporation	Aug. 16	1,308	1,133	+ 175	—	—
Hull Corporation, E. S.	,, 16	1,839	1,706	+ 133	35,363	33,894
Liverpool Corporation	,, 9	11,347	10,344	+ 1,003	307,582	281,848
Liverpool Overhead Railway	,, 17	1,604	1,734	- 130	11,468	12,306
Newcastle-on-Tyne Corporation	July 12	2,688	—	—	—	—
Portsmouth Corporation	Aug. 9	2,771	1,359	+ 1,412	—	—
Sheffield Corporation	,, 17	4,434	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Sunderland Corporation	,, 17	1,373	1,301	+ 72	24,487	22,277

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £100 increase.

Barcelona Ensanche y Gracia, £94 decrease. Barcelona £308 increase.

Brisbane, £558 increase (month of June, £10,187; increase, £1,813).

Buenos Ayres and Belgrano Electric (month of June, receipts £12,229; increase £478), £166 increase.

Calcutta, £246 increase.

Cape Town (month of June), receipts, £14,148; expenditure, £6,689.

Isle of Thanet Electric, £376 increase

Mexico Electric (month of July), receipts, £20,300; expenditure, £12,600.

Perth Electric, £79 increase.

Port Elizabeth (month of June), receipts, £3,849; expenditure, £1,891.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Insulated Wire, Ord., 1-70,000	5 ..	7¼-7⅝
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5⅝
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6⅛
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2 ..	1⅛-2
—— 4½ per cent. 1st Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16½
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	2¼-3 xd
—— 5 per cent. Debentures	100 ..	101-106 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	78-83
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-5⅞
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20½-21½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15½
Telegraph Construction and Maintenance	12 ..	37-40
—— 5 per cent. Bonds	100 ..	102-105
Electric Railways.—		
Central London, Ordinary	100 ..	103-106 xd
—— 4 per cent. Pref.	100 ..	104-107 xd
—— ,, ,, deferred	100 ..	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	71-73
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	127-130
—— ,, ,, ,, '96	100 ..	126-129
—— ,, ,, ,, '01	100 ..	121-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	90-93 xd

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	103-106
Bournemouth and Poole, Ordinary	10 ..	11¼-12½
—— 4½ per cent. Cum. Pref.	10 ..	9¾-10½ xd
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	9¼-10 xd
—— 7 per cent. Preference	5 ..	9¼-10 xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8½
—— Nos. 20,001-30,000	5 ..	8½-9½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, £10 Ord.	6 ..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	8¼-9¼ xd
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-6 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¼-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	106-107
Chelsea Electricity Supply	5 ..	5¼-5⅝
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼ xd
—— 6 per cent. Cum. Pref.	10 ..	12-12½ xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅝
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5⅜-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10½-11¼
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1⅞-2¼
—— 6 per cent. Pref.	5 ..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	96-99
Metropolitan, Ordinary	10 ..	15-16 xd
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	13½-14½
Oriental, 1879	1 ..	—
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	97-100
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	5⅜-6¼
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13¼-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	103-105 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	12¼-13¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12⅝ xd
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	10¼-11¼
—— ,, ,, ,, ,,	5 ..	8-8¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	108-110
—— ,, ,, Prov. Crts.	50 ..	81-83
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11 xd
—— 4½ per cent. Debenture Stock	100 ..	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 5 per cent. Preference	14s. ..	¾
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	70 p.c. ..	70 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	92-96 xd
—— Preferred, 590,001-790,000	3½ ..	4⅝-4¾ xd
—— Deferred Stock	100 ..	54-58 xd
—— 6 per cent. Cum. First Pref.	10 ..	11-13 xd
—— 6 per cent. Cum. Second Pref.	10 ..	10-12 xd
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¾-5 xd
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
—— 4 per cent. Deb. Stock, Red.	100 ..	102-106
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Lord Rayleigh.—A Vienna message states that the Emperor Francis Joseph has confirmed the appointment of Lord Rayleigh as corresponding member of the Austrian Academy of Sciences.

Book Received.—We have received from Messrs. Longmans, Green, and Co. a "Text-Book of Electro-Chemistry," written by Svante Arrhenius, professor at the University of Stockholm, and translated into English by Mr. John McCrae. The price of the book is 9s. 6d.

Board of Trade and American Railways.—It is stated on authority that Colonel H. A. Yorke, senior inspecting officer of railways, has been commissioned by the Board of Trade to proceed to America next month in order to examine into and report to the Board on the working of railways in the States, including both steam and electric lines.

Photographic Exhibitions.—Next month there will be two photographic exhibitions in London, the one following close upon the other. That known as the Photographic Salon opens on Sept. 19, and the Royal Photographic Society's exhibition is arranged to throw open its doors 10 days later. The receiving days for the two shows are Sept. 8 and 12 respectively.

Marconi Station in South Africa.—It is announced that the erection of a wireless telegraph station by the Marconi Company at Cape Town will soon be taken in hand. The station at Cape Breton, Nova Scotia, is now completed, and Mr. Vyvyan, the engineer who has carried out the work, will shortly leave for South Africa to superintend the erection of the new station.

Labour Rule.—We have to acknowledge from the Master Builders' Association of New South Wales the receipt of a pamphlet entitled "Ten Years of Labour Rule in New South Wales." It is a report upon the progress of labour politics in that State, which was considered and adopted by the above association in June last year. To those interested in the subject the information given in the report should prove instructive.

The Pacific Cable.—What will ultimately form part of the great all-British cable between England and Australia is now being laid by the Canadian Pacific Telegraph Company from Lanarmo, B.C., to Banfield Creek, at which point the British Pacific cable will end. The cost of the line is estimated at £2,400, and it is to be completed by Dec. 1 next. The Pacific cable is already laid between Australia and the Fiji Islands, a distance of 2,500 miles, and the remainder is on the way.

Personal.—We note that the German Emperor has conferred the order "Pour le Mérite" on Lord Avebury and Prof. A. Agassiz, the latter of Harvard University. Lord Avebury is well known for his all-round knowledge of scientific subjects, and he has at different times been described as botanist, entomologist, statistician, and geologist. He is also a vigorous investigator in plant and animal life. Prof. Agassiz, the other recipient of the honour, was born in Switzerland, being the son of the great Swiss naturalist. He is also a naturalist, and has passed nearly all his life in America.

Space Telegraphy in War.—Wireless telegraphy will play an important part in the naval manœuvres of the United States in a few weeks' time. As explained in our previous issue, the American navy is about to adopt a system of wireless telegraphy, and its use in the forthcoming manœuvres will be in the nature of an experiment. The whole of the coast from New York to the Gulf of Mexico is to be protected by stations, so that at all points the scouts of the defending squadron will be in touch with land. The tests should go a long way to proving the great value of wireless telegraphy in naval warfare.

The British Academy.—A Royal charter has been granted by the King incorporating the British Academy for the Promotion of Historical, Philosophical, and Philological Studies. The new institution starts on its career with a fellowship of 49, headed by Lord Rosebery. The list of first Fellows also includes the Prime Minister, Lord Dillon, Lord Reay, Mr. Lecky, M.P., Mr. John Morley, M.P., Mr. James Bryce, M.P., Sir Wm. Anson, M.P., Sir Edward Maunde Thompson, Dr. Monro, Dr. A. W. Ward, Dr. Caird, Profs. Bywater, Butcher, Cowell, Maitland, Rhys, Skeat, Dr. J. A. H. Murray, and other scholars of distinction.

Institute of Carriage Manufacturers. — The fifteenth autumnal conference of the Institute of British Carriage Manufacturers will be held in Oxford on Sept. 9, 10, and 11 next. The Mayor of Oxford will officially welcome the members at the town hall, and thereafter the president (Mr. Harold Thorpe, of Tunbridge Wells) will deliver his address. Papers will also be read by Mr. James Young, of Bromley, and Mr. W. H. Hamshaw, of Wimbledon. During the meeting the members will visit Blenheim Palace, Woodstock, by kind permission of his grace the Duke of Marlborough, K.G., and a river trip has also been arranged to Henley, Marlow, and Windsor.

Telegraphic Communication with Scotland.—Telegraphic communication between London and Scotland was recently the subject of a petition from the Glasgow Chamber of Commerce to the Postmaster-General in London. The argument is that in view of the many breakdowns by storm in the overhead telegraph wires going northwards in the past few years, underground cables should be laid between London and Scotland so as ensure an uninterrupted service under all conditions. Mr. Austen Chamberlain, who under the new Ministry becomes Postmaster-General in the room of Lord Londonderry, has now written the Glasgow Chamber assuring it that he will not lose sight of this important subject.

Electric Shock.—A committee of Russian electrical engineers have drawn up a set of regulations which they recommend to the Government as being suitable for the whole profession. The object of these regulations is to avoid accidental shocks on high-voltage systems of electric light and power transmission, and also to provide that in the event of an accident occurring there shall be ample means at hand to resuscitate, if possible, the victim. The precautionary measures, apart from the construction of the plant, include the provision of indiarubber gloves and shoes, which have to be tested every six months at three times the voltage ordinarily employed in the station. A series of instructions is also to be placarded in any building using high-voltage currents, giving full particulars as to how to restore respiration and to treat those who have been disabled by shock.

Record Cable Span.—What is believed to be the longest aerial cable span in the world has just been swung for the Columbia Telephone Company across the Susquehanna River. The air-line distance is 3,200ft. Wires of steel, hard-drawn copper, and aluminium were first tried, but they all went down in a storm last winter, the suspension cable, made of a special steel, only remaining. In these conditions a rubber-covered cable, consisting of 10 pairs of No. 19 B. & S. conductors, weighing about 880lb. per 1,000ft., was fastened to the suspension wire, which has a tensile strength of 25,000lb. This, with the span wire, weighs 1·09lb. per 1ft., or a total of 3,500lb., allowing

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14ft. extra for the dip of the span. In order to secure a firm support, the poles supporting the line are of heavy chestnut, 12in. in diameter at the top, and the anchorages are connected to two poles on either side. It is believed that the present cable will be able to withstand the stress of the weather at all times.

Protection from Lightning.—Mr. Killingworth Hedges, hon. secretary of the Lightning Research Committee, writes to the *Times* calling attention to the great risk of fire there is arising from the unprotected state of buildings from lightning, such as the British Museum, the Victoria and Albert Museum, the National Gallery, and the Tate Gallery. The Office of Works, he says, appear to do nothing, and refused last year to spend the trifling amount required to protect the Chapter House and include in it a modern system of conductors designed for the protection of Westminster Abbey. At the British Museum, for instance, the electric light mains would form an excellent path should even a portion of a lightning stroke find an entrance, and a most disastrous fire might occur. The writer urges that our cathedrals and museums should follow the example of Germany, and have a complete protection from lightning, which should be subjected to frequent inspections. The annual expense for upkeep in the case of a public building would be sufficiently provided for by, say, a 1 per cent. rate on the sum spent for structural repairs, and this amount could be treated as an insurance.

Rubber Tree Cultivation.—A new industry in the Republic of Guatemala, in Central America, is the cultivation of the rubber tree. The export of the product from that country is a growth entirely of the last few years, but it seems likely that in future a large supply of rubber from the coast districts of this republic will be forthcoming. Good rubber is as yet only obtainable in a few parts of the world, and the increasing demand for it in all branches of the manufacturing industries, and especially the electrical business, makes it imperative that new fields should be opened up for the cultivation of the plant. The method usually followed by a planter is this: He plants a grove of, say, 100,000 plants, which at the end of five years yields a certain amount—say, one-third of what fully-matured trees should yield. At the end of the fifth year he thins the plants down to about half that number, or 50,000. On these 50,000 trees a handsome sum is realised, which entirely repays the original outlay, the running expenses being paid by the cultivation of some such fruit as the banana, thus leaving the planter at the end of five years with all his outlay paid and a grove in his possession yielding an increasing product every year.

Engineers' and Shipbuilders' "Transactions."—Vol. xviii. of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders has reached us this week. It contains a record of the proceedings of the institution from March 21 to April 18 last as follows: resumed discussion on Mr. E. C. Chaston's paper on "The Ballasting of Modern Tramp Steamers"; resumed discussion on Mr. F. J. Warburton's paper on "Some Notes on Steam-Turbines"; discussion on Mr. M. C. James's paper on "Passenger Accommodation in Steamships"; paper on "Workshop Records," by Mr. Geo. Parker; and paper on "Co-operation and Mechanical Aids to Workshop Cost Keeping," by Mr. R. P. Link. We have also received vol. xlv. of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland. This volume contains the following: Mr. Johnstone's reply to discussion on "Notes on the Serious Deterioration of Steel Vessels from the Effects of Corrosion"; correspondence on a paper by Mr. Dugald Clerk on "Gas and other Internal-Combustion Engines"; and discussion on a paper by Mr. E. Hall-Brown on "Some Considerations affecting the Economy of Marine Screw Engines."

Baking Carbon Electrodes.—The following disposition of apparatus for baking carbon electrodes, particularly such as are intended for the electrolytic decomposition of fused baths, is described by Mr. Chas. M. Hall, of Niagara Falls. The carbons are arranged horizontally or vertically, and in one or several rows, around the carbon core and within the masonry walls of a furnace, the carbons being insulated not only from the core, but from one another by means of a refractory and non-conducting powder such as bauxite, purified alumina, magnesia, etc. Upon the passage of a suitable current through the core, the carbons are brought to a temperature of 3,000deg. or 4,000deg. F., the interposed insulation guaranteeing against the diversion of notable quantities of current through the carbons themselves. It is given that a core 4ft. or 5ft. in length and 12in. by 30in. in cross-sectional area requires to have developed therein 400 h.p. to 500 h.p. by an alternating current of 35 to 50 volts. The conducting core is preferably of granular charcoal or coke, but the inventor suggests also the employment, as a heating resistance, of a fused electrolyte, in which case the baking of the carbons becomes an additional feature of the exceedingly interesting method of purifying bauxite by the reduction of its impurities heretofore fully described.

Institution of Electrical Engineers.—The *Journal* of the Institution of Electrical Engineers for August has now been issued. It contains several papers of considerable interest which were read last session before several of the various local sections. They include: "Starting Resistances" (abstract), by Mr. A. E. Gott (Newcastle Section); "The Equipment of a Modern Telephone Exchange" (abstract), by Mr. F. A. S. Wormull (Newcastle Section); "The Construction of High-Tension Central-Station Switchgears, with a Comparison of British and Foreign Methods," by Mr. H. W. Clothier (Manchester Section); "Lighting and Driving of Textile Mills by Electricity," by Mr. M. Osborne (Dublin Section); "Notes on the Testing of Tramway Motors, and an Investigation into their Characteristic Properties," by Mr. M. B. Field (Glasgow Section); and a report of the deputation to the Board of Trade on the subject of "Legislative Restraints on Electrical Enterprise." Several obituary notices also appear in this volume of W. D. Bailey, A. S. Bolton, G. L. Bristow, W. T. Goolden, J. Howe, J. S. Lewis, C. W. Lundy, and John Neale, all of whom were members of the Institution of one class or another. We have further to acknowledge the receipt of the list of officers and members of the Institution for the current year.

Wireless Telegraphy and Telephony.—It is reported that the patents taken out by Messrs. Popp and Branly for their system of wireless telegraphy have been taken over by a company known as the Société Française de Telegraphes et Telephones sans fil," with the object of working the same. It is well to note, however, that the so-called company, according to advices from Paris, has not been formed in conformity with the French laws, but is merely a company "en participation." In these circumstances it is liable to be declared null and void unless certain conditions are fulfilled, and up to the present it does not seem that these have been complied with. Turning to home matters, we hear that Mr. Marconi is contemplating the establishment of wireless telegraphic communication between Iceland and Scotland. The Danish Government's permission to instal the apparatus in Iceland will be required if the scheme is to be carried out, and it is stated that Mr.

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Marconi intends visiting the place in the winter to make investigations. Regarding wireless telephony, a telegram from Sassnitz says that the first messages were exchanged on Sunday morning by wireless telegraphy and wireless telephony between the stations of Sassnitz and Kolberg, about 106 miles apart. The installations were put down by the Siemens-Halske Electrical Company, of Berlin, for experimental purposes.

Obituary.—It is with much regret we chronicle the tragic death of Mr. Henry Chas. Digby Fearon, one of his Majesty's inspectors of factories, who with his brother, the Rev. M. B. Fearon, was killed by lightning while climbing the Wetterhorn on the 22nd inst. The late Mr. Henry Fearon will have been known to many of our readers as a prominent member of the Electrical Engineers Volunteers' Cycling Club, and as an associate of the Institution of Electrical Engineers. His duties as an inspector of factories did not allow him much opportunity of attending the Thursday evening meetings of the Institution, but it will be recalled that when the subject of the effect of the new Factory Act on the electrical industry was discussed last session Mr. Fearon was present, and was able to give some important information on the points raised. Prior to his leaving England with his family for the Alps, Mr. Fearon underwent his fortnight's training in the field with his comrades of the Electrical Engineers Volunteers Corps, and to them as well as other members of the profession his sad end at so young and promising an age—we believe he was not yet 30—will be a matter of deep regret. His tragic death is made all the more pathetic by the fact that the ascent of the Wetterhorn was to be the last excursion of the holiday, the family having to return to London a day or two later.

New Submarines.—Although not generally known, the past two or three months have witnessed some severe tests in home waters of four of the five latest submarine boats constructed for the Admiralty which have now been added to the British first line of defence. In this time their efficiency has been amply proved, they having been made to travel submerged at various speeds up to 10 knots an hour. When once below the surface it is very often impossible even in daylight to follow their movements. The ordinary measurements of the boats are 63ft. 4in. in length, with a beam of 11ft. 9in. and a displacement of 120 tons. When on the surface they are driven by gasolene engines, and when submerged by electric motors. The boats will withstand the pressure consequent upon a submersion to a depth of 100ft. below the water. The last of the five submarines to be completed is at present lying in the docks at Barrow awaiting her preliminary trials. She is by far the largest boat of the flotilla. Measuring fully 100ft. long, she carries with it a greater displacement than the others, a greater speed, and some marked improvements on the earlier construction. One of the principal advances has been made in the steering gear which will allow of the boat advancing or retreating without reversing the engines. The tests of the four submarines which have already been added to the list of available vessels in the British navy are said to have been attended with complete success in all directions.

Multiplex Telegraphy.—We understand from our American contemporaries that Prof. M. I. Pupin has been awarded priority of invention by the Commissioner of Patents for his system of multiple telegraphy. When Prof. Pupin filed his claim for this invention it was severely questioned by his opponents, it being contended that his original specifications were ambiguous, and that they contained statements that conflicted with each other. On the other hand, it was urged that the original claims were, in fact, drawn to cover a system of electrical signalling in which the entire circuits were to be tuned from end to end, and not for a system in which the tuning was to be confined to each separate receiving circuit. Each of the receiving circuits is provided with a coil of fixed self-induction and a condenser of fixed capacity capable of adjustment relative to each other. Each branch or receiving circuit is then tuned or readjusted in resonance by relatively adjusting its capacity and induction, so that each receiving circuit will be affected by a current of a certain periodicity which may be developed at the transmitting end of the main line. Transmitters are then adjusted so that they will each respectively develop upon the main line currents of different predetermined periodicities, these currents then to be separately selected, each by its own receiving circuit, to the exclusion of all other currents of different periodicities. It is maintained by Prof. Pupin that the larger part of the specifications clearly describe his invention, and are sufficient to support his contention for priority of invention.

German Electrical Industry.—There is no indication at present that the existing depression in the electrical industry in Germany has reached its lowest point, or that the prospects of improvement are any brighter than they were 12 months ago. That the industry in that country is in a bad way it is impossible to deny, and this is admitted in a report just issued by the Bank for Electrical Enterprises at Zürich, which represents the views of the Allgemeine Elektricitäts-Gesellschaft, of Berlin, as well as other well-known electrical concerns in Germany. In the report referred to the present state of affairs is attributed primarily to the general depression of trade in Europe, but another contributing factor is to be found in the exhaustion of all the more paying branches of electrical installation business. Various observations in the report lead to the belief that all the more profitable work in Germany has been undertaken; hence the avidity with which the German firms come forward from time to time with tenders for electrical plant abroad at prices far below those it is possible for other countries to compete with. The report further charges the uncertainty which has been created throughout the commercial world by the present long-drawn-out debates on the new customs tariff, with having much to do with the present bad state of the electrical industry in Germany. The remedy suggested for securing an improvement in the trade is by the formation of a trust, or "protective union" of the various electrical concerns and allied undertakings. It is understood that negotiations to this end have already been commenced, and we may expect to hear soon that some concerted action on the part of the electrical firms in Germany has been determined upon as the only probable solution of the problem.

Hardening Armour Plates by Electricity.—Lieut. Cleland Davis, of the U.S. navy, has been successful in producing a new process of super-carbonisation or "face-hardening" of armour plate. Both in effectiveness and in cost of manufacture it is claimed to be a great advance on the Krupp system. We gather from a description of the process in the *Scientific American* that it includes the substitution of electrical currents for the heat of the gas-fired furnace, and the direction of these currents against the face of the armour plate while it is in a heated condition by means of large carbon anodes. These anodes in form are said to be not unlike the carbons used in arc lamps, but, of course, they are of vastly greater size. In his experiments Lieutenant Davis found that if a current of electricity were sent from a carbon into the surface of

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a plate, it carried with it a certain amount of the carbon and implanted it within the body of the metal. The depth of the hardening is determined by the period of time during which the current is applied, and it is claimed that not only is the surface thus treated harder than that treated by the Krupp process, but the depth to which the hardening is carried is increased. Further, while the Krupp plate is kept in the soaking pits at a red heat for from 15 to 20 days, the same amount of impregnation with carbon is obtained with the Davis process in five hours. An experimental plate was subjected to the process, but the result was not at first altogether satisfactory, the hardness of the face not being uniform. In the subsequent experiments carbon rollers are to be substituted for the present anodes, and with these it is hoped to secure a uniform depth and hardness of carbonising. One claim which Lieutenant Davies makes for his system is that, as compared with a Krupp plate of equal resistance, it will produce plates from 20 to 30 per cent. lighter in weight.

Instruction in Electricity.—The current number of the *London Technical Education Gazette* contains the report by the examiners upon the examination for intermediate county scholarships, and among these is one by Mr. Chas V. Drysdale on electricity and magnetism. His remarks on the result of the examination are not very encouraging, but they show the great need there is for improvement in the machinery available in the county of London for giving adequate instruction in this subject. The number of candidates for the examination in electricity and magnetism was 41, and many of them, says the report, showed a considerable aptitude for the subject. It proceeds: "There is, however, a strong indication throughout the answers that the instruction has suffered from want of equipment in modern and practical instruments; and that in some instances the teaching has been entirely founded on elementary text-books. As an example, few students had apparently ever seen an ammeter, and not one was able to give an intelligible sketch or description of one. Most of them were under the decided impression that currents were always practically measured by a tangent galvanometer, copper voltameter, or calorimeter. Not one student, again, could give a fair idea of the conditions necessary to strongly magnetise a horseshoe magnet, and the descriptions and sketches of an induction coil were poor. In describing an influence machine a number of candidates, evidently from the same school, all described the same machine with exactly the same sketches, the same reference letters, and nearly all with the same mistakes; and in question 2 the correction for the earth's field was made irrespective of the relative directions of the fields. The teaching as a whole suffers from being far too abstract, and every effort should be made to make the students as familiar with the use and measurements of electrical as well as other physical quantities."

Electric Omnibuses.—There have been many persistent rumours circulated lately to the effect that London is very soon to have a service of electric omnibuses, but no definite news has up to now been published concerning the subject. We, however, are in a position to state that there is a certain amount of foundation in the rumours. For some time the directors of the London General Omnibus Company have had under consideration the question of supplanting the present horse 'bus by electrically-driven vehicles in the Metropolis, and they decided some months ago to try the experiment. Designs were prepared and tenders got in, but many of them were found to be for vehicles which did not meet the requirements of the congested thoroughfares of our streets, although in other respects no fault was to be found with them. In June last, however, the company entered into a contract with Mr. Fischer, of New Jersey, to build them an experimental omnibus to be driven by electricity. We understand that this vehicle is now nearly completed, and will be delivered in London within the next few weeks. It will mark an entirely new departure in the electrically-driven vehicle for road traffic in that the electricity will be generated on the 'bus itself, the generating plant consisting of a dynamo driven by a small petrol engine. While, no doubt, this will add considerably to the dead-weight of the 'bus, the obvious advantage of the arrangement is that accumulators will be entirely dispensed with, and the vehicle will not be tied down in the length of its run by the amount of electric storage The 'bus is constructed to accommodate 30 passengers inside and outside, the seating arrangements being very similar to those now in vogue in the horse-drawn vehicle. Its length is about 19ft, and it weighs when empty of passengers a little over five tons. The company, we are authorised to state, intend to place the electric omnibus on the road as soon as it is received from the makers. It must, however, for the time being be regarded purely as an experiment, and whether the company ultimately decide to replace the whole or part of their horse-drawn vehicles by electric 'buses will depend entirely upon the performance of this one. It may be of interest to state that the company have at present an electric 'bus in London, but this will not be put in service, as it has been found not to meet the requirements of metropolitan traffic.

Electric Haulage.—For any country possessing an extensive canal system the subject of electric haulage is one of great importance, but in England, where we have many valuable waterways, practically nothing has as yet been done in this direction. There is, however, a proposal now before Parliament to build a canal in Kent to connect the River Medway with the Thames at Gravesend, and to employ electric haulage, but so far progress in this country is practically confined to this one scheme. In Belgium things are different. For some two years now there has been in operation on a canal between Brussels and Charleroi, 50 miles in length, a system of electric haulage which is said to have given most encouraging results. Barges are towed up and down the canal by what are known as tractors. These run at the sides of the canal, and are driven by electricity. Three-phase currents at 6,000 volts are generated. The line has two circuits of bare conductors; three primary wires for 6,000 volts, and three secondary wires for 600 volts; every three miles there is a 36-kw. transformer. By means of a triple trolley the current is supplied to the 5-h.p. six-pole three-phase motors on the tractors. Each tractor runs only over its own section of ground; it can draw five boats, each laden with 70 tons, at a speed of a little over 2½ miles an hour. For passing through the towns where the river banks are occupied by business premises, or in going through crowded locks, electric tugs or launches are brought into service temporarily. Although the tractors are capable of hauling four or five boats laden with merchandise, the Belgian Government does not allow this; hence the boats are hauled singly. The actual cost of the electric haulage is said to come out, per boat mile, at a very much lower figure than animal haulage. The company working the installation also supplies electricity for lighting and power purposes in the locality of the canal, which brings in an auxiliary yearly revenue of about £3,300 The receipts of haulage last year amounted to £5,460, bringing the total yearly income up to £8,760. The company's central generating station, from which power is at present obtained, is at Roux. Another generating plant, however, has recently been erected at Oisquercq, which is

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the first station in Belgium where polyphase alternators, driven by steam-engines, have been put in parallel. The company holds no fewer than 37 communal concessions, opening the way to further canal work, as well as considerable incidental supply for light and power.

Tube Railways.—Very timely indeed is the article which appears in the current number of the *Lancet* on the subject of tube railways. As becomes its province, our contemporary discusses the matter as a departure in social life which must have many more or less medical bearings, and it has not attempted to deal with the engineering features of the various schemes in contemplation for London. As a matter of first consideration, however, it is concluded that these deep tube lines are more desirable for London within a radius of six miles from Charing Cross, than shallow subways such as are proposed by the London County Council under the new street from the Strand to Holborn, on account of the difficulties attendant upon the construction of the latter. The article then goes on to give the details of all the schemes for tube railways that have successfully passed the first stage and will come before the House of Commons in due course for approval or rejection. It may be convenient here to give the names of these. They are the Brompton and Piccadilly-circus Railway, the Great Northern and Strand Railway, the Charing Cross, Euston, and Hampstead Railway, and the Baker-street and Waterloo Railway, forming the group controlled by the Underground Electric Railway Company of London; the Hammersmith to Charing Cross and City Railway, the North-East London Railway, the City and North-East Suburban Railway, and the Marble Arch to Wandsworth Railway, forming the London United or White-Morgan group; and, lastly, there are the independent lines—viz., the Central London Railway Extensions; the North-West London Railway, the Great Northern and City Railway, the City and Brixton Railway, and the London County Council subway for electric tramways. Such are the main schemes in course of completion, and the *Lancet* thinks the result should be a relief of the congested street and suburban railway traffic, and help to the solution of the housing problem and a consequent reduction of the existing danger to health from overcrowding. The manner in which our contemporary takes up the question of ventilation shows that it does not agree with the present method of ventilating the tunnels by the passage of the trains. In the case of the Central London Railway the hopes of the engineers in this direction have not been realised, and efforts are being made on that railway to accomplish the object by a process of exhaustion. This, considering the numbers carried, must be quite inadequate to the requirements. At present it is very noticeable how large a proportion of the passengers are affected by the influence of an excessive quantity of carbonic acid gas associated with other human exhalations. What might result from a prolonged exposure in the event of a serious accident our contemporary refrains from contemplating. There have been one or two fatal cases, in which people have fallen upon the line from some cause not very clearly defined. It is understood that the Great Northern and the City Railways will have a continuous current of fresh air admitted at some point between each station. This in conjunction with the large size of tube—*i.e.*, 16ft. in diameter—should give very good results. The article also deals with the subject of vibration, and records the measures which are being taken to avoid this effect. The opinion, however, is expressed that the sinking of the tubes to a greater depth, while minimising the intensity of any movement, will probably extend the area over which it may be felt. The final conclusion is expressed, however, that the vast network of tube railways soon to be crossing and recrossing each other in the clay below London, will not subject the public health to the strain that has been suggested.

British Association.—As we promised in a previous issue, we are publishing particulars of the forthcoming meeting of the British Association at Belfast as they come to hand week by week. We have already given a *résumé* of the general arrangements, and we are now in possession of a full summary of the arrangements made by each section of the meeting, from which we have selected the information which will be of most interest to the profession. In Section A, in addition to the papers noted in our last issue, Mr. J. E. Petavel, in conjunction with Captain Bruce-Kingsmill, will give a paper on the question of a high-pressure gauge for artillery, and Prof. Trouton will describe his experiments on the magnetic field due to the motion of a charged condenser. In the Chemistry Section (B) there is one paper of particular interest to accumulator makers by Dr. F. Clowes on "The Action of Distilled Water on Lead." The arrangements for Section E (Geography) include a paper of considerable interest by Mr. R. B. Buckley on colonisation and irrigation in British East Africa. A paper is also expected on the survey of Scottish lakes, which is being carried out under Sir John Murray, and several papers in this section will deal with some of the aspects of the geography of Ireland. Prof. Johnson, of Dublin, will discuss the subject of peat, and Mr. Porter has a paper on the Cork valleys. Coming to Section F, embracing the subjects of economic science and statistics, there are several papers which should prove especially interesting. First of all there is Mr. Benjamin Allen's paper on the effect of the adoption of free trade in Ireland, followed by one by the Right Hon. Horace Plunkett dealing with technical instruction and industrial development. Factory legislation will form the subject of a report by a committee and the subject is also dealt with in two papers by Miss Hutchings and Miss Harrison respectively. "Municipal Trading" is the title of a paper by the Hon. R. Porter, while Dr. W. R. Scott has one on the "Position of Economics and the Applied Sciences in the University Training of Men." The subject of "Industrial Superannuation" will be dealt with by Dr. Alexander, and this, together with others, will give labour questions a considerable share of attention. Prof. Graham's paper on "Trusts" should also prove a very interesting one at the present time. Among the papers that have been promised for Section G (Engineering), of which Prof. John Perry is president, are the following: "The Combustion of Bituminous Coal," by Mr. W. H. Boots; "Water Power in Ireland," by Mr. F. J. Dick; "The Belfast Water Supply," by Mr. L. L. Macassey; "Exhibition of Electrical Apparatus," by Mr. M. B. Field; "Recent Progress in Large Gas-Engines," by Mr. H. A. Humphrey; "The Importance of Minor Details in Engineering Work," by Mr. L. Holroyd Smith; and "Direct Reducing Levelling Staff," by Mr. G. W. Herdman. Papers have also been promised by Mr. P. McMahon and Mr. F. Holden, and Mr. J. E. Kingsbury will give one on "Some Aspects of Telephony." Reports will also be submitted by the Road Traction Committee and the Screw Gauge Committee. Particulars of Section L, embracing educational science, etc., were given in our last issue. The Friday evening discourse is to be delivered by Prof. J. J. Thomson, F.R.S., on "Becquerel Rays and Radio-Activity." From the above it will be seen that the Belfast meeting is likely to prove as successful as any of its predecessors, and from the point of view of the subjects dealt with by the authors of papers the proceedings should be of more than average interest.

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THE DUSSELDORF EXHIBITION.—II.

One of the most gratifying features of the Düsseldorf Exhibition is the very extensive application which electricity finds in every department for power purposes. The unlimited scope of electric power for driving machinery of all kinds could scarcely be better exemplified than in the machinery hall (Fig. 1), where, among other exhibits, there is a splendid display of heavy machine tools. The exhibit of Messrs. Breuer, Schumacher, and Co., Kalk, near Cologne, is prominent in this section. Included in their display they have two machines which are specially worthy of notice. One of them is the electric-hydraulic girder cutter (Fig. 2). This machine consists of the girder cutter proper and a force pump driven by a 10-h.p. electric motor. The cutter has two strong cast-steel legs, which act as supports to the cast-steel pressure cylinder by embracing it as shown. The piston, which is rendered watertight by means of cup leather packing, works in this cylinder. At its lower extremity the piston carries the holder for the moving upper cutter. This holder is arranged to one side of the legs, and in combination with a guide placed immediately above the girder to be cut takes the side thrust on the cutter, which is liable to occur in cutting material of ununiform hardness. The lower guide serves also to prevent a deflection of the upper cutter either way. The fixed lower cutter, together with the side cutters—which latter are adjusted by means of a screw spindle and connecting wheel gear—are arranged centrally between the two halves of the legs. Care is taken to ensure the removal of scrap metal. All the cutters are easily removed and replaced.

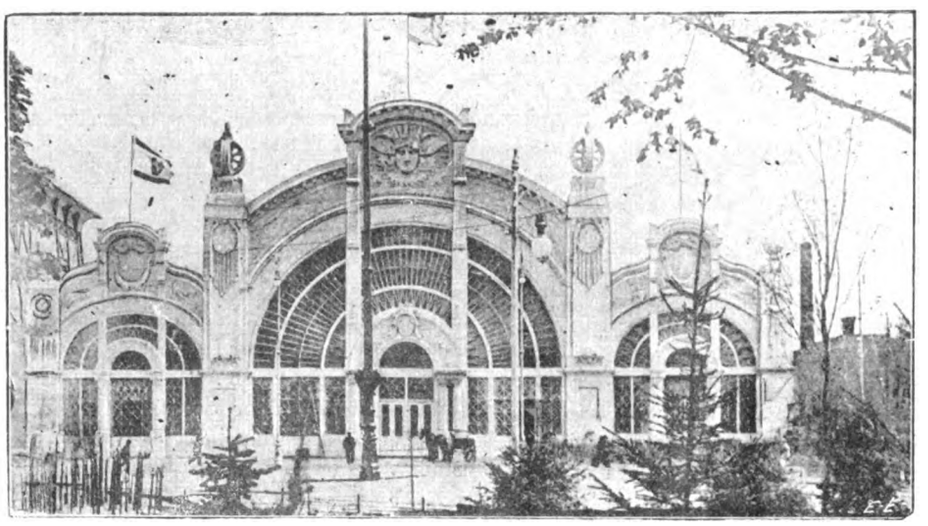

FIG. 1.—Machinery Hall, Dusseldorf Exhibition.

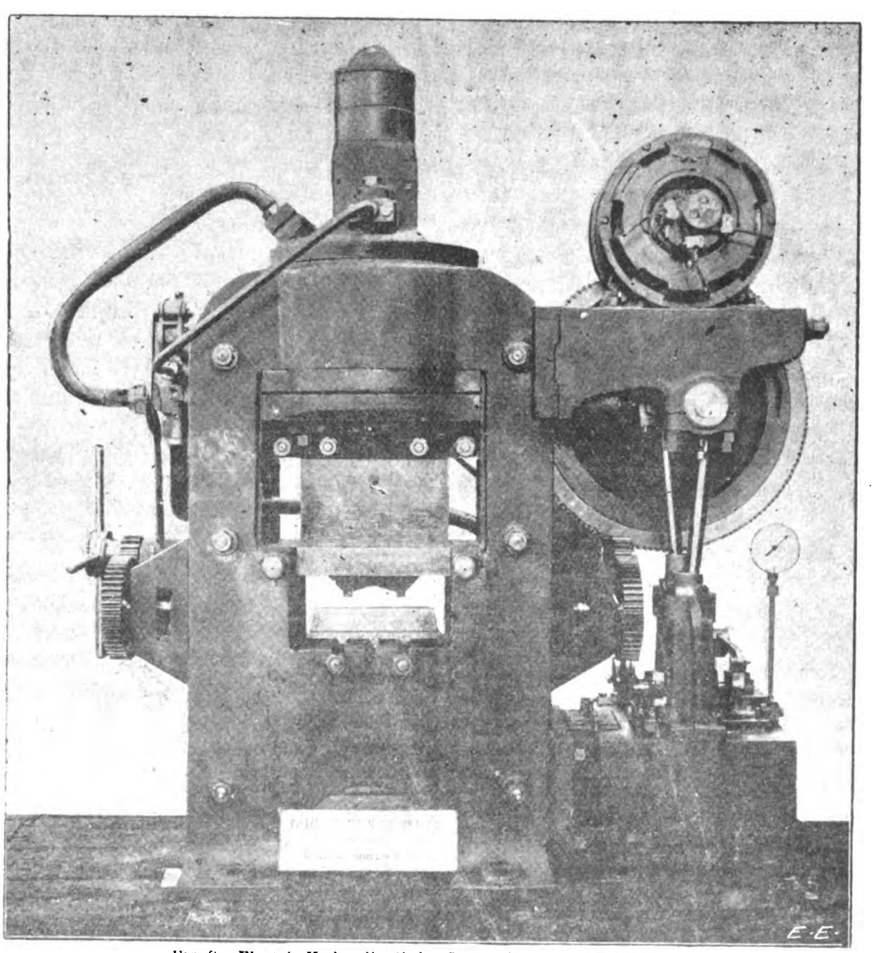

FIG. 2.—Electric-Hydraulic Girder Cutter, Dusseldorf Exhibition.

The return of the moving cutter after each cut is effected by a small back-stroke cylinder fixed above the pressure

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cylinder. The water supply to these two cylinders is regulated by a controller attached to the side of the cutter and worked by hand. The force pump is provided with two pistons.

The two cranks driving the pistons are so arranged that their dead centres do not coincide, there being consequently less chance of their stopping the motor. If the girder to be cut offer more than a certain resistance to the cutting effort of the machine, one of the pistons is automatically cut out, and the second continues to work alone at correspondingly higher pressure.

The second machine referred to is a large slotting mill and key sinker (Fig. 3). This machine has a stroke of 5ft., and is likewise driven by an electric motor. The special feature of the machine is the vertical tool guide, which is movable and adjustable. By means of this provision for adjustment it is ensured that the tool is always properly guided, even in extreme positions, whereby the possibility of a deflection of the tool as it reaches the work is minimised. The bed-plate is efficiently anchored to the foundation, and carries the tool guide and tool. The back stroke of the tool is accomplished in half the time occupied by the cutting stroke. The tool is counterweighted. Both of the cams by means of which the motion of the tool is reversed are attached to a disc at a convenient height, and the stroke of the tool may be quickly interrupted by means of an arrangement attached to the switch panel. The vertical adjustment of the tool guide is effected by hand, and in the highest position of the guide castings up to 6ft. 10in. in height above the surface of the table can be machined. The round-faced table, which is provided with T-shaped grooves for the holding-down bolts, has a diameter of 6ft. 7in., and has a travel both longitudinally and transversely of 5ft. The machine is driven by an electric motor arranged as shown. The motion of the motor is transmitted by means of spur wheels, open and crossed belts, and coned pulleys to the worm spindle. To enable the motor to be run up to its full speed at starting and for emergency stopping, a friction clutch is provided on the motor shaft, which is also arranged to serve as a quick-acting brake, enabling the machine to be stopped independently of the motor. The driving shaft is of Siemens-Martin steel, and runs in bronze bearings, the upper one being constructed as a foot-step bearing to take the axial thrust.

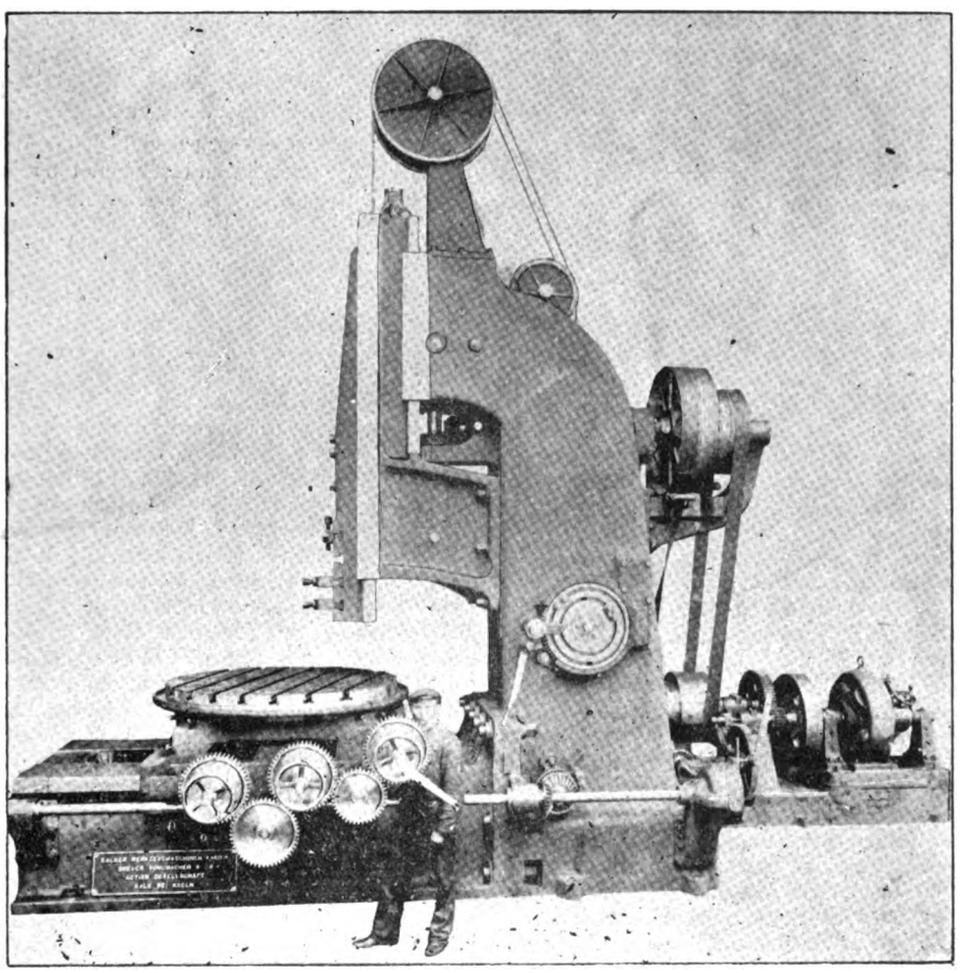

FIG. 3.- Slotting Mill and Key Sinker, Dusseldorf Exhibition.

THE EVOLUTION OF ELECTRICAL TELEGRAPHY.

BY PERRY F. NURSEY.

If there is one science more than another the practical development of which impressed with an indelible seal the nineteenth century, it is the science of that mysterious, invisible, and intangible power known as electricity. And if there is one art more than another which, in the words of the charter of the Institution of Civil Engineers, may be considered as that of "directing the great sources of power in nature for the use and convenience of man," it is the art which has succeeded, during that century, in subduing and controlling that most subtle and intractable agent, in rendering it amenable to fixed laws, and in harnessing it for the use of mankind in every conceivable direction. The earliest purpose it was made to subserve in practice was that of inter-communication of thought irrespective of distance, or, in other words, electrical telegraphy. The second general phase of its development was its practical adoption as an illuminant, whilst the third was the transformation of its resistless energy into a docile motive power. It is with electrical telegraphy, which constitutes the first practical adaptation of that latest-born daughter of modern science—electricity—that we have now to deal. And who shall say that the principles involved in and underlying several of the most recent developments of science were not unknown to some who have lived in bygone ages? Unquestionably there were those, as will presently be seen, who appear to have been distinctly conversant with those principles, but who lacked the power of giving practical effect to their knowledge.

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It is the possession of this power—this civilising quality—and its legitimate utilisation, which have led to the remarkable scientific developments of modern times. The scant records of the past have, for the most part, only brought down to us the theories of the ancients in such a vague form as to cause them to be passed by as the vapourings of visionaries, or the fantastic day dreams of poets, unless perchance a train of thought should establish a connection between what may be regarded as the prophecy and its fulfilment.

This is especially true of electrical telegraphy. To the uninformed and the unreflective mind, the honoured names of Cooke and Wheatstone alone are associated with its invention, so prominent is their position in this connection, and so important the part they played. The truth is, electrical telegraphy stretches back a long way, and we have to gaze far into the past to catch a glimpse of its dawn. Dated from its primary vague and inchoate inception, its age really counts by centuries. At length, however, it has culminated in the magnificent telegraphic system which the whole world now possesses—overland and submarine—and which the dying century saw refined and etherealised by the banishment of all physical connection, and by the inaudible, indiscernible, and intangible projection of thought through space—we had almost said, through infinity—thanks to a Marconi, a Preece, and now to a Slaby—the three great apostles of wireless telegraphy.

Great as was the work effected by Cooke and Wheatstone, they only took up and, so far, perfected the work of others, their predecessors, whose labours led up to their successes. The electric telegraph of to-day had, properly speaking, no inventor; it grew up little by little, each inventor contributing his share towards its advancement. At least a score of names adorn the roll of fame in this respect. Commencing very nearly a century ago with those of Galvani and Volta, we encounter in our run down the stream of time the names of Sömmering, Schweigger, Cöxe, Romagnési, Oerstadt, Ampère, La Place, Fechner, Alexander, Sturgeon, von Cannstedt, Faraday, Morse, Gauss, Weber, and Steinheil, each of whom contributed successively a rung in the ladder which was ascended by Cooke and Wheatstone. These latter, however, were the first to establish a telegraph for practical purposes on a comparatively large scale, and thus their names came into prominence, whilst those of Oerstadt, von Cannstedt, Steinheil, and others remain comparatively unknown in this immediate connection.

In referring to Galvani and Volta, a retrospective glance of over 100 years has been taken to what appears to have been the first conception of the idea of an electric telegraph. The means of attaining this end may, however, have been struggling for birth in reflective minds for centuries for aught we know. In support of this we may here refer to Galileo, who more than two centuries and a half since appears to have been fully aware of the importance of employing magnets for transmitting intelligence to a distance, although he did not see his way to the practical accomplishment of his idea. In one of his dialogues, which he wrote in 1632, on the two great rival astronomical systems, he makes one of his myths, Sagredus, to say: "You remind me of one who offered to sell me a secret art, by which, through the attraction of a certain magnet needle, it would be possible to converse across a space of two or three thousand miles. I said to him that I would willingly become the purchaser, provided only that I might first make a trial of the art, and that it would be sufficient for the purpose if I were to place myself in one corner of the sofa and he in the other. He replied that in so short a distance the action would be scarcely discernible; so I dismissed the fellow, and said that it was not convenient for me just then to travel into Egypt or Muscovy for the purpose of trying the experiment, but that if he chose to go there himself I would remain in Venice and attend to the rest."* Whether the idea originated with Galileo, or with another who communicated it to him, is not certain. What seems perfectly clear, however, is that in this dialogue is embodied the first absolutely defined conception of the electric telegraph ever published.

It is not improbable that Shakspere may have been acquainted with Galileo's dialogue, inasmuch as he makes the mischievous Puck to exclaim, "I'll put a girdle round the earth in 40 minutes," when, in obedience to Oberon's behest, he started off to search for the "little western flower." He succeeded in finding the flower, and he may have succeeded in putting a girdle round the earth, and in 40 minutes, too; but if so, ungrateful history has failed to record the fact. Nevertheless, a girdle has since been put around the earth, and Shakspere's idealism has become transformed into a reality in the present day, the girdle having been completed by means of the submarine cable. The truth is that, in more instances than one, it can be shown that the idealism—the imagination of a bygone age—has become transformed into a reality in the present one. The dream of the poet and the inchoate, indefinite idea of the sage of antiquity have become materialised and produce the daily bread of the artisan. That which was once purely spiritualistic, and which formed one of the highest elements of fiction—communication and identity of thought without sense of distance—has become strangely realistic, and is inextricably interwoven with the web of ordinary everyday life. It is, however, one thing to have a vision, but quite another to invest the conception with practical existence. Great results are not achieved in a day, or, as Smiles appropriately puts it, "great inventions are not brought forth at a heat." They are begun by one, improved by another, and perfected by a whole host of successors.

True, the "secret art" of Sagredus and the wireless system of telegraphy of Marconi are extremes, and they stand very wide apart. But they are to-day the beginning and the ending, the alpha and the omega, of telegraphic science, and thus stated they bring out in bold relief the contour lines of progress. But they are the ending of that science as regards the present only. They are by no means final, for science never stands still. They are but the landmarks of our times, which, as Emerson puts it, are "trivial to the dull, tokens of noble and majestic agents to the wise; the receptacle in which the past leaves its history; the quarry out of which the genius of to-day is building up the future." And what may we not expect of the future as regards electrical development? Let us answer the question in the words used by Prof. Perry at the close of his presidential address to the Institution of Electrical Engineers. Lamenting the spirit of antagonism manifested in certain quarters with respect to terrestrial magnetism, the professor said: "Was Nature ever so open and yet so closed about a secret as she is about this one of terrestrial magnetism? Was there ever one whose revelation promised so much! How very little we know of electricity and magnetism? Does the mere motion of the earth, taking no account of electric charges at all, cause it to be magnetic? Almost anything is on the cards. . . . It is quite possible that our knowledge of this secret may enable us to tap a tremendous store of Nature's energy."

CABLE-LAYING IN DARTMOUTH.

This popular Devonshire seaside resort is to have electricity supplied by the Urban Electric Supply Company. The Council have arranged with this company for a 10 years' contract for street-lighting, which will involve the use of 140 incandescent lamps and 10 arc lamps. As the contract for the gas lighting falls through this month, every effort has been made to get the electric supply started. Thus we understand that Messrs. the Callender Cable and Construction Company have been putting their work through with a large staff working up till half-past seven or eight each evening. The two photographs reproduced herewith give a good representation of the work being done. The last of these photographs shows the decorated van which the Cable Company equipped for the recent Coronation trade procession. The van does credit to the staff of the company, and no doubt was highly appreciated by the people of Dartmouth.

All the cables for the electric lighting scheme in this

* "Galilei Systema Cosmicum," Dialogue I., Leyden edition, 1700.

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town are being supplied and laid by the Callender Cable and Construction Company, Limited, on the three-wire, solid system of distribution, and consist of single-conductor cables laid in wooden troughing filled solid with Trinidad bitumen, then covered over with a hard-burned pressed tile. The feeders are ·25, ·125, ·25 square inch sectional area, each a single-conductor, vulcanised-bitumen cable, and the distributors are ·05, ·03, ·05 square inch sectional area

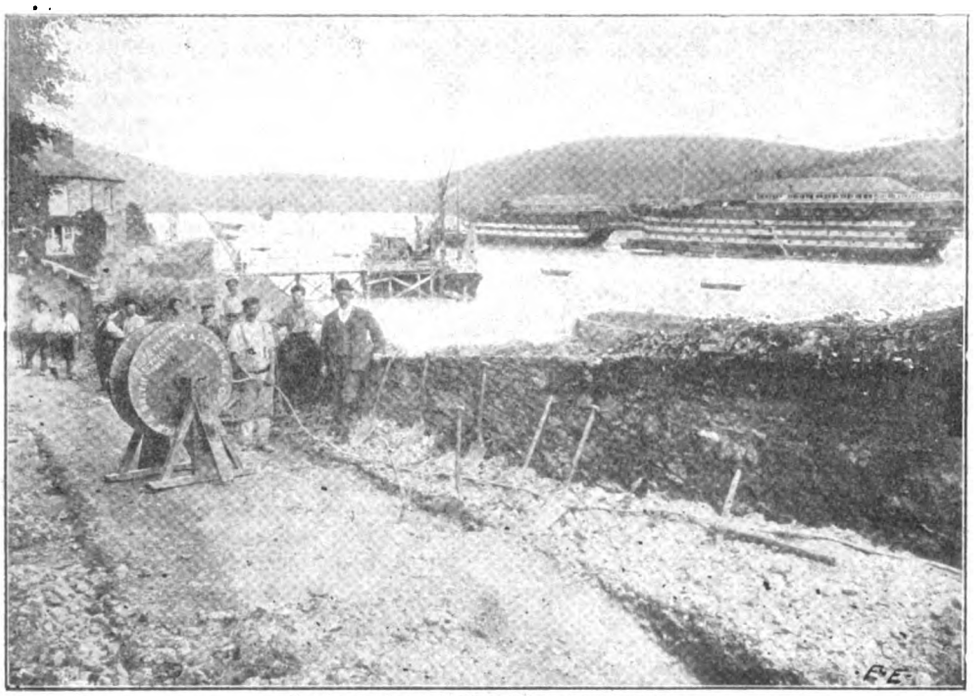

FIG. 1.—Laying Callender Cables at Dartmouth.

single-conductor, vulcanised-bitumen cables. At various points throughout the town link disconnecting boxes are erected in brick pits. In addition to the solid system, armoured cables having a sectional area of ·008, three-core,

FIG. 2.—Electric Trade Car as arranged for the Dartmouth Coronation Procession by the Staff of the Callender Cable and Construction Co.

are laid along side the distributors for street-lighting, and in streets where no solid system distributors are laid, armoured cables having a sectional area of ·012, four-core, for both private and public lighting. Up till now 1,300 yards of feeders, 3,000 yards of distributors, and 1,300 yards of armoured cables have been laid, but the contract when completed will need, at least, 18 miles in all.

STAITE AND PETRIE'S ELECTRIC LIGHT—1846-1853.

BY J. J. FAHIE, M.I.E.E.

'Tis not in mortals to command success ;
But we'll do more, Sempronius : we'll deserve it.

These articles have been drawn up mainly from two sources: (1) Two volumes of newspaper cuttings, etc., collected and arranged by Mr. William Edwards Staite, and now in the possession of his son, the Rev. G. H. Staite. These he has kindly and unreservedly placed at my disposal for the purposes of these articles, together with some interesting biographic notes and a copy of the only portrait of his father in existence—a silhouette taken about 1828. And (2) a mass of valuable materials in letters, documents, notes, and drawings which have been most obligingly furnished by Mr. William Petrie. He has also given me copies of two of his portraits for reproduction—one taken in 1844 and the other in 1894.

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Owing to exigencies of space, I have been able to use only a portion of the matter thus placed in my hands; but I hope I have given enough to enable the reader to form an opinion of the labours of two great pioneers in electric lighting—one long since dead, and the other, Mr. Petrie, still with us in his eighty-second year, unknown and unhonoured by the electrical profession.

In some prefatory remarks prefixed to the volumes of paper cuttings just mentioned, Mr. W. E. Staite tells us that as early as 1834, impressed with the conviction that light from electric agency was the purest known, he commenced a series of experiments, in the hope of turning it to useful purposes. "I found," he says, "my path beset with innumerable difficulties, and it was only after 12 years of patient labour that I succeeded in producing a light more or less continuous; but my first attempts were very imperfect, and consequently of little practical value." These, apparently, were embodied in a patent, No. 11,076, of Feb. 7, 1846, taken out in the joint names of W. Greener and W. E. Staite, of which the following is an abstract: The invention consists in effecting illumination (1) by means of solid prisms or cylinders of carbon, enclosed in airtight vessels of glass or other transparent substance, and rendered luminous by voltaic or magneto electricity, such carbon being previously freed from impurities and divided on the surface into numerous acute points; or (2) by means of rods or strips of platinum or other difficultly fusible metal, such metal being also divided on the surface into numerous acute points; or (3) by means of hollow cylinders of carbon, with surfaces either plain or acuminated, partially inserted within, and placed in contact with, hollow cones of platinum, either plain or acuminated; or (4) by a combination of all the said means, or of any of them, or of any parts thereof.

To obtain a carbon more nearly approaching purity than any hitherto known, a quantity of lampblack is taken, or plumbago, or blacklead, or powdered charcoal, or preferably powdered coke which has been electrically purified by the process for which Jabez Church, of Colchester, obtained letters patent on Dec. 20, 1845. The substance selected is first digested in dilute nitro-muriatic or other acid, then strained, and washed several times in water. It is next washed in some weak alkaline or carbonated alkaline solution, and finally washed in distilled water until no trace of impurity is perceptible. The carbon thus prepared is thoroughly dried, and then cut into prisms or cylinders (solid or hollow) as may be required. And sometimes, the better to secure perfect dryness and homogeneousness, these prisms or cylinders are exposed to an intense heat in a furnace for 24 hours. To give the carbons the numerous acute points they are cast in suitably indented discs, or the points may be formed by means of a fine saw. By opposing two such acuminated surfaces the advantage is secured that should the current cease between any two points it will be kept up by the others, and so the light will be maintained without any perceptible abatement. The electrodes in whatever way formed may either be kept stationary or made to rotate on their axes.

As the outcome of "12 years of patient labour," it must be confessed that this is a poor result, and is hardly such an advance on previous contrivances of others as to be worth the expense (heavy in those days) of a patent. As there are no drawings to illustrate the specification, it is not clear how the light was to be produced, whether as an incandescent (by contact of the electrodes), or as an arc (by disruptive discharge); but in either case it is easy to see that the acuminations would not last long.*

By the end of 1846 Staite had designed other lamps of more promise, having simple mechanical contrivances for adjusting the electrodes and compensating for the waste of the positive carbon. These improvements were secured by patent No. 11,449, Nov. 12, 1846.

Fig. 1 shows one arrangement of the lamp. A is a sole-plate of glass, and B a glass cover. W^1 is one of the wires from the battery, terminating in a copper holder, C, into which is securely fixed a solid carbon cylinder, D. W^2 is the other wire from the battery to a hollow tube of copper, E, which carries a solid carbon cylinder, F, with conical top. G G are triangular pieces of platinum, attached to the free ends of vertical springs, and so placed as to abut against, and serve as guides to, the carbon rod. H is a rack and pinion connected with a clockwork (not shown in the drawing), by which any degree of velocity of movement can be given to the rack and, consequently, to the electrode. The rate to which the clockwork is adjusted will depend on the power of the battery and the quality of the carbons.

WILLIAM PETRIE, REPRODUCED FROM A DAGUERREOTYPE OF JANUARY, 1844

WILLIAM EDWARDS STAITE, REPRODUCED FROM A SILHOUETTE OF CIRCA, 1828.

WILLIAM PETRIE, FROM A RECENT PHOTOGRAPH BY LAVENDER, OF BROMLEY.

In practice one can see a fatal objection to a lamp of this construction. The rate of motion of the clockwork is fixed, and if it corresponds with the rate of wear of the carbon, well and good; but the latter would most likely be variable owing to inequalities in the battery power, flaws or impurities in the carbons, etc., so that from time to time hand regulation of the electrodes or of the clockwork would have to be resorted to.

Fig. 2 shows another arrangement, in which the electrodes are placed in lateral instead of perpendicular opposition, and the clockwork is dispensed with. C and E are copper tubes which are respectively connected to the battery wires, W^1 W^2, and F^1 F^2 are carbon rods of similar form. Each tube has a coiled spring, T, which exerts a continuous pressure on the carbon beneath. P is a cylinder of compressed pipeclay, phosphate of lime, or other like non-conducting and heat-resisting substance, against which the ends of the electrodes impinge. As this cylinder counteracts the pressure of the springs, the electrodes can

* Lamps of this multiple-points type were again tried by Slater and Watson in 1852, and by Binks in 1853, but with no practicable results.

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be protruded only in the same proportions as they happen to be consumed. The arm, W¹, passes through a slot in the sole-plate of such length as to allow of a lateral movement of the carbon point to or from the other according to the strength of the battery power.*

The specification figures and describes modified arrangements of Figs. 1 and 2, which need not detain us, as they are little more than inversions of the electrodes. Neither need we stay to describe yet another modification (Fig. 5 in the patent), in which a platinum ring, as one of the electrodes, closely encircles a hollow cylinder of carbon, as the other electrode, the progressive movement of which is effected by a spring instead of by clockwork.

The second part of the patent has reference to the employment of the electric light for purposes where it is necessary that the light should be intermitted more or less frequently, as, for example, where flashes with various intervals between them are required as signals for the conveyance of intelligence. The third part deals with the preparation of the carbons by a process which is claimed to be an improvement on that described in the first patent.

A lamp constructed as in Fig 1 was shown during the summer of 1847 to numerous visitors, "scientific and otherwise," at Staite's laboratory in Clerkenwell, London,

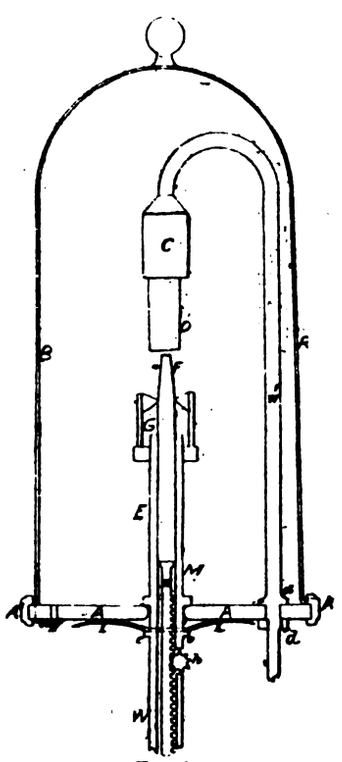

FIG. 1.

and at the request of Prof. George Bachhoffner a special exhibition was arranged for the directors of the Royal Polytechnic Institution. These displays were more or less of a private nature, and it was not until some months later that an opportunity offered of exhibiting the lamps in public. This was done for the first time at the Athenæum, Sunderland, on the evening of Oct. 25, 1847, before the members of the Sunderland Literary and Philosophical Society, when, by special request, the inventor delivered a lecture on electric illumination, "illustrating the subject by numerous experiments, many of which were new to the lecture-room."

Amongst the Staite papers there is preserved what is probably the rough draft of this lecture in Staite's handwriting. It is undated, but bears internal evidence of having been written about this time. As a first attempt it is an interesting and creditable performance—indeed, with a very little alteration it might serve as a popular exposition of the principles of electric lighting at the present day. After referring to the powers of steam, he says: "Much as steam has accomplished for the civilisation of mankind, electricity is probably destined to do more. With even our present limited knowledge, the inventive genius of man has succeeded in applying it to a vast number of useful purposes." Then he instances briefly its application to electrometallurgy, plating and engraving, electric blasting, electric clocks, and the then crowning triumph—the electric telegraph. "And who shall say," he continues, "that in the coming age electricity will not be the universal motive power—the great propeller? Who shall presume to limit its useful application to agriculture, commerce, and the arts of life? when its all-pervading essence is better understood, and its tremendous powers are brought more fully under the control of the human will."

At this time Staite appears to have used for the production of the light 40 cells of Callan's cast-iron and zinc arrangement, modified so as to render its action more constant. "I have," he says, "so arranged both the supply of the exciting fluid, and the removal by percolation of the sulphate as quickly as formed, that a constant battery which may be worked for months together is now available." He hints at other contrivances for still further increasing the power and constancy of the Callan cell, which we will meet with later on in his fourth patent.

In the part of his lecture descriptive of the lamp which he exhibited Staite has some passages which find no application in his patents, and which evidently refer to some

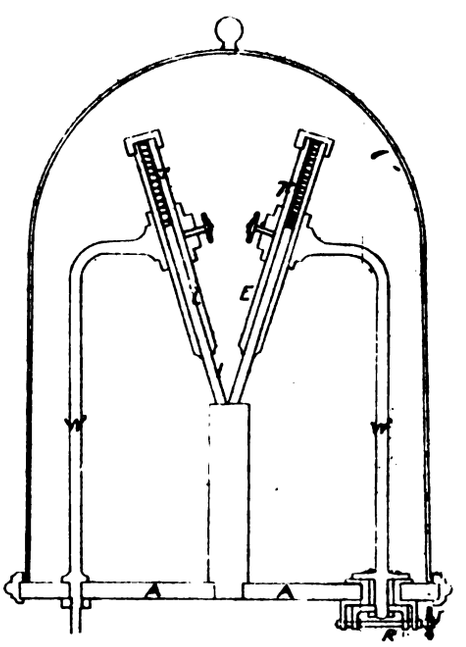

FIG. 2.

transition ideas between the continuous motion of clockwork, as in Fig. 1, and the electromagnetic regulator to be presently described. "To the lamp," he says, "is attached clockwork of very simple construction, either worked by a spring or, in the case of suspended lamps, by a weight. This clockwork is set going or is stopped by means of a detent or lever escapement, which is influenced solely by the elongation or shortening of a wire, according to the greater or lesser degree of heat evolved in it by the current in its passage through the electrodes. When the distance between the electrodes exceeds that which is the regulated and proper distance, increased heat results, the copper wire elongates, the detent is raised, the clockwork is set in motion, and the electrodes are brought nearer together. The temperature then lowers, the wire contracts, the detent drops and stops the clockwork until, by the gradual consumption of the carbon, its agency is again brought into requisition."*

"Another method," he says, "is by interposing in the circuit a galvanometer having a magnet properly weighted in relation to the current passing. When the current from

* The practical reader will see in this the first of a series of similar contrivances. Pearce (1849), Werdermann (1874), Rapieff (1877), and others all brought out lamps on the same principle, all of which would be quite practicable if a "non-conducting and heat-resisting substance" could be found.

* This pyrometric principle was applied in Allman's lamp of 1848, and 30 years later by Siemens and Edison in their lamps and current regulators.

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the too great separation of the electrodes or their too near approach undergoes a diminution or an increase, the magnetic equilibrium is affected, the detent is either released or stopped (*sic*), as the case may be, and the machinery is affected accordingly."

The next passage is curious, and seems to refer to some form of semi-incandescent lamp, of which Werdermann's is a modern example: "For lights of small power, such as I would propose to use in collieries, I dispense with the pyrometric lever or electrometric balance altogether, and bring the two electrodes into absolute but delicate contact. This contact I maintain either by a spring or by the weight

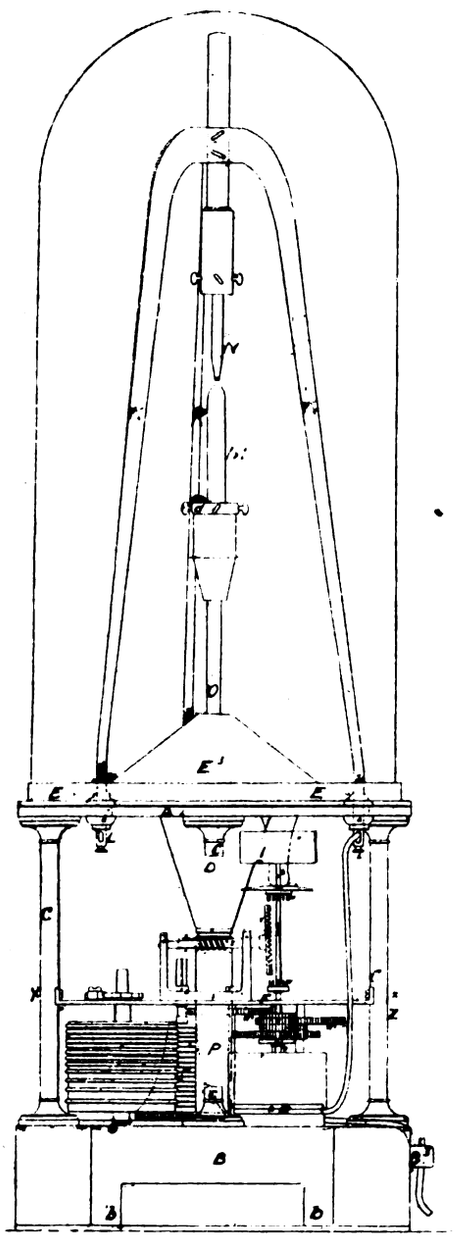

FIG. 3.

of the electrode itself. By keeping one of the electrodes, either the point or the disc, slowly rotating, fusion is prevented."

On the evening following this lecture—Oct. 26, 1847—on the occasion of the annual ball of the Sunderland Literary and Philosophical Society, the large room of the Athenæum was lit up by the electric lamp. "The scene,' saye Mr. Staite, "was most brilliant, and the excitement of the groups of dancers in this artificial sunshine, the rich colours of the ladies' dresses, and the evident delight of all present were cheering indications of still greater successes when the invention should become more matured."

Soon after this Staite had another exhibition of his lamp at Newcastle, where, according to a local paper, "the peculiar dazzling and brilliant appearance produced by an apparatus of modest exterior excited the surprise and admiration of the assemblage."

Staite's next patent—No. 11,783, sealed July 3, 1847, enrolled Jan. 3, 1848—marks a very important advance in the introduction of the automatic regulation of the carbons by electromagnetic agency—the first of a long line of similar contrivances extending down to the present day.

Although this patent stands in the name of Staite, Mr. William Petrie, then a well-known civil engineer and electrician, was really the author of its most distinctive feature—namely, the automatic regulator. The two men came together in October, 1847, and under circumstances which we will leave Mr. Petrie himself to explain in another part of these articles.

The specification drawn up by Mr. Petrie in November-December, 1847,* sets out with the declaration that the object of the invention is to impart more surely such motions to one of the electrodes that the light may be preserved from going out, be kept more uniform, and be renewed by the action of the apparatus itself whenever it has been put out. Fig 3 is an external elevation of the apparatus, and Fig. 4 a sectional elevation showing more clearly some of the regulating mechanism. M and N are cylinders of carbon, prepared as hereinafter described, and separated by an interval of from $\frac{1}{20}$in. to $\frac{1}{4}$in.,

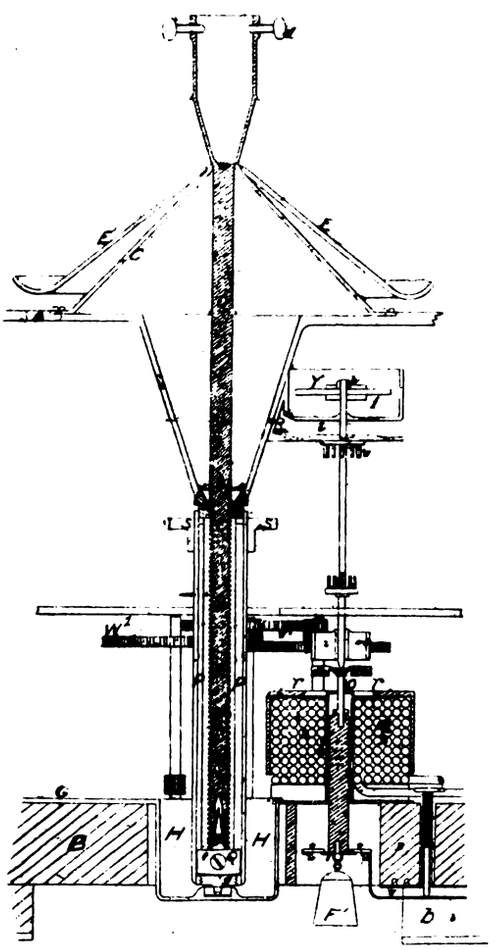

FIG. 4.

according to the power of the battery. The upper electrode is supported by the tripod, K, which is connected by wire with one end of regulator coil, R. The shaft, O, holds at its upper end the lower carbon, while its lower end is screw-cut (see Fig. 4), the threads allowing a rise of $\frac{1}{13}$in. for each turn. This part of the shaft passes through a hollow cylinder slotted internally as shown at *f f*, Fig. 4. A little cross-piece of metal, Q, is screwed on the end of the shaft and fits across the tube, P, working into the slots on each side so as to slide up and down in

* It will strike the reader as odd that improvements "patented" in July were not "specified," or even invented in their most distinctive feature, until several months later. But it must be remembered that the old patent law, instead of (as now) limiting the completed specification to the matters outlined in a preliminary document, allowed six months for "specifying and claiming," during which time, of course, any matter coming under the title of the patent could be included in the specification.

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them. When, therefore, the tube, P, is made to revolve it carries the shaft, O, round with it, so that the electrode, M, has a rotary motion combined with its vertical motion for the purpose of equalising the wear of the carbon. On the upper part of the tube, P, a worm-wheel, S, having 40 teeth, is attached, and is made to revolve by a horizontal double-threaded tangent screw, T, the pitch radius of which is $\frac{1}{10}$in. To one end of the screw is attached a crown wheel, U, of 40 teeth which is actuated by pinions, V and W, on an upright spindle, X. The pinions are at a greater distance apart than the diameter of the wheel, U, and gear into it from opposite sides, so that when the spindle is raised a little the lower pinion, V, having eight teeth, is geared into the lower side of the crown wheel and turns it in one direction, but when the spindle is sunk the upper pinion gears into the upper side of the crown wheel, which now revolves in the opposite direction. When the spindle is at a medium elevation—that is, in its normal position—neither pinion is in gear, and the crown wheel remains quiescent. The upper end of the spindle passes through a hole in the box, I, and terminates in a centrifugal regulator or governor, Y. Below this governor is a cross-piece, *i*, so that when the spindle is at its medium elevation the end of the cross-piece catches in it and prevents its revolution, but whenever it is raised or lowered the cross-piece passes over or under the stop and allows it (the spindle) to begin revolving just before one of the pinions gears into the crown wheel. The spindle is actuated by the toothed wheel, Z, which is driven by any ordinary clockwork.

The way in which the spindle is raised or lowered so as to drive in one direction or the other the crown wheel, according to the exigencies of the light, is as follows: "The bottom of the spindle is screwed into a solid cylinder of pure soft iron, *p*, which can move freely up and down in the centre of the electromagnet or solenoid, *q*. One end of the coil is led to the binding screw, B, which connects it with the positive pole of the battery, while the other passes to the binding screw, L, and thence through the electrodes to the other battery pole. Attached to the bottom of the iron bar is a counterpoise, F^1, adjusted to such a weight as to exactly counterbalance the lifting power of that current which flows through the coil when the electrodes are at the proper distance apart for most efficient lighting. So long, then, as this current (the normal current) remains steady, the bar will be just in equilibrium, or just ready to rise or fall. Now, should the current become greater than normal, as will be the case when the light is first started by bringing the carbons together, its lifting power will exceed the counterpoise; the bar will therefore ascend, and with it the spindle, which will cause the crown wheel to revolve, so as to draw down the electrode to the regulated distance. Should, on the other hand, the current diminish owing to the greater separation of the electrodes through waste of the carbon, the bar will be drawn down by the counterpoise, and with it the spindle, which will now cause the crown wheel to turn in the opposite direction and raise the electrode.

"The necessary current may be obtained from a galvanic battery of any of the known sorts, or from any other convenient source. A good degree of power to use is such as would be afforded by 100 cells in series."

A cone of white glass or porcelain, E^3, is made to slip over the cone, C, of the main plate, so as to reflect the light, and is turned up at the edge, as shown in Fig. 4, to catch any dust or ash that may be thrown off from the carbons. A glass shade, which may be ground partially or not as desired, fits over the electrodes and the stand, K, and is screwed down to the main plate, so that the electrodes are enclosed entirely from the outer air.

After describing a way of making the carbons, which differs little from that of Staite's patent of Nov. 12, 1846, already described, the specification goes on to say: "The carbon which is found in old gas retorts makes very good electrodes, but it frequently contains iron and other impurities, which cause it to split and break when heated. Besides, the quantity of light from such electrodes is small compared with that obtained from carbons of the improved description aforesaid. Electrodes made of gas carbon may, however, be much improved by gradually exposing them to the strongest white heat for some days in close vessels with charcoal."

The specification concludes with the description of a method of lighting and extinguishing, at a distance, inflammable oil lamps, which is now only interesting as yet another adaptation of the heated platinum wire *cum* spirit lamp, which was first proposed by Sir Humphrey Davy, and was a favourite experiment 50 years ago.

A patent for these improvements was simultaneously applied for in France, and soon after the celebrated physicist, Léon Foucault, began to make lamps in Paris on the same principle of automatic regulation. But his first lamp was a poor production, and, moreover, it was not made public until January, 1849. Doubtless he had been engaged upon it for some considerable time before this date, and his experiments may have been known to some of his friends, but such facts are inadequate to establish a claim to priority; yet apparently upon them the credit of the invention was claimed for Foucault and for France. Messrs. Staite and Petrie immediately took steps to dispute this claim, and the question was referred to a committee of the Academy of Sciences, of which Dumas, the great chemist, was president. We have not seen the report of the committee, but that it was entirely in favour of the English inventors may be gathered from the following extract from an article in *Le Courrier Français* of Feb. 4, 1849, which we find among Staite's paper cuttings: "Our learned colleague, M. Foucault, has already demonstrated in our scientific *feuilleton* the extraordinary brilliancy of the light produced of late years from currents of electricity by means of charcoal points in a vacuum. Nothing was wanting to make this light applicable to lighthouses and navy signals but to overcome the irregularity of the axis of the light and the perpetually varying distances of the charcoal points, continually operated upon and altered as they are by the electric current. This question having been again brought before the Society for the Encouragement of Science, we are informed that an English engineer named Staite (whose experiments on the subject were laid before the Academy of Sciences, and proved to be long anterior in date to those of M. Foucault in France) has accomplished this object in a way of which the *Journal* of the society has given the fullest details, with drawings of the lamp and of the mechanism by which the electric current is controlled. We are informed that Mr. Petrie (a learned coadjutor of Herschell) has assisted Mr. Staite, and is equally interested with him in the patent for the invention taken out in France."*

(To be continued.)

NOTES ON THE TESTING OF TRAMWAY MOTORS, AND AN INVESTIGATION INTO THEIR CHARACTERISTIC PROPERTIES.†

BY MICHAEL B. FIELD, MEMBER, A.M.I.C.E.

(Continued from page 226.)

It is to be noted that when the motors are being supplied with power from an external source, the tractive effort at the tread of the wheel represents a smaller turning moment than that exercised on the armature (by the mutual action of field and armature current) multiplied by the gear ratio, by an amount depending on the iron and gear losses. When, however, the motors are short-circuited and acting as brakes, the torque exerted by the rail on the car wheel must be greater than the retarding torque on the armature multiplied by the gear ratio, by approximately the same amount.

This means that a larger current can be put through the motors when supplying them with power, without skidding the wheels, than can circulate when the motors are themselves generating current to brake the car.

We may look at this matter in the following light:

Referring to Fig. 12, we have $\eta_1 + \eta_2 + \eta_3 = 1$;

also $V C$ = input into motor.

* See also du Moncel's "Exposition des Applications d'Electricité," Paris, 1878, vol. 4, p. 477.

† Paper read before the Glasgow Local Section of the Institution of Electrical Engineers.

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Hence $V C \eta_1$ = output;
$V C \eta_2$ = gear, friction, and iron loss;
$V C \eta_3 = C^2 R$ (R being resistance of motor).

If n = actual speed;
ν = theoretical speed—*i.e.*, if R were zero;
T = actual torque at tread of wheel, motor being supplied with a current C;
τ = theoretical torque—*i.e.*, if gear, iron, etc., loss were zero;

then the "speed efficiency" or $\frac{n}{\nu} = 1 - \eta_3$,

and lost speed or $(\nu - n) = \frac{\eta_3}{1 - \eta_3} \cdot n$

also the "torque efficiency," or $\frac{T}{\tau} = \frac{\eta_1}{\eta_1 + \eta_2}$

and lost torque or $\tau - T = \frac{\eta_2}{\eta_1} \cdot T$.

Hence

$$\frac{\text{Retarding force at tread when generating current, C}}{\text{Tractive effort at tread when receiving current, C, as motor}} = \frac{\eta_1 + 2\eta_2}{\eta_1}.$$

Taking this into consideration, the retarding force at the tread of the wheel has been shown also in Fig. 10 as a function of $\frac{n}{R}$. Now, we may take the adhesive force of a tramcar under different conditions as follows:

Greasy rail	8-10	per cent. of dead-weight.
Wet rail	15	,, ,,
Dry and clean	20	,, ,,
Gritty	25	,, ,,
Sanded	30	,, ,,

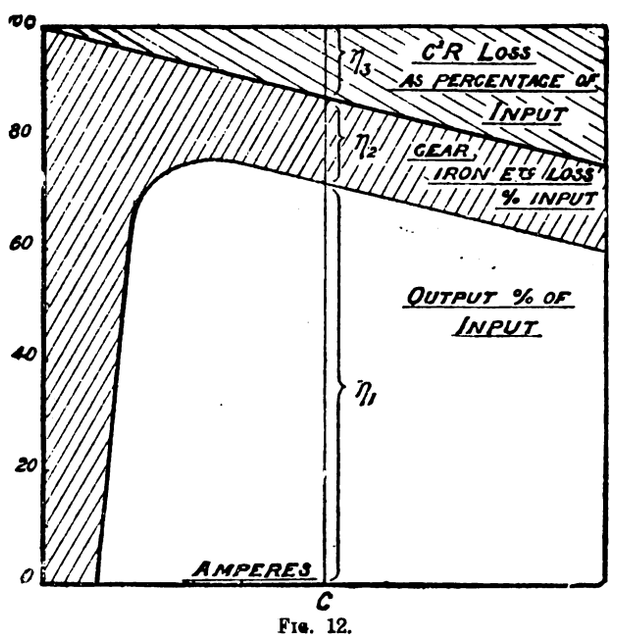

Fig. 12.

We will further take the resistance of each motor at ·96 ohm, and the external resistance on the different notches of the controller at 9·3, 7, 3·1, 1·1, and 0 ohms respectively—*i.e.*,

Notch 1.	Total resistance in circuit			= 9·78	ohms.
,, 2.	,,	,,	,,	= 7·48	,,
,, 3.	,,	,,	,,	= 3·58	,,
,, 4.	,,	,,	,,	= 1·58	,,
,, 5.	,,	,,	,,	= ·48	,,

Referring to Fig. 10, we see that with a 12-ton four-wheel car, provided with one motor on each axle, travelling 19·5 miles per hour, with the controller on the first notch the retarding effort per pair of wheels will be 2,000lb.—*i.e.*, the wheels will be on the point of slipping on a wet rail. Now let the retarding effort fall to 1,040lb., then $\frac{n}{R} = 1{\cdot}43$—*i.e.*, n = 14 miles per hour. Suppose the controller is then moved on to the second notch, retarding force = 1,800lb. The speed falls to, say, 8·5 miles per hour before proceeding to the third notch, and so on, thus:

					speed from		
Notch 1.	Retarding	force	falls from	2,000	to 1,040;	19·5	to 14·0
,, 2.	,,	,,		1,800	,, 650;	14·0	,, 8·5
,, 3.	,,	,,		2,760	,, 500;	8·5	,, 3·75
,, 4.	,,	,,		2,800	,, 800;	3·75	,, 2·0

Hand-brake applied.

On a good gritty rail there would probably be no slipping of the wheels, but on a wet rail there would probably be slipping for a moment when first coming on to the third and fourth notches.

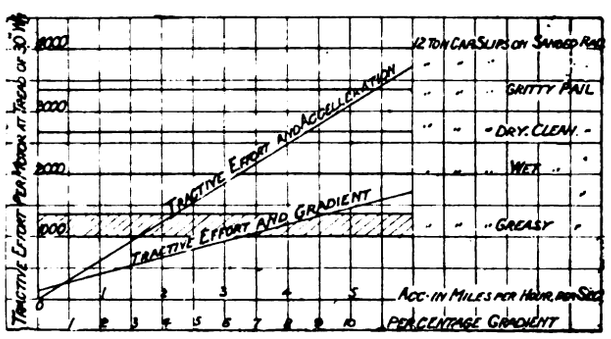

Fig. 13.

[*Note* 3.—If a sufficiently small time interval be taken during which one may assume that the tractive effort or retarding effort, as the case may be, decreases uniformly, the total change of velocity during that time interval is exactly equal to the mean acceleration multiplied by the time, but the distance traversed is *not* equal to one-half the mean acceleration multiplied by the square of the time, but to one-third of the maximum plus one-sixth of the minimum acceleration, multiplied by the square of the time. In other words, if

a represents acceleration;
a_0 a_1 represent the initial and final values of a taken over the time interval t_1;
k = rate of change of acceleration;
t = time in seconds;
t_1 = length of time interval;
v = velocity;
v_0 v_1 = initial and final velocities taken over time interval t_1;
s = distance traversed;
S = total distance traversed in t_1;

we have the following relations:

$$a = a_0 - k\,t$$
$$a_1 = a_0 - k\,t_1.$$

Hence $v = v_0 + a_0\,t - \frac{k\,t^2}{2}$,

and $v_1 = v_0 + a_0\,t_1 - \frac{k\,t_1^2}{2} = v_0 + \frac{a_0 + a_1}{2}\,t_1$,

or, $v_1 - v_0 = \frac{a_0 + a_1}{2}\,t$.

Further, $s = v_0\,t + \frac{a_0\,t^2}{2} - \frac{k\,t^3}{6}$.

$$\therefore S = v_0 t_1 + \left(\frac{a_0}{3} + \frac{a_1}{6}\right) t_1^2.$$

If $a_0 - a_1$ be a sufficiently small quantity in comparison with a_1, or if $\frac{a_0\,t}{2}$ is small compared with v_0, we may write $\frac{a_0 + a_1}{4}$ for $\frac{a_0}{3} + \frac{a_1}{6}$—*i.e.*, we may calculate the distance traversed from the mean acceleration.

It would be incorrect, however, to assume that the retarding force decreases uniformly throughout large ranges. The subsequent diagrams show that this is not the case.

It will be at once recognised that the curves shown in Fig. 10 are most useful in helping us to estimate the heating effect on the motors and resistance, due to coasting down long grades with the rheostatic brake on, and are further applicable in all cases where this type of brake is employed, such as for cranes, lifts, hoists, mining machinery, etc.

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For studying the probable current required along a given route it is convenient to have the tractive effort necessary for propelling a given weight of car up different gradients,

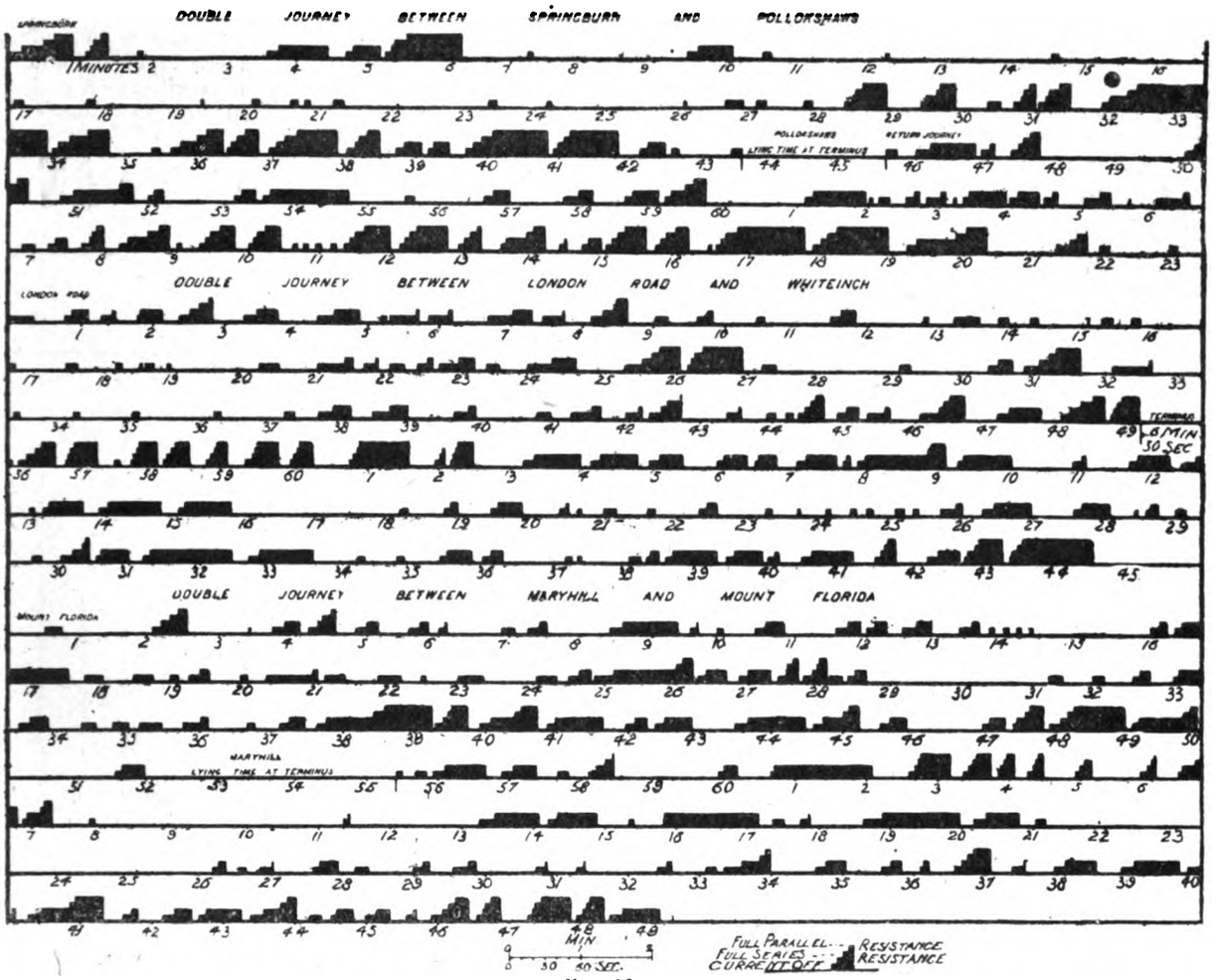

FIG. 14.

and for accelerating, drawn out on the same sheet. As an example, examine Fig. 13, drawn out for a 12-ton car as above described. The rolling and journal friction of the car-truck have been allowed for in the gradient line. They may, of course, be represented by a small up grade. Thus this line does not pass through the origin. In calculating the force necessary to produce a given acceleration it is necessary not only to consider the lineal acceleration of the car as whole, but also the angular acceleration of all rotating parts. We must, in fact, increase the actual dead-weight of the car by a certain amount when calculating accelerations, to allow for the angular acceleration of motor armatures, wheels, etc.

If W = dead weight of car with all accessories, in pounds;
r_1 = radius of gyration of armature shaft with armature, commutator, and pinion;
r_2 = radius of gyration of axle with car wheels and gear wheel;

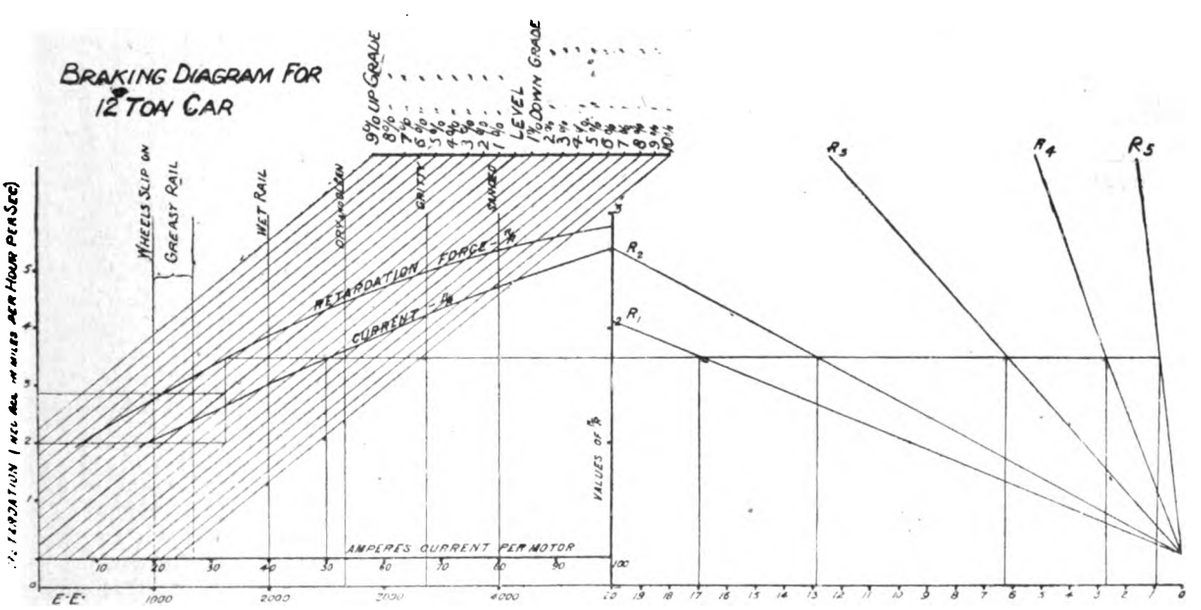

FIG. 15.

r = radius of car wheel;
w_1 = weight of armature shaft, armature, commutator, and pinion, in pounds;
w_2 = weight of axle, two car wheels, and one gear wheel, in pounds;

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ρ = gear ratio;
T = tractive effort—measured at tread of wheels—per axle, in pounds;
a = acceleration of car, in miles per hour per second;
then for a four-wheel car with two motors:

$$T = \cdot 0456 \left\{ \frac{W}{2} a + (w_1 r_1 \rho + w_2 r_2) \frac{a}{r} \right\}.$$

Thus, for an ordinary case, such as has been assumed, from 9 to 10 per cent. should be added to the dead-weight of the car to allow for the angular acceleration of the rotating parts. This has been allowed for in Fig. 13.

Suppose we wish to find the current to accelerate a car up a grade of 5 per cent. three miles per hour per second, we see that for the acceleration alone 2,020lb. tractive effort is necessary; to this we add 800lb. to overcome the grade and friction, obtaining a total of 2,820lb. On greasy rails the wheels would slip, but on sanded rails the car would mount with the desired acceleration with 90 amperes (motors in series).

Having obtained all the characteristic curves relative to the motor, the question at once arises, at what point is the efficiency of most importance to us—*i.e.*, to say, what shape should the efficiency curve have in order to get the greatest commercial advantage? This is a most difficult point to settle; it will naturally depend on the nature of the route, hilly or otherwise, amount of traffic, average number of stops per hour, skill of motorman, maximum speed allowed by the Board of Trade, and a large number of other factors. I prefer to divide up the journey into five periods: (1) current cut off; (2) running with resistance in circuit, motors in series; (3) full series; (4) resistance with motors in parallel; (5) full parallel.

To show you roughly the proportion of these intervals I have constructed diagram (Fig. 14), which shows three complete journeys at different times of the day, on different routes, and with different motormen. Time is represented horizontally, and the various intervals, which were carefully observed under normal traffic conditions, blocked in to form a square diagram. These journeys give the following analyses:

Journey.	Time of day.	Total time.	Total time in seconds for periods.				
		Secs.	1	2	3	4	5
Springburn to Pollokshaws and back ...	11 a.m.-12.30	5,070	2,756 54·2 %	625 12·4 %	758 15 %	253 5 %	678 13·4 %
London - road to Whiteinch and back ...	4 p.m.-4.55, and 3.30-4.20 p.m.	6,415	3,531 54·9 %	1,158 18 %	1,217 19·2 %	105 1·6 %	404 6·3 %
Mount Florida to Maryhill and back ...	11.15 a.m.-12.5, and 12.5-1 p.m.	6,738	3,600 53·3 %	1,124 16·7 %	1,507 22·5 %	142 2·1 %	363 5·4 %

Suppose, after taking a large number of such tables on different routes, at different times of the day, and with different experienced motormen, we come to the conclusion that the current is cut off for 50 per cent. of the whole time, the series notches are in use during 35 per cent., and the parallel notches during 15 per cent. of the whole time. Suppose, further, that from readings taken in the power station we find the average current per car = 15 amperes, then the average current per car taken over the time that the current is actually on will be 30 amperes. We may assume, moreover, that the average current on the parallel notches is twice that on the series notches, which will result in an average current per motor of 23 amperes. In all probability the average current per motor during the time the motors are in full series and in full parallel will be less than this rather than more, since the momentary rushes of current during acceleration on the different controller notches are considerable. At present the average current per car for the Glasgow system is more nearly 12 amperes than 15 amperes, and it is, therefore, from considerations such as these that I am led to the belief that in Glasgow, at any rate, the 250-volt efficiency curve just about the bend is of very great importance, and we should try to have as high an efficiency at this part as possible, even at the expense of a drooping efficiency curve at the higher current values. This part of the curve is most difficult to obtain accurately, but a large number of points should be taken, so that the true shape of the bend can be studied. There is one point for each motor where the total motor loss will be a minimum. I have shown a "total loss" curve in Figs. 3 and 4; in Fig. 3 is shown the total loss in kilowatts at 500 and 250 volts, and in Fig. 4 total loss in horse-power at

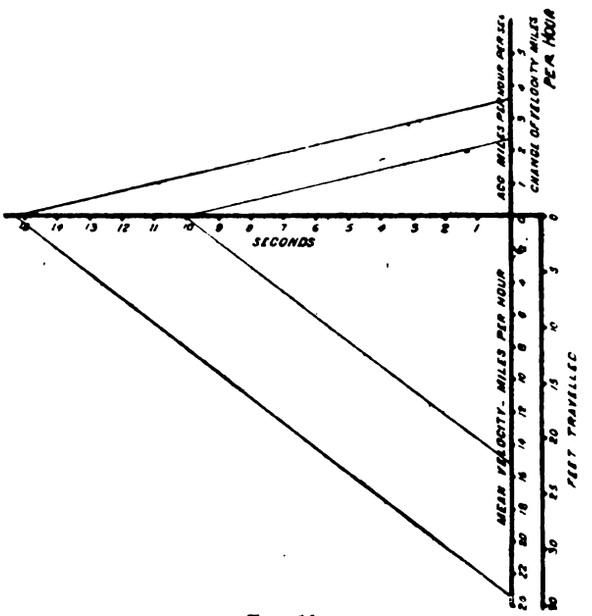

Fig. 16

500 volts. In Fig. 4 the line for horse-power input is also drawn to same scale, so that the difference between this and "total loss" curve represents brake horse-power at 500 volts. It is interesting to compare the current corresponding to minimum loss with the average current per motor.

The writer is convinced that in many cases a considerable economy may be effected by giving due consideration to the manipulation of the controller. Undoubtedly the most satisfactory way of studying the acceleration, as

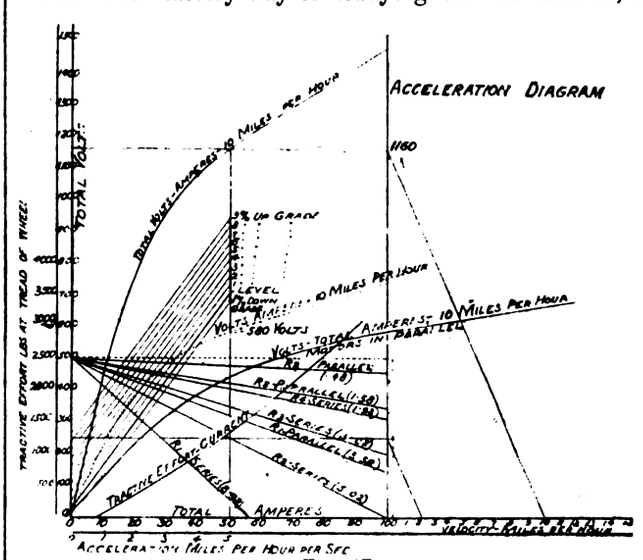

Fig. 17.

also the retardation periods, is by means of a recording ammeter actually installed on a car. My predecessor, Mr. A. E. Le Rosignol, worked with such an apparatus, it being arranged to record not only current, but speed, and the controller notch, simultaneously. This apparatus has been for a long time out of order, so that I am unable to place before you the results of any such tests. I hope, however, before long that we shall have time to reset up this apparatus in a practical shape. I will content myself, therefore, with merely giving here some graphical methods devised by myself for determining with considerable accuracy the current consumption and the curves of

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current, velocity, distance travelled, etc., during the acceleration and retardation periods. First, let us look at the retardation diagram (Fig. 15). Current per motor

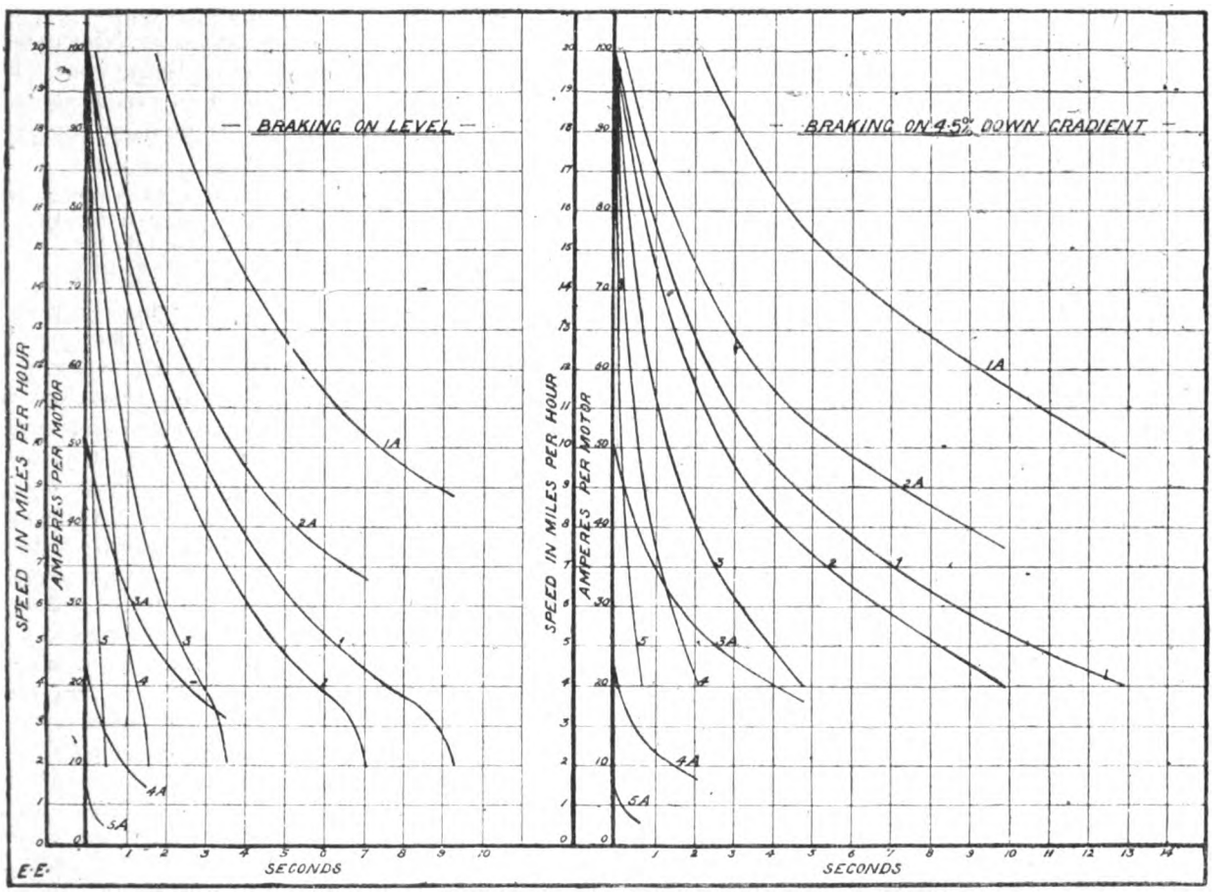

FIG. 18.

is plotted horizontally, and to the right-hand side a scale for values of $\frac{n}{R}$ is constructed vertically. Continuing in the same horizontal as the current scale a reversed speed scale is marked off, and a straight-line curve connecting the values of $\frac{n}{R}$ and n is drawn for each value of R—*i.e.*, for the five controller notches. The curve

hour per second and pounds retarding force per axle for a 12-ton car and a number of different grades have been drawn in. The friction of the car is here represented, for sake of simplicity, as 1 per cent. up grade. This diagram then gives us very full information. We see, for example, we shall have 50 amperes per motor circulating, provided the car is travelling 17 miles per hour on first notch, or 13 nearly on the second, or 6¼ on third notch, or 2¾ on fourth notch, and so on, and for no other speeds. We see, further, that the retarding for each of these speeds with the corresponding notch is 1,600lb.; that on greasy rails this would cause skidding of the wheels, but on a good

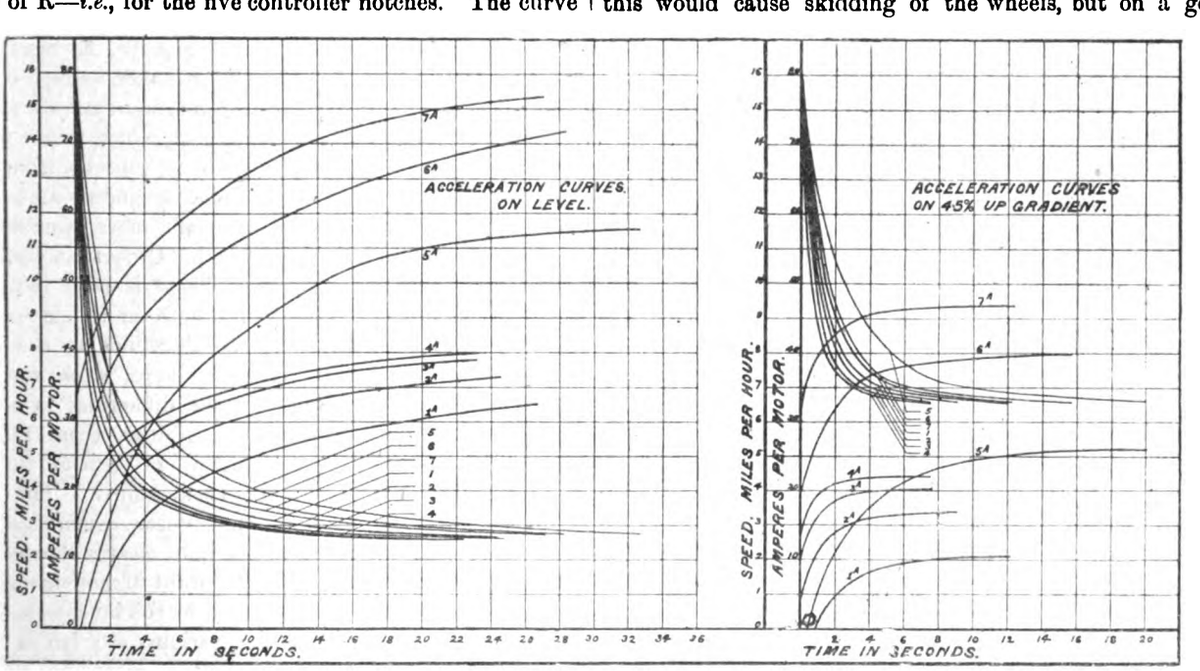
ACCELERATION CURVES ON LEVEL.
ACCELERATION CURVES ON 4.5% UP GRADIENT.
SPEED. MILES PER HOUR.
AMPERES PER MOTOR.
TIME IN SECONDS.

FIG. 19.

connecting retarding force at the tread of the wheels and $\frac{n}{R}$ is further constructed, the retarding force in pounds being plotted horizontally. Beyond this a number of straight-line curves connecting retardation in miles per

wet rail ample adhesion would be obtained. Lastly, the same diagram gives us the retardation in miles per hour per second corresponding to the above retarding force on any up or down grade between 0 and 10 per cent.

(To be continued.)

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CONTENTS.

Notes	289	Trade Notices and Novelties	311
The Dusseldorf Exhibition—II	294	Glasgow Accounts	312
The Evolution of Electrical Telegraphy	295	West Bromwich Accounts	312
Cable-Laying in Dartmouth	296	Manchester Accounts	313
Staite and Petrie's Electric Light—1846-1853	297	New Companies Registered	313
Notes on the Testing of Tramway Motors, and an Investigation into their Characteristic Properties	301	Questions and Answers	313
Pioneers	306	Legal Intelligence	317
Correspondence	307	Companies' Meetings and Reports	317
Forthcoming Events	307	Appointments Vacant	317
The "Newton" Tramcar Guard	308	Contracts for Electrical Supplies	317
The Electric Third Rail	309	Lighting Notes	318
Electric Lighting of Large Office Blocks	310	Traction Notes	320
		Provisional Patents, 1902	323
		Specifications Accepted	323
		Traffic Returns	324
		Companies' Stock and Share List	324

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PIONEERS.

The lives and work of the early pioneers—whether in developing uncivilised countries or starting new commercial undertakings—are invariably hard, and too often unremunerative. It is the exception for such men to derive much material benefit from their pioneering work. More frequently life and energy are spent in producing results which benefit posterity only. In the words of Kipling:

> In the faith of little children we lay down and died:
> On the sand drift—on the veldt side—in the fern scrub we lay,
> That our sons might follow after by the bones on the way;
> Follow after—follow after. We have watered the root,
> And the bud has come to blossom that ripens for fruit.

This is equally true of the pioneers of engineering progress. Even if a man can overcome the technical difficulties of the pioneering work he has laid down as his object in life, he finds commercial difficulties which prevent him from enjoying the fruits of his labour. Such a case is revealed by the article by Mr. J. J. Fahie in this issue on the "Staite and Petrie Electric Light." The work done by these two experts rather more than fifty years ago is indicated in these articles. The records clearly show that the essentials for a successful arc lighting were recognised by them, and were provided in the lamps which they exhibited in all parts of the United Kingdom. The success of these pioneers was such that a committee of twenty-eight prominent Manchester men was formed in August, 1850, "to investigate and report upon the electric light with a view to its general adoption." The conclusions of this committee condemned the electric light on the main question of cost, although there were also complaints of the flickering of the light. This decision of the Manchester committee was, we gather, the beginning of the end so far as these pioneers were concerned, and Mr. W. E. Staite, having spent his fortune and exhausted his vital energies, died in 1854 at the early age of forty-four. The real cause of the commercial failure of these two experts lay in the source from which they obtained their electricity. The primary battery in those days was perhaps not so far advanced as it is now, but even within the last few years electric lighting undertakings relying on primary batteries as their source of electricity have been financed for a time, only to pass away in disgrace. Mr. W. E. Staite had the hope that has misled so many primary battery experimenters, that he would succeed in finding a market for the by-products from the cells employed, which would render the cost of the electricity very low. This delusive hope has in some cases even gone so far as to induce statements that the by-products would be much more valuable than the original components of the cell. Unfortunately, these hopes have not been realised. There is every indication that all the difficulties met with both in the use of the primary batteries, which were modifications by the above inventors of the Callen cast-iron type, were met in a true engineering spirit, as were the difficulties in connection with the arc lamps. For instance, these pioneers experimented with the manufacture of carbons in order to get pure carbon rods for their lamps. The reply to those members of the Manchester committee who objected to the flickering of the light clearly showed that the real reason of this—*i.e.*, the want of homogeneity of the carbons—was fully appreciated by the inventors. In the same way the details of the various arc lamps made, described, and, as a rule, patented by them, show a wonderful grasp of the many different ways in which the burning away of the carbon electrodes can be automatically compensated for by the feeding arrangements. It wanted but the modern dynamo to make these gentlemen

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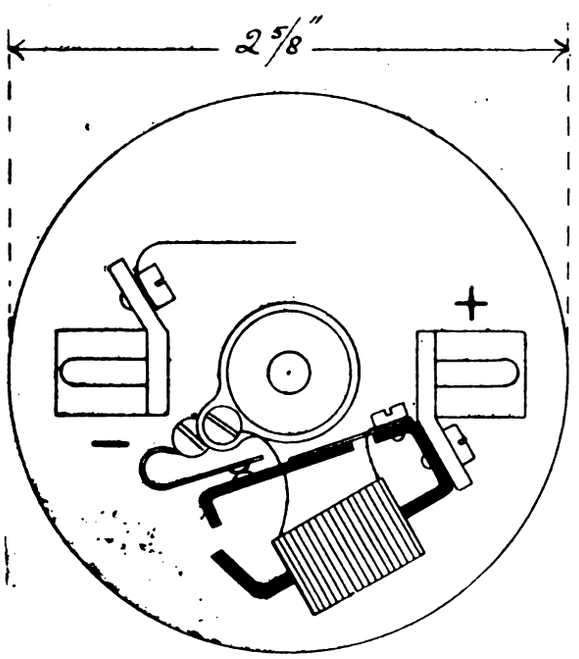
successful commercially, and their work was obviously of great service to the engineers who came after them, and who had the advantage of possessing, firstly, the magneto generators, and afterwards the Gramme dynamos. We are pleased, therefore, to publish articles which will remind electrical engineers of the pioneering work of the late Mr. W. E. Staite, and of Mr. W. Petrie, who is still with us, which work formed an important step in the way towards the present state of progress in electrical engineering. It was at a lecture in 1847 that Mr. Staite said: "Much as steam has accomplished for the civilisation of mankind, electricity is probably destined to do more. With even our present limited knowledge, the inventive genius of man has succeeded in applying it to a vast number of useful purposes, such as its application to electrometallurgy, plating and engraving, electric blasting, electric clocks, and the then crowning triumph—the electric telegraph." And who shall say," he continued, "that in the coming age electricity will not be the universal motive power—the great propeller? Who shall presume to limit its useful application to agriculture, commerce, and the arts of life? when its all-pervading essence is better understood, and its tremendous powers are brought more fully under the control of the human will."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE NERNST LAMP.

SIR,—Being particularly interested in the Nernst lamp, as no doubt are many more of your readers, I have enclosed



a drawing of the cut-out arrangement. This is as per latest pattern, and is common to both alternating and direct current lamps. The burner and heating coil in the lamps for alternating current are rather longer and thinner than in those for direct current. In the figure base is of porcelain, fittings are of brass, the soft iron electromagnet and its armature are black. Bobbin is wound with very fine wire.

Current enters at + terminal and divides at screw holding spring and armature; one part goes through magnet bobbin, outer part of socket holder, iron resistance, centre contact, burner, to negative terminal; other part goes through spring and armature, platinum contacts, heating coil, to negative terminal. (Note that screw holding piece with platinum contact is distinct from screw on outer of socket holder; it is about ½in. below it.) When burner is hot enough, sufficient current passes to pull over armature and break contact; the whole current then passes through burner. I have found the lamps burn very satisfactorily, but have been informed that after a time the heating coil fails to do its duty. Perhaps some of your readers may favour us with their experience.—Yours, etc., M. M.

WIRELESS TELEGRAPHY.

SIR,—In the number for the 22nd inst. of the *Electrical Engineer* you reproduce an article from the *Scientific American* describing the new installation of wireless telegraphy which Marconi has arranged at Cape Breton, in America, in view of his Transatlantic trials. Without wishing to detract from the value of the great work of my young and illustrious compatriot Marconi, of whom I am a great admirer, and who has only too many seeking to diminish his credit, I may be allowed to remark that the antennæ which Marconi proposes to instal and to try at Cape Breton—that is to say, an inverted cone or pyramid of wires—are those which I employed in my wireless telegraphy experiments between Brussels, Malines, and Antwerp on Dec. 15, 1900, and March 23, 1901. The apparatus was described in the *Electrical Engineer* of July 12 and 19, 1901, the arrangement being indicated in Fig. 24. Precisely the same antennæ were afterwards adopted by Mr. Ducretet, of Paris, who, in his notes published September and October, 1901, remarks that he had obtained remarkable results with these antennæ.—Yours, etc. EMILE GUARINI.

Brussels, Aug. 24, 1902.

ROYAL VISIT TO THE ISLE OF MAN.

SIR,—It may interest your numerous readers to learn that during the visit of their Most Gracious Majesties to the Isle of Man, the Royal party, including the King, Queen, Princess Victoria, and the Portuguese Ambassador, travelled by saloon car over the lines of the Isle of Man electric tramways from Douglas to Ramsey, a distance of 18 miles, the journey occupying one hour. The King and his party were much struck with the beauty of the scenery through which they passed, and with the splendid reception accorded to them by the thousands of people assembled at the various stations and along the route.

The Royal car was artistically decorated, and was under the charge of, and driven by, Mr. Frank Edmondson, the chief engineer of the company.

I am under the impression that in the British Isles this is the first occasion on which his Majesty the King has made use of an electric line as a means of locomotion, and it is therefore of immense importance to the electrical industry in general.

Perhaps you will verify this.—Yours, etc.,

OSWALD R. EDMONDSON.

Douglas, Isle of Man, Aug. 26, 1902.

FORTHCOMING EVENTS.

TUESDAY, SEPT. 2.

Iron and Steel Institute.—Annual meeting at Dusseldorf.

The following fixtures for meetings have also been made:

Institute of British Carriage Manufacturers.—Sept. 9-11, Oxford.

Sanitary Institute.—Sept. 9-13, congress, Manchester. Sept. 9-27, health exhibition.

British Association.—Meeting at Belfast commences Sept. 10.

Municipal and County Engineers.—District meetings. Midland: Sept. 27, West Bromwich. Eastern: Oct. 25, King's Lynn. Yorkshire: Sept. 13, Shipley. Home: September or October, Aldershot.

Municipal Officers' Association.—District meetings at Birmingham, Liverpool, and Newcastle are being arranged.

Battle Abbey.—The Abbey is now being renovated, and will be fitted up with electric light.

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THE "NEWTON" TRAMCAR GUARD.

The "Newton" lifeguard (Fig. 1) for electric tramcars comprises a tubular iron framework, covered with wire netting, and is supported by pivots which work in standards bolted to the pilot board. At the rear end of the frame there are counter balancing weights which are adjustable, so that the front end of the guard can be raised or depressed as desired.

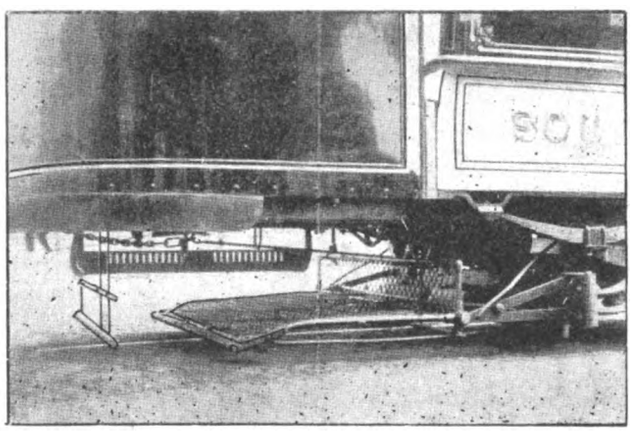

FIG. 1.—The Newton Tramcar Lifeguard.

The front end is furnished with a number of loose wood bobbins or small rollers, and meet the obstacle in the way. Underneath this end there are also steel rollers, that come upon the rails, and run along smoothly, keeping the wood rollers clear of the roadway: therefore, any body or obstacle in the track touching these wood rollers will depress the guard, and the forward motion of the car will force them under the obstacle and roll it on to the netting, where it will be retained until taken off. This action is without the assistance of gate or the motorman. On the platform of the car there is a pedal arrangement, whereby the motorman can bring the guard down to the rails at will by simply pressing a button with his foot, and upon lifting his foot the guard, by its counterbalance, resumes its normal position—that is, if there is no weight upon the guard.

The action of this mechanism is a bell lever pulling a chain over pulleys and lifting the counterweight from its seating, this weight being about 9lb., and could be added to or reduced as found desired. This is a most certain action should the motorman see any object in the way, and can preserve his presence of mind, as he could drop the guard immediately and pull up his car afterwards, the body or whatever it was picked up being carried along until taken off. Under numerous trials it has never failed, and the late manager of the Southport Corporation tramways, Mr. R. J. Wilton, bears this out, the trials taking place in his presence.

Again, there is a gate appliance (Fig. 2) added—*i.e.*, a light iron frame reaching nearly to the ground, and swinging loose on a shaft connected to the gate working on hinges. There is a *cam*, which when the gate is pushed inwards presses against a loose hinged plate connected by a rod to the upright portion of the framework at the back of the guard and pulls this end forward, bringing the front end to the rails, as described before. This action is exceedingly quick, the gate moving inwards only 3in., or 22½deg., accomplishes its work, and then swings up clear out of the way of the object.

There are also fixed to the underpart of the platform of the cars bracket arms with rollers, that come in contact with plates fastened to the upright end of the guard. The overcrowding of the rear end of the platform of a car will bring these brackets at the front end of the car in contact with these plates on the front guard, consequently pushing the guard towards the ground.

The gate being attached to the body of the car would, under these circumstances, rise above its usual height, and would probably allow a child to get underneath, but the guard being depressed (as stated above) would pick it up. The rising of the gate and guard has been the greatest difficulty in this line tramway managers have had to contend against. This is now obviated by the above appliance, and can only be adopted to the "Newton" guard, owing to the gate *not* being attached in any way to the guard. The gate can be swung up and tied, and still the motorman can work the guard as usual.

The Southport Corporation Tramways Committee have allowed a car to be fitted up with this "Newton" guard. It has now been running three months, and working most satisfactorily, and is awaiting the decision of the inspecting officer of the Board of Trade. The picking up of a dummy with arm extended in front, facing the car, the guard where dropped by the motorman, accomplished with the greatest ease. This position managers of tramways consider the most difficult test, the arm being the first to come in contact with guard.

The "Newton" guard seems a sound and lasting mechanical appliance. It is adjustable, the parts are interchangeable, and there are no springs or catches of any description to get out of order.

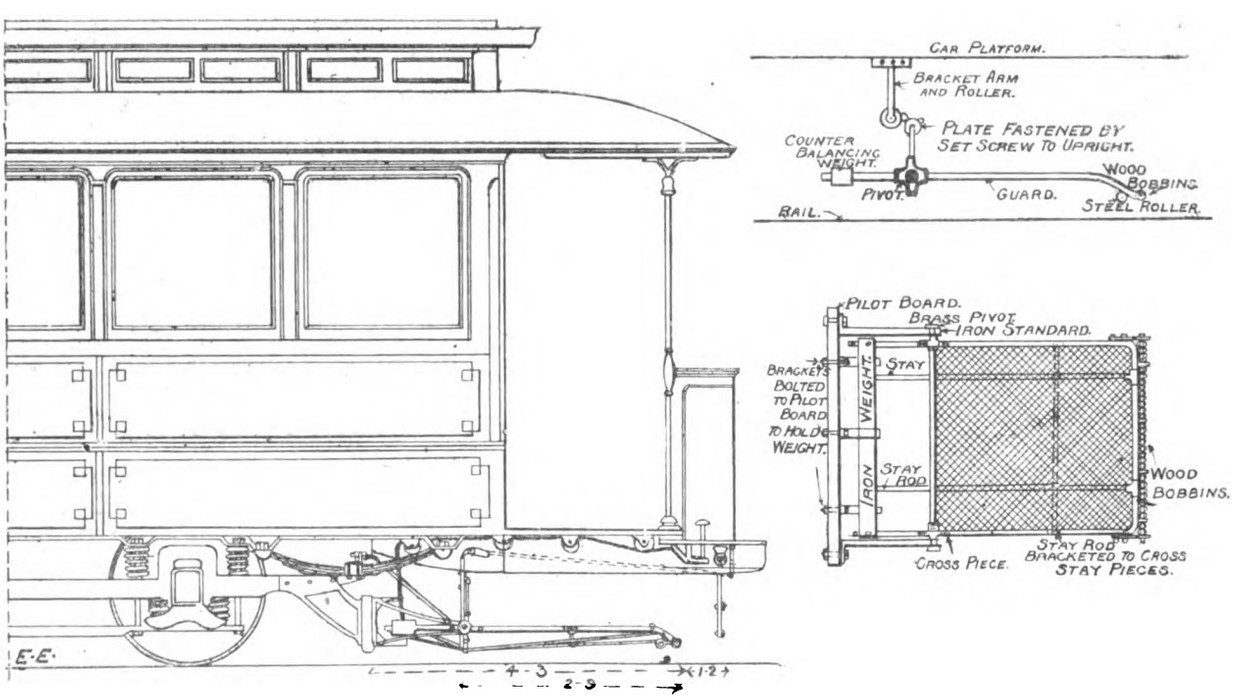

FIG. 2.—Details of the Newton Tramcar Lifeguard.

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THE ELECTRIC THIRD RAIL.*

BY W. B. POTTER.

The third rail as a means of conducting current to the car is a simple, unobtrusive method, easily installed, and inexpensive to maintain. In yards and terminals, and for high-speed or heavy service, it is generally preferable to the overhead trolley, the absence of superstructure and its large section both for conducting and collecting the current making it particularly suitable. While in some cases there may be no objection to the installation without a protection, there are places where a guard or protection is advisable as

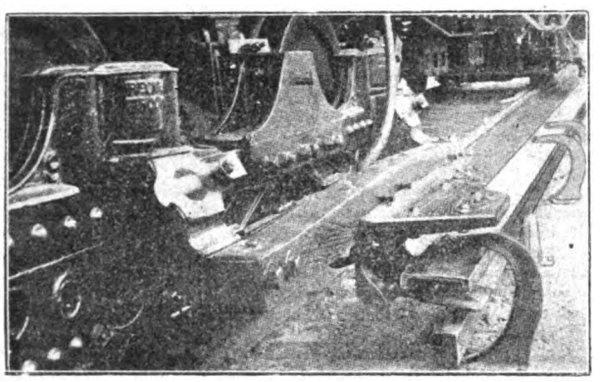

FIG. 1.—Contact Shoe entering Protected Third Rail.

a safeguard to employés and others from accidental contact, or the liability of being burned by short-circuits caused by careless handling of track tools. It is especially desirable that this guard be of such form as to protect the third rail from ice and sleet, as ice on the top of the third rail is a very troublesome feature and difficult to remove.

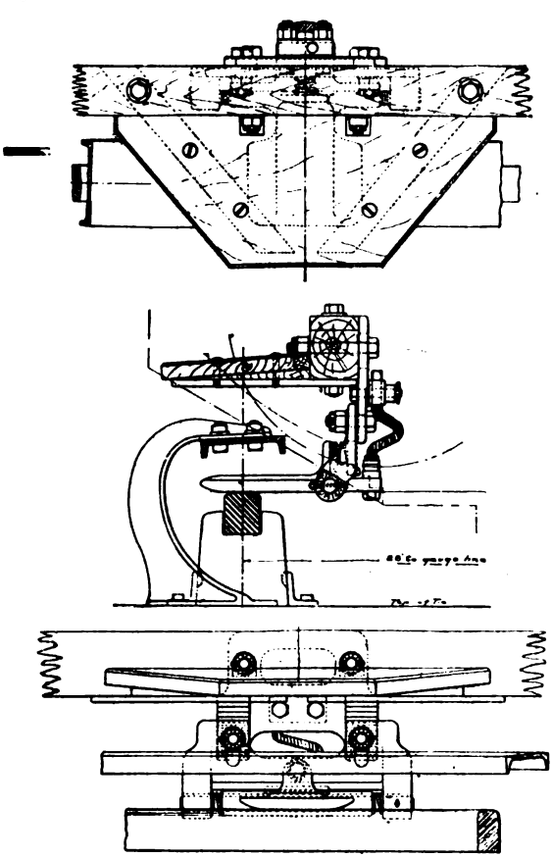

FIG. 2.—Plan and Elevations of Contact and Protected Third Rail.

The third-rail protection which is here described is simple in construction and very effective for every purpose for which protection is needed. The protection consists of a channel iron (Figs. 1 and 2) or plank supported by brackets directly over and about 2in. above the third rail, as shown in cuts of end view and side elevation. A slight gap is left between the ends of each length of the protection when of metal to separate them electrically. As it is often essential that steam locomotives should run over the same tracks, the distance and height from the running rail

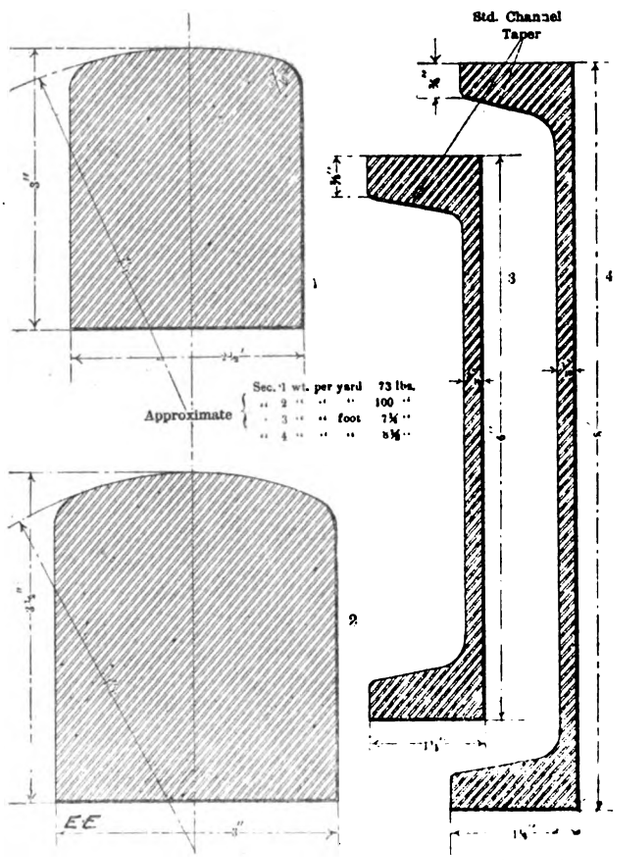

FIG. 3.—Suggested Sections of Third Rail and Channel Iron Protection.

as shown is recommended, as providing the necessary clearance for even the large low-pressure cylinders of compound steam locomotives. The centre of the third rail is 28in. from the gauge line, and the top 3in. above the top of the running rail. It is not advisable to locate the third rail lower than 3in. below the top of the track rail, for if lower, the contact shoe, which ordinarily drops 1in. lower than the third rail, would be in danger of touching the track rails at frogs and switches, causing a short-circuit.

FIG. 4.—Third Rail Insulator

The third rail being so low, and the maximum distance to ground being desirable for insulation, it is advantageous to use a section giving the maximum conductivity. There being no special advantage in using the standard T rail section, a rectangular section with rounded top (Fig. 3) is recommended. This section is convenient to bend and bond, and can easily be aligned by fishplate on the bottom.

It is advisable to use a special composition of rail, containing a relatively small amount of carbon and manganese, in order to obtain high electric conductivity. The main consideration with steel rails for ordinary use is to obtain long life in service, and they are usually made as hard as is consistent with the toughness necessary to withstand shocks and strains, while in a third rail there are no strains, and the wear amounts to practically nothing. Manganese appears to be the element most affecting the conductivity, carbon being next. The resistance of an ordinary track rail high in carbon and manganese will often be found to be 12 or 13 times that of copper for the same section. The following composition for a third rail

* From the *Street Railway Journal*.

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is suggested as not being difficult to obtain commercially, while providing a reasonably high conductivity: carbon not to exceed 12 per cent.; manganese not to exceed 15 per cent.; phosphorus, not to exceed 10 per cent.; sulphur, not to exceed 5 per cent. The electrical conductivity of a third rail of this composition will be about 60 per cent. higher than that of an ordinary running rail of the same cross-section—that is, a third rail of this special composition would weigh only 63 per cent. of a track rail of ordinary composition for the same conductivity, and would have about 7·5 times the resistance of copper.

The third-rail insulator here shown is a block of wood or vitreous material (Fig. 4) with a slot in the top into which the third rail is laid, no clamps or bolts being required to hold the rail in place. The third-rail shoe used with this form of protected third rail is a plate of cast iron hinged at the point of support and carried by brackets adjustable for height to allow for wear of the wheels. These brackets are bolted to an insulating timber attached to the truck journal boxes. A guard or protection of wood may be placed over the shoe and support, preventing accidental contact with the shoe on the side opposite the third rail. This form of protected third rail (Fig. 5) as installed on the yard and tracks of the General Electric Railroad has been operated with marked success during the last winter, with less trouble from sleet and snow than previously experienced with any other form of third rail tried. The protected third rail, as with the ordinary form of exposed rail, is located on either side of the track as convenient, gaps in the continuity being necessary as switches and crossing. Each car is equipped with four

FIG. 6.—View of Collecting Shoe.

shoes, one midway each side of both trucks. In specially complicated slip switches it may be found difficult to locate the third rail, so that the gap may be spanned by the shoes, and in such cases a short length of rail or wire may be installed overhead, a length of about 50ft. being generally sufficient. Current from this overhead section may be selected by a low pantagraph shoe mounted on top of the car.

The location of the third rail with reference to the track rails is a detail deserving careful consideration. Uniformity in this respect is as desirable as any standard, particularly if cars of different companies are likely to operate over each other's lines. Some of the variations in third rail location are shown by the following partial list of third-rail installations, which include some of the most interesting examples in this country and abroad. Column A gives the distance from top of third rail to top of track rail, and column B the distance from track gauge line to centre of third rail:

	A.	B.
General Electric Railroad, Schenectady	3in.	28in.
Met. West Side Elevated, Chicago	6¼in.	20½in.
Lake Street Elevated, Chicago	6½in.	20½in.
South Side Elevated, Chicago	6⅜in.	20⅜in.
North-Western Elevated, Chicago	6½in.	20½in.
Brooklyn Elevated, Brooklyn	6in.	22½in.
Manhattan Elevated, New York	7½in.	20⅜in.
Albany and Hudson, New York	6in.	27in.
Boston Elevated, Boston	6in.	20⅜in.
Aurora, Elgin, and Chicago, Illinois	6 5/8in.	20⅜in.
Columbus, Buckeye Lake, and Newark, Ohio..	6in.	27in.
Columbus, London, and Springfield, Ohio	6in.	27in.
B. and O. R. R., Baltimore	2⅜in.	24in.
N. Y., N. H., and H. R. R., Connecticut	1½in.	centre
Central London, England	1½in.	centre
Paris-Orleans, France	7⅜in.	25⅜in.
Gallarate, Italy	7½in.	26⅜in.

Local conditions may in many cases influence the location, but the ultimate advantage in the interchange of service is such as to warrant the early adoption of what may at least be called the standard location for a third rail. The cost of a protection for the third rail will vary, depending upon the material or weight of channel used and the price per ton. The cost of the conductor rail would also depend upon its weight and price per ton. The author's estimate of the cost of one mile of single track of protected third rail laid complete is £908, including the bonding of the track to act as return.

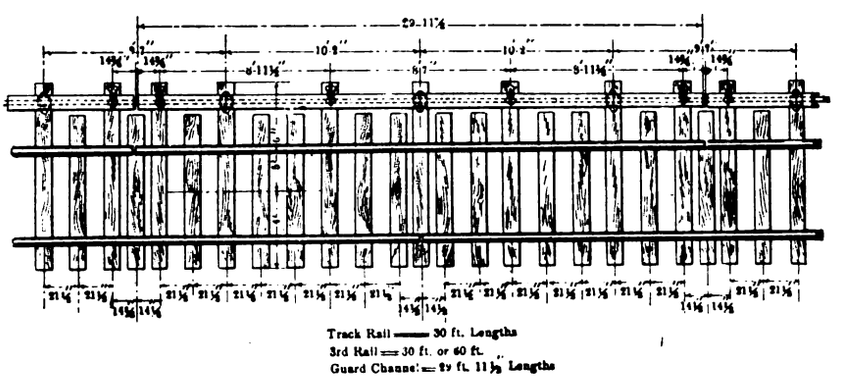

FIG. 5.—Details of Track.

ELECTRIC LIGHTING OF LARGE OFFICE BLOCKS.

In the present day, when the price of electric energy is comparatively cheap, it is not uncommon to find that current required for the lighting of large blocks of buildings in London is taken from the electric street mains. An important addition to an already very large installation is that of the new "Westinghouse" Building and its annexe, comprising part of the Law Land Company's estate. The building consists of seven floors and basement, each floor being designed for about 14 rooms. Three-wire service mains are brought into the building by the Charing Cross and Strand Electricity Supply Corporation, the supply being by continuous current at a pressure of 200 volts at the lamps. The three-wire system only extends to the main fuse box, this being of the triple-pole type.

An independent 100-volt service (two wire) is also brought into the building for feeding a special circuit for the supply of current to electric radiators, and also to a number of the arc lamps of the Westinghouse Company. The meters used are of the Aron type. The main distribution board is of enamelled slate, mounted in a massive teak frame, and provides for a separate circuit to each floor of the building, each circuit being controlled by double-pole fuses and single-pole chopper-type switch. From this main board a separate circuit is run to each of the local distribution boards for supplying the various floors through the double-pole bridge-type fuses. These sub-mains are run singly in separate Simplex tubes, and direct from the main board to their respective sub-main boards. All lamp circuits

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are run back direct to a distribution board, no fuses being employed locally. The maximum number of incandescent lamps supplied from any sub-circuit is eight, and with few exceptions every lamp is furnished with a separate switch. The wiring is carried out in Simplex brazed tube, all the tubes being fixed in position as the building work proceeded and the wires drawn in afterwards. "Westinghouse" Building contains upwards of 700 lights, together with a very elaborate and extensive system of electric bells for tenants and services, gas fire points, speaking-tubes, etc. The total number of lamps on the estate now supplied is estimated at about 5,000.

The whole of the work has been done under the supervision of Mr. Frederic H. Taylor, A.M.I.E.E., of 14, Victoria-street, S.W., the consulting engineer to the company, and has been carried out by the electrical staff of the Law Land Company's building department.

TRADE NOTICES AND NOVELTIES.

Continuous-Current Dynamos.

The Lahmeyer Electrical Company, Limited, 109-111, New Oxford-street, London, W.C., have just issued an illustrated description of their continuous-current dynamos for direct coupling, which is well worth perusing. We reproduce herewith the first two illustrations contained in the description, Fig. 1 showing the general appearance of one of the firm's continuous-current machines for direct coupling, and Fig. 2 a section of

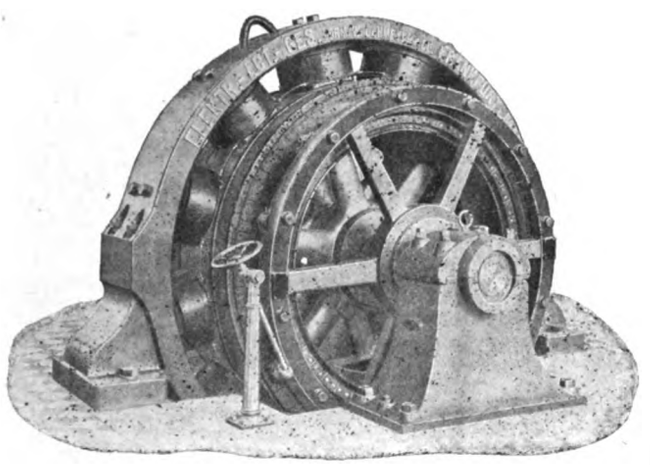

FIG. 1.

the same. In designing these machines great care is taken, we are told, in calculating all the different portions to obtain a safe working, and in the construction special care is taken to obtain no sparking, low temperature rise, and small brush displacement. By suitable arrangement of the provisions for ventilation, the temperature rise is kept low, this not exceeding 70deg. F. after six hours' full-load run. The armatures are all drum wound. In the case of large size machines, the winding consists of flat copper rods, the coils being bent out of one piece, thus avoiding any danger of breakdown in the coil owing to a faulty joint, connections only being required at the commutator. Where there is any advantage to be obtained, the coils are former-wound with wire. But whether bars or former-wound wire coils are used, they are fixed in slots on the periphery of the armature. The commutators are built so as to allow separate segments to be taken out without disturbing the rest of the commutator. Carbon brushes are used for all normal voltage machines. The brush rockers are of a simple and safe kind, it being impossible for vibration—causing sparking—to be set up in them. The rocker is either fixed on a projecting sleeve from the bearing, or, in the case of machines having a large diameter, on the field frame. The collecting bars are embedded in a girder-shaped cast-iron ring, and thoroughly insulated, making it impossible to effect a short-circuit across these bars. The brush-holder spindles are connected alternately to the left or right collecting bar, the spindles, in passing through the iron, being insulated by means of stabilit. Further particulars of these well-designed machines will be found in the description in question, together with full illustrations. Careful design and workmanship may be said to have been primarily responsible for the great reputation which Lahmeyer machines have won on the Continent and elsewhere. This reputation is calculated to alone serve as guarantee for their excellence.

Mechanical Stokers and Conveying Plant.

We have received from Messrs. T. and T. Vicars, 20, Bucklersbury, London, E.C., a copy of a booklet dealing with their patent stokers and conveying plant. It contains numerous excellent elevations and sections, from which the action of the stokers can be seen at a glance; also a number of views of boiler plants equipped with the firm's stokers, showing the modifications which they undergo to suit them to different types of boilers. The many advantages resulting from improved mechanical methods of handling fuel are touched upon in the text. Some useful hints to steam users are also given, the importance of gas analysis being emphasised, as it enables one to judge whether coal is being burnt in the best manner when boilers are running under ordinary working conditions, and is an excellent check on the firemen. As regards conveying plant, we gather that Messrs. Vicars find the worm and belt types give the best results, the worm for actually feeding the coal into the hoppers of the stokers and for dealing with ashes, and the belt for carrying coal long distances, or for bunkering the same. Full specifications are included; also a quantity of data in tabular form calculated to be of use to steam users. To indicate the extent of the

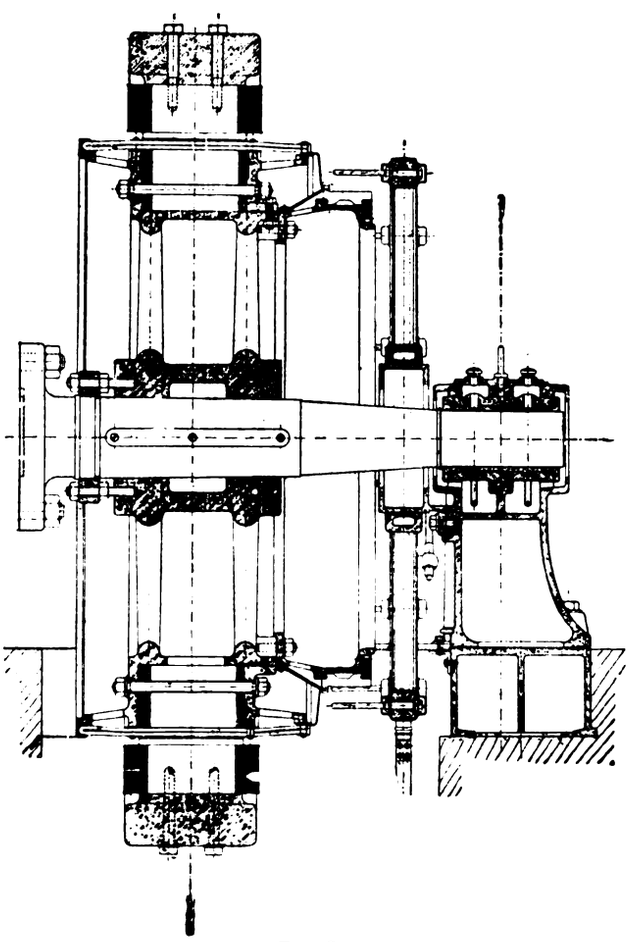

FIG. 2.

favour with which the Vicars type of stoker is meeting, it is only necessary, in conclusion, to append the following list of orders which the firm have, among others, on their books or are just about completing: Great Northern and City Railway, 20 machines; Aston Manor electric lighting station, 10 machines; Dudley electric lighting station, four machines (repeat order); Cardiff electric lighting station, 14 machines with conveying plant (worm type); Nottingham electric lighting station, 16 machines with conveying plant (worm and belt type); Liverpool Overhead Railway, two machines with conveying plant (worm type, repeat order); British Insulated Wire Company's works, two machines (repeat order); Bristol waterworks, 12 machines with conveying plant (worm type); Stobhill asylum, 10 machines; North British Rubber Company, 10 machines (repeat order), with conveying plant (worm type); Portsmouth electric lighting station, eight machines, fifth repeat order, with conveying plant (belt type); Antwerp trams, 12 machines with conveying plant (worm type); Plymouth electricity station, four machines (second repeat order); Fulham electric lighting station, six machines (repeat order).

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Catalogues Received.

From the British Thomson-Houston Company, Limited, Rugby, we have received copies of three recently-issued pamphlets. The first of them, No. 130, which supersedes pamphlet 107, dated Aug. 23, 1901, deals with the firm's type C E slow and moderate speed motors; the second, No. 131, with air compressors of the Reavell patented duplex type, driven by B.T.-H. C E motors; and the third, No. 132, which supersedes pamphlet No. 51, issued Nov. 15, 1899, with the firm's G E=58 type traction motor.

Messrs. Benham and Froud, Limited, Chandos Works, Chandos-street, London, W.C., have issued a new catalogue of electric light fittings. Illustrations of about 150 selected designs are given, some of them being highly artistic in conception. Church fittings are dealt with separately.

From Messrs. Johnson and Phillips, Old Charlton, Kent, we have received copies of their new price-lists E M, P M, and H W. The first of these lists deals with electromagnetic ammeters and voltmeters in iron cases for continuous and alternating currents, the second with permanent-magnet moving-coil ammeters and voltmeters in iron cases, and the third with hot-wire ammeters and voltmeters—switchboard and portable types.

The "General" Electrical Progress Sheet No. 41, just issued by the General Electric Company, Limited, Queen Victoria-street, London, E.C., illustrates the "Adelphi" D.P. motor switch suitable for circuits up to 500 volts, a new type of bayonet switch lamp-holder for circuits up to 250 volts, the "Combat" intercommunication telephone, and several new patterns in glass shades, cord pendants, etc. From the same firm we have a circular describing Wood's patent improved combined water-cart, rail-cleaner, and snow-sweeper for electric tramways; also a paragraph relating to the new works erected by the firm at Witton, near Birmingham, for the manufacture of electric light carbons.

Messrs. Rosling and Fynn, Limited, Trafalgar Works, Thornbury, Bradford, have sent us a copy of their new list of standard motors and generators.

GLASGOW ELECTRICITY ACCOUNTS.

From the accounts of the Glasgow Corporation electricity department for the year ended May 31, 1902, it appears that the total expenditure on capital account amounts to £962,726. Abstracts of the revenue account, general balance-sheet, etc., are given herewith.

REVENUE ACCOUNT.

Dr.			s.	d.
Generation of Electricity.				
Coal or other fuel	£13,550	12 8		
Oil, waste, water, and stores	1,918	6 6		
Salaries of superintendents at works	225	0 0		
Wages at generating stations	6,871	2 6		
Carting account	456	3 2		
Repairs and maintenance	5,091	8 8		
			28,112	13 6
Distribution of Electricity.				
Repairs, etc., of mains, cables, etc.	6,672	13 2		
Repairs, etc., of meters, etc.	1,070	13 10		
Salaries of surveyors	1,090	9 8		
			8,833	16 8
Attending and repairing public lamps			2,306	9 1
Rents, Rates, and Taxes.				
Rents and feu duties	1,416	4 1		
Rates, taxes, and assessments	4,562	6 7		
			5,978	10 8
Management Expenses.				
Salaries—Engineer's department	2,360	7 9		
Treasurer's department	1,070	0 0		
General establishment charges	1,652	15 9		
Stationery, printing, advertising, etc.	1,126	16 4		
			6,209	19 10
			51,441	9 9
Special charges			3,083	10 0
			54,524	19 9
Depreciation on works, etc.			11,430	16 3
			£65,955	16 0
Balance carried to profit and loss account			37,984	10 1
			£103,940	6 1

Cr.	£	s.	d.
Sale of current per meter	97,050	12	9
Public lighting	6,889	13	4
	£103,940	6	1

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	1,017,000	0	0
Sinking fund	36,768	11	11
Accounts due to sundry tradesmen and others	7,893	18	10
	£1,061,662	10	9

Cr.	£	s.	d.
Capital account—amount expended for works	962,726	19	2
Outstanding revenue assets	13,957	2	7
Stocks on hand	38,187	4	3
Balance in bank	2,719	5	11
Sinking fund (invested)	36,768	11	11
Suspense account	7,303	6	11
	£1,061,662	10	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			11,122,606
Quantity sold	Private consumers	8,384,696	
	Public lamps	884,839	9,282,043
	By contract	12,508	
Quantity used on works			829,713
Total quantity accounted for			10,111,756
Quantity not accounted for			1,010,850
Number of consumers			5,374
Number of public lamps			500
Total maximum supply demanded (kilowatts)			15,722

WEST BROMWICH ELECTRICITY ACCOUNTS.

Abstracts are given herewith of the revenue account, general balance-sheet, etc., recently issued by the West Bromwich Corporation electricity department for the year ended March 31, 1902. The total expenditure on capital account to that date amounted to £27,596.

Dr. REVENUE ACCOUNT.	£	s.	d.
Coal or other fuel	238	13	0
Oil, waste, water, and engine-room stores	89	14	4
Wages at generating station	111	0	5
Repairs and maintenance of buildings, plant, etc.	45	10	11
Repairs and maintenance and renewals of mains	9	17	3
Repairs and maintenance of meters and inspection	8	0	3
Repairs and maintenance of free wiring installation	9	13	8
Rents	6	8	5
Rates and taxes	93	13	9
Salaries—Engineer's department	250	0	0
Accountants' department	94	13	9
Stationery, printing, and general establishment charges	101	8	11
Insurances	9	6	4
Law expenses and stamp duty re £30,000 loan	92	10	6
Bank commission	14	6	10
Interest paid and accrued on loans	935	12	7
	£2,110	10	11

Cr.	£	s.	d.
Sale of current for lighting and power	680	16	1
Lamps, carbons, globes, etc.	21	8	2
Rent of farm	4	13	2
	706	17	8
Balance, being deficit	1,403	13	3
	£2,110	10	11

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	30,000	0	0
Sundry creditors for goods supplied and work done	2,181	0	7
Amount due for wages, March 31, 1902	4	3	4
Interest accrued and unpaid, March 31, 1902	322	2	4
	£32,507	6	3

Cr. Assets.	£	s.	d.
Amount expended for works	27,596	7	7
Stocks on hand, March 31, 1902	1,392	0	9
Sundry debtors for current supplied	353	9	8
Other debtors	571	7	7
Balance due to Electricity Committee on free wiring account	1,039	7	10
Cash in bank	145	19	7
Cash in hand	5	0	0
Revenue account—deficiency to March 31, 1902	1,403	13	3
	£32,507	6	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			79,772
Quantity sold	Public lamps	1,641	
	Private consumers by meter	61,253	62,894
Quantity used in works			3,050
Total quantity accounted for			65,944
Quantity not accounted for			13,828
Total maximum supply demanded (kilowatts)			122

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MANCHESTER ELECTRICITY ACCOUNTS.

From the accounts of the Manchester Corporation electricity department for the year ended March 31, 1902, it appears that the total expenditure on capital account amounts to £1,164,309. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal, etc.	£18,092	14	6			
Oil, waste, water, and stores	3,919	12	10			
Sundries	685	18	8			
Wages at generating stations	5,266	12	8			
Repairs, etc., of buildings and plant	7,940	19	6			
Maintenance of lamps, etc., in station	286	10	8			
				36,192	8	10
Distribution of Electricity.						
Wages	2,499	12	11			
Sundries	384	1	1			
Repairs, etc., of mains, etc.	11,373	1	0			
				14,256	15	0
Rents, Rates, and Taxes.						
Chief rents	479	14	2			
Rents of sub-stations and offices	798	13	0			
Rent of telephones	80	14	5			
Rates	5 625	0	8			
Income tax	798	7	10			
				7,782	10	1
Management Expenses.						
Salaries—Engineer's department	3,858	2	11			
Secretary's department	5,320	9	10			
Stationery, printing, and advertising	1,977	7	11			
General establishment charges	1,825	9	0			
				12,981	9	8
Law and parliamentary charges				1,179	9	0
Special charges—insurances, etc.				1,557	13	10
Amount written off for bad debts				104	11	10
				74,054	18	3
Balance carried to net revenue account				60,407	15	2
				£134,462	13	5

Cr.	£	s.	d.
Sales of current per meter	133,785	3	11
Public lighting	317	13	4
Rental of meters	289	12	11
Cottage rental	70	3	3
	£134,462	13	5

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Mortgage debt—loans as per capital account	1,020,444	8	4
Amount owing to bankers	44,689	15	2
Sundry creditors	68,280	13	4
Total liabilities	1,133,414	16	10
Amount at credit of reserve fund	16,340	14	7
Balance	92,856	11	8
	£1,242,612	3	1

Outlay and Assets.	£	s.	d.
Amount expended as per capital account	1,164,307	3	8
Stocks on hand	7,928	11	3
Cash in hands of treasurer	1,783	13	3
Reserve fund investment	16,340	14	7
Sundry debtors	51,291	2	8
Law and parliamentary charges	960	17	8
	£1,242,612	3	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			12,697,590
Quantity sold	Private consumers	8,512,189	10,502,299
	Public lamps	38,120	
	Traction	1,951,990	
Quantity used on works			1,016,641
Total quantity accounted for			11,518,940
Quantity used in distribution			1,178,650
Number of public lamps			29
Total maximum supply demanded (watts)			9,140,000

NEW COMPANIES REGISTERED.

Dublin and Slane Tramway Company, Limited.—Capital, £1,000. Object: to obtain concessions under the orders of the Lord-Lieutenant in Council for running systems of electric, steam, or oil tramways from Dublin to Slane, Garrisstown, and other places.

Slough and Datchet Electric Supply Company, Limited.—Capital, £50,000. Object: to carry on at Slough and elsewhere the business of an electric light and power company, etc.

Calvert's Motor Company, Limited.—Capital, £5,000. Objects: to acquire and carry on the business of an electrical and motor engineer of G. Calvert at 8-9, Kingsland-passage and at 487, Kingsland-road, N., etc.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

511. I recently saw a rotary converter with a device for steadying and controlling speed within certain limits. This was designated a "teazer," but I can find no account of it. Can any reader please explain?—F. P. S.

512. Describe what you consider the best system of engine-room telegraph worked by electricity, such as is used on board ship.—P. T.

ANSWERS.

Question No. 505.—Give the formulæ and principles on which solenoids are designed as used in arc lamps, cut-outs, etc. (series and shunt). Are they designed to give a certain pull in weight? What is the value of M.M.F., R, H, and B in a coil, length 15cm., with close-fitting core 15cm. long. 2cm. diameter, wound with 48 turns, six layers deep, traversed by 10 amperes?

Best Answer to No. 505 (*awarded* 10*s.*).—The actual amount of the pull which such a solenoid is required to give is seldom known with accuracy, as it usually depends on friction at joints or similar indefinite conditions. At the same time, no simple and exact rules exist for the calculation of plain solenoids to exert a given pull. It is, therefore, almost invariably the rule to base their design entirely on previous experimental results. As the final adjustment of the lamp or cut-out is always made by means of springs or counterweights acting against the magnet, it is only necessary to ensure that the pull of the solenoid shall not fall below a certain minimum value, and any excess can easily be taken up in the adjustment.

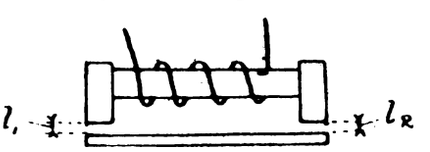

FIG. 1.

When, as is often the case in cut-outs, the plain solenoid is replaced by a magnet in which the attracted armature is separated from the poles by air-gaps of definite area and length (Fig. 1), a fairly exact calculation of the number of ampere-turns required for a given pull can be made as follows: Let the areas of the two air-gaps, measured at right angles to the direction of the flux, be A_1 and A_2 square inches respectively. Let their length measured parallel to the direction of the flux be l_1 and l_2. Let the flux density in the gaps be B_1 and B_2 C.G.S. lines per square inch respectively; then the total pull on the armature is given by the expression

$$\text{Pull in pounds} = \left\{\left(\frac{B_1}{1{,}000}\right)^2 \times A_1 + \left(\frac{B_2}{1{,}000}\right)^2 \times A_2\right\} \times \cdot 014,$$

and since the two air-gaps are in the same magnetic circuit the total flux in both must be the same, or $B_1 A_1 = B_2 A_2$. From these two expressions the necessary values of B_1 and B_2 for a given pull can be obtained. The number of ampere-turns required to pass the flux through the two air-gaps is

$$(B_1 l_1 + B_2 l_2) \times \cdot 313.$$

A small addition should be made to this number of ampere-turns to allow for the iron core. The section of the iron core should be sufficient to carry a flux equal to $B_1 A_1$ or $B_2 A_2$, together with a certain amount of leakage—say, 15 to 30 per cent.—with a flux density not exceeding about 100,000 C.G.S. lines per square inch if

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the core is of wrought iron or steel, or about 40,000 if it is of cast iron. Knowing the number of ampere-turns required either by calculation as above, or, in the case of a plain solenoid, by experiment, the winding can be decided as follows: If the coil is to be series wound for a current of C amperes the number of turns required is simply ampere-turns ÷ C, and the size of the wire should be chosen to give a current density of from 1,000 to 2,000 according to the depth of winding. The value of the current density should be checked by working out the number of watts per square inch of outer surface of the coil which should not exceed ·5 to ·75 watt per square inch. In the case of a shunt-wound coil the size of wire is determined by the expression

$$\text{Area of wire in square inches} = \frac{\cdot00000077 \times \text{Mean length of one turn in inches} \times \text{Ampere-turns required}}{\text{Volts across the coil}}$$

In this case the number of turns to be put on must be decided by a trial calculation, so as to give about ·5 to ·75 watt per square inch of outer surface of coil.

With regard to the second part of the question, it is not possible to give definite values for the magnetic reluctance, R, the magnetising force, H, or the magnetic density, B, for such a solenoid, for its magnetic circuit is composed partly of the iron core and partly of a very indefinite air circuit. The density, B, varies at every part of the core, being a maximum at a point midway between the ends of the coil and gradually falling off towards the ends. At the same time a knowledge of these quantities would be valueless in determining the pull. The M.M.F. of the solenoid stated in ampere-turns is simply the total number of ampere-turns on the coil—viz.: 6 × 48 × 10 = 2,880 in this case. Stated in C.G.S. units, the M.M.F. is $2{,}880 \times \frac{4\pi}{10} = 3{,}620$.—Q.

Answer to No. 505 (*awarded* 7*s.* 6*d.*).—Pull in weight is one of the main points in the design of these coils. The series coil strikes the arc and has to be strong enough to support the rods and carbons of the arc lamp. The shunt coil is designed so that when the D.P. across the arc is 45 volts, its pull will be equal to that of the series coil.

Rules and Formulæ for Design.—(1) Straight cores should be twice as long as the coil; (2) the coil should be about six times its diameter. The mechanical force on the core is known when we know (1) the strength of the field; (2) the susceptibility of the material; (3) the rate at which the field varies in the direction of the motion. The strength of the field; let us take an example: current, 15 amperes; length of solenoid, 15·24cm.; length of plunger, 20·32cm.; core diameter, 1·50cm.; core area, 1·96 square centimetres; number of turns, 220; plunger, 6·98cm. from top, 13·33cm. inside solenoid.

$$N = \frac{1{\cdot}25 \text{ S.C.}}{\frac{l_1}{\mu_1 a_1} + \frac{l_2}{\mu_2 a_2} + \frac{1{\cdot}273\, l}{d\,(2\,l - d)}}$$

$\frac{l_1}{\mu_1 a_1} = \frac{13{\cdot}33}{1{\cdot}96 \times 1{,}000} = {\cdot}006$ = reluctance of iron core.

$\frac{l_2}{\mu_2 a_2} = \frac{7}{1{\cdot}96} = 3{\cdot}5$ = reluctance of air space inside solenoid

$\frac{1{\cdot}273\, l}{d\,(2\,l - d)} = \frac{1{\cdot}27 \times 15{\cdot}24}{1{\cdot}58\,(30{\cdot}48 - 1{\cdot}58)}$ = reluctance of air space outside solenoid.

Total reluctance = 3·926.

$$N = \frac{1{\cdot}25 \times 220 \times 15}{3{\cdot}9} = 1{,}058.$$

Plunger, 4·98cm. from top; 15·33cm. inside core.

Then $\frac{l_1}{\mu_1 a_1} = {\cdot}008.$

$\frac{l_2}{\mu_2 a_2} = 2{\cdot}5.$

$\frac{1{\cdot}273\, l}{d(2\,l - d)} = {\cdot}42.$

Total reluctance = 2·928.

$$N = \frac{1{\cdot}25 \times 220 \times 15}{2{\cdot}9} = 1{,}422.$$

Increase of lines of force = 364 in 2cm.; = 182 in 1cm.; = 91 per centimetre.

F dynes = 529 × 91 × 6; F dynes = strength of field × rate of increase of field × susceptibility of material.

F = 290 grm.

Pull = 1lb. 4oz.

The current taken by the shunt coil should be very small, about ·25 ampere. Coil supposed to be straight.

M.M.F. = 1·25 S.C.
= 1·25 × 48 × 10
= 600.

$$H = \frac{1{\cdot}25 \text{ S.C.}}{l} = \frac{1{\cdot}25 \times 48 \times 10}{15} = 400.$$

(This formula is not strictly correct; the value of H is nearer 366).

Permeability of iron taken as 500:

$R = \frac{l}{a\,\mu}$ reluctance of iron
$= \frac{15}{1{,}500}$
$= {\cdot}001.$

$R_2 = \frac{1{\cdot}273\, l}{d\,(2\,l - d)}$ reluctance of air
$= \frac{1{\cdot}273 \times 15}{2 \times 28} = 34.$

$N = \frac{6{,}000}{{\cdot}001 + {\cdot}34}.$

N = 18,000.

$B = \frac{N}{a} = \frac{18{,}000}{3}$
= 6,000 through the core.—P. A.

Answer to No. 505 (*awarded* 5*s.*).—Arc lamp cut-out and motor-starting solenoids are generally designed to have a certain number of ampere-turns on them. This number of ampere-turns is generally found by experiment; the winding must be of such a type that not more than one watt waste per 1·5 square inches of surface is obtained. This amount of surface is generally taken as the circumference of the outside of the winding, multiplied by the length of the winding. To find the waste watts, let D stand for inside diameter of winding of coil; F, outside diameter of winding; B, distance between insulation on flanges; S, number of spirals; C, current passing through the winding; R, resistance per unit length of wire.

Mean turn $= \frac{D+F}{2} \times \frac{3{\cdot}1416}{1}.$

Total length $= \frac{D+F}{2} \times \frac{3{\cdot}1416}{1} \times \frac{S}{1}.$

Resistance $= \frac{D+F}{2} \times \frac{3{\cdot}1416}{1} \times \frac{S}{1} \times \frac{R}{1}.$

Watt waste $= \frac{D+F}{2} \times \frac{3{\cdot}1416}{1} \times \frac{S}{1} \times \frac{R}{1} \times \frac{C^2}{1}.$

Area of surface = F × 3·1416 × B.

Having given the following particulars for a motor-starting overload-type solenoid: D, 1in.; F, 2½in.; outside diameter of coil not to exceed 3in.; 1,500 ampere-turns required on the coil, with a current of 10 amperes; total number of turns or spirals = $\frac{1{,}500}{10}$; therefore S = 150. Assume a current density of 1,500 amperes per square inch sectional area of the wire. Area required = $\frac{10}{1{,}500} = {\cdot}066$in., area = ·092in. diameter = 13 S.W.G. Add ·020in. for covering, total diameter = ·112in.

S per layer = $\frac{2{\cdot}5}{{\cdot}112} = 22$;

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Number of layers $= \frac{150}{22} = 7$;

Depth of winding per side = ·112 × 7 = ·784, say ·8;

F = 2 × ·8 + 1 = 2·6in.;

Mean turn $= \frac{2{\cdot}6 + 1}{2} \times 3{\cdot}1416 = 5{\cdot}65$in.;

Total length = 5·65 × 150 = 847·5in., say 71ft.
R per foot from table-book = ·00122 ohm at 60deg. F.;
R of coil = ·00122 × 71 = ·08662 ohm;
Watt waste = ·08662 × 10 × 10 = 8·66 watts;

Area of surface = 2·6 × 3·1416 × 2·5 = 20 42 square inches; so that 8·66 watts are lost for 20·42 square inches of surface, which is under one watt per 1·5in. of surface. A fresh calculation can now be made, using a smaller size of wire. If wound with 14 S.W.G., 10 watts will be lost, the coil now having a surface of 17·3 square inches, so that it now complies with all the particulars given.—C. G.

Answer to No. 505 (*awarded* 5*s.*).—The principles on which the primary and secondary coils of electromagnetically controlled arc lamps are based depends, in the first place, upon the general mechanism—that is, on the size and weight of the several parts.

Providing the lamps are exactly similar, then the ampere-turns on the secondary or shunt coil in each lamp should be the same, also the ampere-turns on each primary coil. Then should the permeability of the iron cores in the lamps be the same, then the magnetic pull will be likewise. Thus, after attending to the mechanism of the lamps as to weight, etc., the permeability of the iron to be employed should be either ascertained from tables as tested for, so that its saturation point can be found, and also the dimensions of the iron that are necessary for a given M.M.F. In regard to the mechanism of the lamps, in lamps such as the Brockie-Pell the top carbon-holder is weighted so that when out of action it descends by gravity, and brings the carbon points into contact. Therefore, the magnetomotive force of the primary coil must be such as to overcome the extra weight attached to the carbon-holder and the brake arrangement, together with the greater weight of the positive carbon, and also the friction of the several points of suspension, and the resistance of the air in that dash-pot, and the opposition offered by the secondary on account of the continued small current that passes during the working of the lamp. The weight of the iron cores in the lamp referred to need not be considered on account of being counterbalanced by the core in the secondary. Thus all the forces tending to bring the carbons together act in opposition to the magnetic pull due to the primary coil, whilst they act in favour of that set up by the secondary. Therefore, the magnetomotive force of the secondary should not be so great, which, providing the pressure of the circuit in which the lamps are to be worked is known, determines what the relative resistance the primary and secondary should be. In regard to the cut-outs, these cannot be considered much more than simply automatic, being put in action mechanically by the descent of the iron core from the coil on the circuit being broken, by the action of which the current is shunted away from the lamp. The magnetic pull set up by a very few turns, which is wound on the limb of this small electromagnet, is all that is necessary to overcome a weak spiral spring. So that the principle resolves itself into a divided circuit of three branches—that of the primary, secondary, and the resistance across the arc itself, which again may be resolved into two—that of primary and secondary. Thus, when the resistance of the arc, together with the primary, becomes nearly equal to that of the secondary coil, the same current is passing through each circuit; but the shunt coil having over 4,000 turns, the magnetomotive force is almost equal to that set up by the primary when the carbon points are together, and it will be seen that the above, to a great extent, determines the length of the arc.

Having approximately calculated the weight that the M.M.F. of the primary coil will have to overcome, the value of μ, the permeability of the iron to be used as cores, can be got from tables, after which we can decide on the value of induction, B, at which it would be safe to work the iron of the cores so as to come below their saturation point; then from this value of B the pull in pounds can be calculated thus:

$$\frac{B^2 s}{8\pi \times 453{\cdot}6 \times 981} = \text{pounds},$$

where s represents the cross-sectional area of the iron.

In reference to the coil in question, the total number of lines, or flux, $N = \frac{\text{M.M.F.}}{R}$.

Then where C represents the strength of the current in amperes, T the total number of turns on the coil, the M.M.F. will be equal to

$$\frac{4\pi C T}{10} = 1{\cdot}257 \times C \times T$$
$$= 1{\cdot}257 \times 10 \times 288 = 3{,}620 = \text{M.M.F.}$$

The magnetic resistance is obtained from the dimensions of the core, together with the value of μ, thus:

$$\frac{1}{s \times \mu} = R.$$

Therefore, the total flux, N,

$$= \frac{\text{M.M.F.}}{R},$$
$$= \frac{\frac{4\pi C T}{10}}{\frac{1}{s \times \mu}} = N.$$

The value of H will vary with the density of the convolutions, or the number per unit length of solenoid. Therefore the value of H equals

$$\frac{4\pi C T}{10 \times 1} = \frac{\text{M.M.F.}}{1}$$
$$= \frac{3{,}620}{15} = 241{\cdot}33.$$

Then, $B = \frac{N}{s} = \frac{N}{\pi} = X$, which can be calculated when the value of μ is known.—K.

Question No. 506.—What is the action of the balancing rings on large traction generators, and how would you ascertain at which points to connect them up to the armature; and if you happened to connect one up in the wrong place, what would be the result?

Answer to No. 506 (*awarded* 10*s.*).—These balancing rings are employed on large multipolar generators, having parallel-coupled armatures for the purpose of ensuring that the different brushes of like sign shall contribute approximately equal currents to the circuit. In such generators it is found difficult, if not impossible, to make all the poles of equal magnetic strength, owing to unequal air-gaps, quality of steel, etc. Consequently the voltages existing between different + and − brushes are never quite equal, and, since all the brushes of similar sign are permanently connected together by the brush rings, these voltage differences are liable to give rise to large internal currents when the machine is running on open circuit, whilst when running on load they cause certain sets of brushes to do more and others less than their proper share. This inequality of the brush currents in itself causes sparking, but a far more serious difficulty arises from the fact that as soon as a given part of the armature becomes overloaded its increased armature reaction tends to right matters again, but owing to the time lag between the armature current and its effect on the field, the current first rises too high and then falls too low for stability, and this alternate rise and fall is liable to go on, gradually increasing in violence, until a flash-over occurs at the brushes or until the vibration set up in the magnets wrecks the machine.

By providing internal cross-connections in the armature winding to aid the brush rings in carrying the balancing currents, it is found possible to prevent this violent surging, and at the same time keep the current practically equal in all the brushes (most of the balancing currents being carried by the cross-connections owing to their low resistance compared with that of the brushes). In order to prevent these cross-connections carrying anything beyond the balancing currents, they are so placed as to connect

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points on the winding which would always be at equal potentials if the magnets were perfectly symmetrical. When some of the poles are stronger than others, a difference of potential is set up between these points, and a current flows along the balancing connection. Such points are those which are similarly situated under poles of similar sign. Thus, in the case of a four-pole machine, each balancing ring would be connected to any two diametrically opposite points of the winding, and in a six-pole machine each ring would be connected to any three points, separated from one another by a third of a circle. It is usual to provide from three to ten of these rings. The greater the number the more perfect will the balancing be, and the smaller will the balancing current passing through any one portion of the armature be.

The relative positions of the connections to different rings are of no great importance, though they should, naturally, be as nearly equally distributed around the armature as possible. Fig. 1 shows a six-pole machine

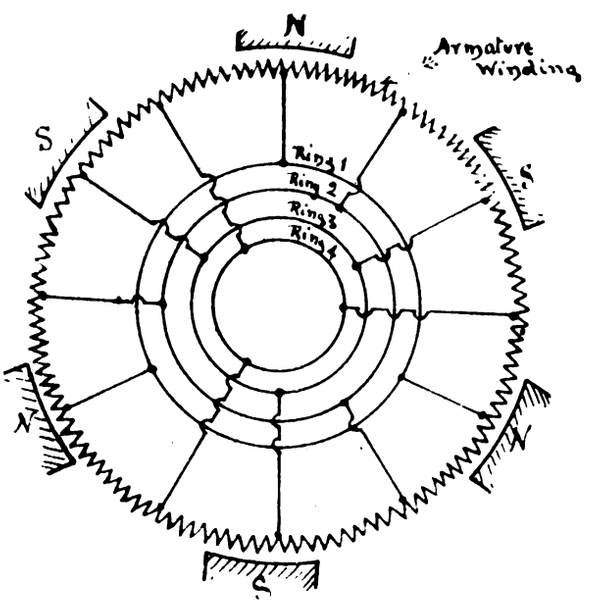
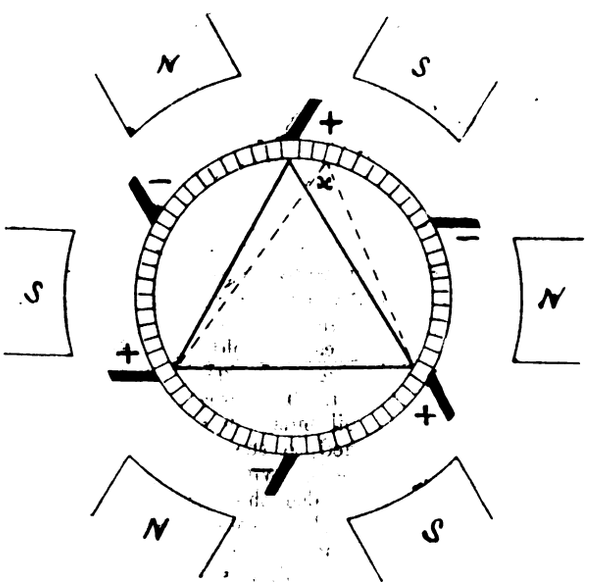


FIG. 1

fitted with four equalising rings. The connections to balancing rings are generally, for the sake of simplicity, made directly to the commutator plates or lugs. When the number of commutator plates is indivisible by half the number of poles of the machine, it becomes impossible to space out the different connections to a ring exactly equally—the span at some points must be greater by a plate or two than that at other points. Though this is undesirable, it does not entirely prevent the use of balancing rings, so long as the error in span does not exceed one or two plates in 100, as the only effect is to increase the balancing current and to cause a certain amount of current to flow in the ring, even when the magnets are perfectly symmetrical. Exactly the same result is obtained when an error is made in one of the ring connections on a winding in which the commutator plates are divisibly by half the poles. If the error exceeds one or two plates in 100, the balancing current will be so much larger at one point on the armature than at others that it will make itself noticeable by a more or less violent vibration of the machine, due to the powerful effect of the large balancing current on the different poles as it passes under them in succession.—Q.

Answer to No. 506 (*awarded* 5*s.*).—Balancing or equalising rings are fitted to multipolar dynamos in order that all brushes of the same sign may be kept at an equal potential. It is generally found impossible to make these large machines symmetrical; this want of symmetry causes varying potentials at the brushes. Although the difference may be but slight, yet owing to the low resistance of the armature, the resulting currents may be large and give rise to sparking. The object of balancing rings is to carry these currents instead of allowing them to pass through the brushes. These rings are often placed at the back end of the armature connected to the bars of armature winding, which are lengthened for that purpose. To ascertain where to connect the rings to armature winding, divide the number of poles by 2. Thus, in the case of a six-pole machine, each ring will have three connections, each connection being an equal distance apart. Although we may say the points of connection subtend an angle of 360/3 = 120deg., an armature winder would carefully count the turns of the armature winding before connecting up. As to the number of rings used to carry out the system perfectly in a six-pole machine having 300 sections, 300/3 = 100 balancing rings would be required; in practice, however, the number rarely exceeds four. The diagrammatic sketch shows connections of a balancing ring for a six-pole dynamo; black line is the *correct* position, dotted line shows *faulty* connection at *x*. In this case, as the total E.M.F. of the machine is generated between each negative and positive brush, the bar at *x* would be at a lower potential that the normal, consequently currents would flow from the two opposite positive brushes to *x*. The E.M.F. of bar at *x* would then be increased, resulting in the potential of the



positive brush nearest to *x* being raised. Thus the fault intended to be cured by the balancing connection would be made worse. Suppose *x* shifted nearer and nearer to the negative brush, or, rather, the position the brush has in sketch, because the rings rotate with the armature whilst brushes are fixed, we should finally have a dead-short-circuit. Balancing rings are an American rather than an English practice, being very seldom fitted by makers in this country. Dynamos used as traction generators are subject to sudden and large changes of load, this greatly accentuating troubles caused by want of electrical balance; machines used for this purpose are the ones usually fitted with equalising rings. Among the causes of want of electrical balance may be mentioned want of uniformity in magnetic permeability of the pole-pieces, variation in magnetic reluctance caused by bad joints and unequal sizes of frame, and eccentricity of armature in the machine. I would recommend "T." to read the abstract of an article on this subject by Prof. E Arnold in the issue of this paper for June 13, 1902. There he will find some valuable information.—M. M.

Answer to No. 506 (*awarded* 5*s.*).—In all multipolar armatures which are "parallel" or "lap" wound there is always a tendency, even if the machines are carefully balanced, for slight differences of potential to exist between the brush arms of like sign. This may be due to small inequalities in the length of the air-gaps or differences in the quality of the material, etc., causing some poles to be stronger than others. These slight differences of potential set up circulating currents between the respective brush arms, which, being all of the same sign, are joined together by a copper terminal ring or by cables. These currents return through the armature windings, and in doing so pass through the two sets of brushes. We thus see that these circulating currents do harm in two ways: (1) they

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overload the brushes, and so cause sparking; (2) they overheat the armature and tend to cause "bucking," as the resistance of the closed circuits in which these currents flow is so low (consisting, as it does, only of the contact resistances of the brushes and the resistance of a section of the armature winding) a very small difference of potential can set up a very considerable circulating current, which will cause these effects to occur in a marked degree.

A third effect of these currents which might be mentioned is that owing to the increase of current flowing in the armature conductors it has a greater demagnetising effect on the field, and we shall, therefore, require a larger exciting current. In some cases this increase of exciting current has been so much that it could not be obtained even when all the external resistance was removed from the circuit, so that the machine would not give its full voltage on load. By means of equalising or balancing rings we can cure all these effects to a considerable extent. They consist of two or more insulated closed rings fixed on the armature, each being joined up to a set of points in the armature winding which are always (except for the slight out-of-balance voltage which we are trying to doctor) at the same potential. The number of points in each such set will obviously be equal to the number of brush arms of like sign—*i.e.*, equal to the number of pairs of poles. In order, therefore, to be able to fit balancing rings to any particular armature, the number of coils (or units into which the winding may be divided up by the connections from the rings) must be divisible by the number of pairs of poles. If it is not exactly divisible the connections will not be exactly equally spaced—*i.e.*, they will not connect points of the same potential, and hence they will, instead of curing, set up fresh circulating currents which may easily be worse than those which were there in the first case. This is the effect if the rings are connected up in the wrong place. The number of balancing rings varies with the size of machine from two to six or more, but the greater the number the more perfect the balance. The points of connection of consecutive rings to the armature winding are made as near as possible the same distance apart all round the armature, but this is not essential.

The principle of the balancing rings is that they provide a series of paths between points of the same potential in the armature which have a very much lower resistance (owing to the contact resistance of the brushes being eliminated) than the alternative path through the "terminal ring" *viâ* the brushes. The current accordingly takes this path, and relieves the brushes. Again, the mutual action between the rings is such that when the currents meet in the armature winding, which is the "common return" for all of them, they oppose one another, and to a large extent wipe each other out. This reduces the overheating and the demagnetising effect.—T. SQUARE

LEGAL INTELLIGENCE.

BRIGHT'S LIGHT AND POWER COMPANY.

The case of Bright's Light and Power Company, Limited, *v.* Wingfield came before Mr. Justice Swinfen Eady, the vacation judge, on Wednesday, on a motion asking that the name of the company be struck out. It was really a contest between Messrs. Wingfield, Wharton, and Blair on the one side, and Messrs. Moreno, Bright, Vidal, and Semmelhaack on the other as to which were the real set of directors of the company.

His Lordship said the length of his list would prevent him finishing the case that day, and he directed the further hearing to be adjourned until Wednesday next.

OVERCROWDING TRAMCARS.

A Leeds magistrate gave an important decision on Tuesday affecting the question of the overcrowding of tramcars. A conductor was summoned for overcrowding his car on Lifeboat Saturday. It was contended that the Corporation had no by-law on the subject, but that the Corporation had come into possession of the lines with certain legal obligations. The magistrate reviewed the by-laws which had been previously enforced, and ruled that conductors were liable to a fine for permitting overcrowding. He imposed the nominal penalty of 5s., and remarked that he hoped this would effectually prevent overcrowding, which had long been a grievance in Leeds, where passengers had been allowed to stand both inside and outside the cars to the great annoyance of many citizens.

COMPANIES' MEETINGS AND REPORTS.

MERSEY RAILWAY.

The report of the directors for the half-year ended June 30 last states that the total receipts from all sources for the half-year have been £31,781, as compared with £38,327 for the corresponding period of 1901. The working expenses have been £29,456, or at the rate of 92·68 per cent., as against £33,499, equal to 87·40 per cent. for the corresponding six months of 1901. The exceptional charges for pumping, ventilation, and hydraulic lifts for the past six months amounted to £6,389, equal to 20·10 per cent., as compared with £7,917, or at the rate of 20·66 per cent. for the corresponding period of 1901. The working expenses, exclusive of the exceptional charges above referred to, have been £23,066, equal to 72·58 per cent., as against £26,582, equal to 66·74, for the corresponding six months. The number of passengers conveyed during the six months has been 3,104,294, as against 3,728,292 for the corresponding period of 1901, exclusive of season-ticket holders. The directors state that the continued decrease in the traffic receipts is due to the competition of the Birkenhead tramway system, worked by electricity, as compared with the railway worked by steam. The works for enabling the railway to be worked by electrical power are well advanced.

LANCASHIRE ELECTRIC POWER.

The fourth ordinary general meeting of this Company was held on Wednesday last week in London, Mr. N. Scott-Russell presiding.

The **Chairman** explained that the meeting was called in pursuance of the requirements of the Act of Parliament, and was purely formal. He might state, however, that before the holidays the directors had almost completed their arrangements for financing the Company, but as they had run it a little too close it had been decided to postpone the issue of the prospectus until October. They had made arrangements contingently upon raising the capital which was practically all underwritten, to supply electric power to the eastern part of their district from Trafford Park to Rawtenstall, taking in the small towns *en route*.

APPOINTMENTS VACANT.

Resident Electrical Engineer, Hoylake and West Kirby Urban District Council, £250 per annum, Sept. 2.

Chief Assistant Engineer, Dewsbury Corporation Electric Light and Power Department, £120 per annum, Sept. 2. See advertisement.

Meter Reader and Tester, Sunderland, 30s. per week. See advertisement.

Engine and Dynamo Attendant, Denbigh Asylum, 32s. per week. See advertisement.

Junior Assistant, mechanical and electrical training essential, £65 a year. See advertisement.

Wireman, first-class hands need apply only. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Calarasi-Stirbey (Roumania).—The Municipality require tenders for public electric lighting. Tenders by Sept. 3.

Nisch.—Tenders are invited for the electric lighting of the town. The central station, cables, etc., are estimated to cost 600,000 dinars.

Madrid.—The Public Works Department require tenders for an electric tramway from Vigo to Bayona. The deposit required is 19,993 pesetas. Tenders by Sept. 29.

Limerick.—The Corporation invite proposals for the wiring of consumers' premises on the "hire-purchase" or any other system. Tenders by Sept. 1. See advertisement.

Christiania.—The Norwegian Government Railways require tenders for 27,400 kilos galvanised iron telegraph wires, 3,600 copper wire, 5,900 porcelain insulators and holders by Sept. 13.

Kirkcaldy.—The Corporation invite tenders for the supply and delivery of electricity meters. Specification, etc., can be obtained from Mr. W. L. MacIndoe, town clerk, Town Clerk's Office, Kirkcaldy. Tenders by Sept. 8.

Paris.—The Colonial Office require tenders for galvanised iron telegraph wire as follows: Tonkin, 100.000 kg. of 5mm.; 2,000 kg. of 2mm.; for Cochin-China, 50.000 kg. of 5mm.; 1,000 kg. of 2mm., by Sept. 9. 4, rue de Jean.

Bedford.—The Corporation invite tenders for the supply and delivery of two boiler feed-pumps. Specifications, etc., can be obtained from Mr. R. W. L. Phillips, borough electrical engineer, Cauldwell-road, Bedford. Tenders by Sept. 15.

Bristol.—The Board of Guardians invite tenders for supply of boilers and electric wiring and fittings, etc., for their infirmary proposed to be erected for the accommodation of about 875 sick patients at Stapleton. Tenders by Sept. 10. See advertisement.

Orense.—The Municipal Authorities invite tenders for the installation and working for 20 years of electric lighting the above. One hundred 16-c.p. lamps will be paid for at the rate of 3,500 pesetas per annum. Tenders to the above authorities, province Celanova, by Sept. 23.

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Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories Tenders by Sept. 15. See advertisement.

Bexley.—The Electric Lighting and Traction Committee invite tenders for permanent way, bonding, overhead equipment, car bodies, trucks, and electrical equipment. Specification, etc., can be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster. Tenders by Sept. 4.

West Ham.—The Council are inviting tenders for steam, exhaust, feed-water, and drain piping, water softener, steam traps and separators, and circulating and air pumps, discharge piping, water purifier, and vapour pipes for the electricity works. Tenders by Sept. 4. See advertisement.

Manchester.—The Electricity Committee invite tenders for the steelwork in the construction of a high-level railway at their Stuart-street generating station, Bradford, Manchester. Specification, etc., can be obtained on application at the City Surveyor's Office, Town Hall, Manchester. Tenders by Sept. 1.

Manchester.—The Tramways Committee invite tenders for electrical repairing stores, electrical fitters' tools, oil, and grease. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by 1 p.m. on 30th inst.

Cabeza del Buey (Spain).—The Municipal Authorities invite tenders for installation and working, for not more than 25 years, of electric lighting; about 3,000 c.p. are now required, for which a maximum of 3·33 pesetas per annum will be paid. Tenders by Sept. 19 to the above authorities, province of Badajoz.

Blackpool.—The Electricity and Tramways Committee invite tenders for about 310 yards of 20in. gauge tramway rails and 10 wagons, to be supplied to the electricity works, West Caroline-street. Particulars on application to Mr. Charles Furness, the borough electrical and tramway engineer. Tenders by Aug. 31.

Swansea.—The Council invite tenders for the whole or portions of the following: supplying and laying telephone conduits and cables, erecting telephone poles, standards, arms, etc., fixing subscribers' instruments, the supply of creosoted telephone poles, insulators, wooden arms, ironwork, galvanised iron arm bolts, nuts, and washers, wire, batteries, instruments, switchboards, etc. Tenders by Sept. 1. See advertisement.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

Pietermaritzburg.—Tenders are invited for the supply and delivery, free on rail, Pietermaritzburg, Natal, South Africa, of six miles of Vignoles rails, 704 pairs of fishplates (complete with bolts and nuts), 21,120 dog spikes, 1,408 crab bolts, nuts, and fang clips, and 1,760 copper bonds. Specifications, etc., may be obtained from the office of the Borough Engineer, Pietermaritzburg, or from the Corporation's London agents, Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, London, W. Tenders by Sept. 15.

Pietermaritzburg.—Tenders are invited for the supply and delivery, free on rail, Pietermaritzburg, Natal, South Africa, of eight miles of girder rails, 938 pairs of fishplates (complete with bolts and nuts), 938 sole-plates (complete with bolts, nuts, and clamps), and 2,345 copper bonds. Specifications, etc., may be obtained from the office of the Borough Engineer, Pietermaritzburg, or from the Corporation's London agents, Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, London, W. Tenders by Sept. 15.

West Ham.—The Corporation invite tenders for the construction of about eight miles of route length of tramways, and the paving of the sides of roads along the entire route, as follows: (Contract No. 1) permanent way and paving, including copper bonding; (1A) paving sides of roads. Specifications, etc., may be obtained for Contract No. 1, at the offices of Mr. J. E. Waller, M.I.C.E., 29, Great George-street, Westminster; for Contract No. 1A, at the office of the borough engineer, Mr. John G. Morley, Town Hall, West Ham. Tenders by Sept. 4.

Amsterdam.—The Board of Trade have received through the Foreign Office copy of a dispatch from H.M. Consul at Amsterdam reporting that on Sept. 8, at 12 noon, the Municipal Council of Amsterdam will receive tenders for the delivery and laying of the entire network of cables for the municipal electric works, consisting of about 150 km. high-tension, 70 km. low-tension, and 25 km. telegraph and telephone cable, with the necessary accessories. Particulars may be obtained from the Municipal Printing Office at a cost of 2·50fr. (4s. 2d). Information will be supplied at the office of the Director of Electrical Works, O. Z. Achterburgwal 213, Amsterdam.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tientsin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of land-owners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

King's Norton, Birmingham.—The Urban District Council are prepared to lease their powers obtained under their electric lighting order in 1898. The area of supply comprises the whole of the civil parishes of King's Norton and Northfield, in the county of Worcester. The streets scheduled for supply within period limited by the order are all within the wards of Moseley and King's Heath, which together contain a population of 20,400. Prints of the order may be obtained from the Government printers, Messrs. Eyre and Spottiswoode. The engineer is Mr. A. W. Cross, A.M.I.C.E., 23, Valentine-road, King's Heath, Birmingham, to whom enquiries for further particulars should be addressed. Preliminary offers must be addressed to Mr. Edwin Docker, clerk to the Council, 10, Newhall-street, Birmingham, and reach his office by Sept. 18.

Leicester.—The Tramways Committee invite tenders for electric tramway works and materials, under the following sections, each comprising a separate contract. For supply and delivery of steel girder tramway rails and fishplates; supply and delivery of bolts, nuts, and tiebars; supply and delivery of points, crossings, and special track work; supply and delivery of stoneware pipes and conduits; supply and laying of feeder cables, telephone and test wires, and supply and delivery of roadway frames and covers; supply and erection of overhead electrical equipment, and the supply of copper bonds; supply and erection at the power station of steam-raising plant; supply and erection at the power station of engines, generators, battery, boosters, switchboard, overhead travelling crane, etc.; supply and delivery of electric tramcars. Specification, etc., may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., engineer, Town Hall, Leicester. Tenders by Sept. 3.

RESULTS OF TENDERS.

Peterborough Tramways.—The Corporation have decided to instal 250 h.p. of Willans engines, direct coupled to multipolar traction generators made by Crompton and Co., Limited, for supplying power to the tramways owned by the British Electric Traction Company.

Victoria (Argentine).—Messrs. Willans and Robinson, Limited, Rugby, have received an order for two of their 100-h.p. standard compound engines, which will be coupled to machines made by the General Electric Company of New York. This plant is to be used for traction and lighting purposes.

Sunderland.—The Corporation have accepted the tender of Dick, Kerr, and Co., for permanent way, and Siemens Bros. and Co. for overhead equipment in connection with the tramway extensions.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board have accepted the following tenders for the construction of permanent way (Contract No. 5): (Section A, Stalybridge and Mossley), Underwood and Bro., Dukinfield; (B, Dukinfield and Hyde), Dick, Kerr, and Co., 110, Cannon-street, London, E.C.

Swansea.—The Corporation have accepted the tender of H. Billings, Swansea, at £2,297, for the erection of the proposed municipal telephone exchange buildings.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Bridgend.—The District Council have decided to advertise for tenders for electrical plant, etc.

Rice Mill.—A rice mill to go by electricity and utilise rice husks as fuel is to be erected by a local prince in Siam.

Dover.—The electric illuminations on the sea-front are to be continued nightly from 8 to 10 instead of 8.30 to 10.30.

Keighley.—The Town Council intend to apply for further borrowing powers to the extent of £6,000 on electricity account.

Limerick.—The Borough Council have decided to appoint a canvasser in the electricity department, to be paid by results.

Worksop.—The question of the charges for electric lighting and the wiring of private houses is before a committee of the Urban District Council.

Broadstairs.—Electric light has now been installed in the district, the Council having entered into an arrangement with the tramway company.

Uxbridge.—The Uxbridge and District Electric Supply Company have recently acquired the title and interest of the Northwood Electric Light Company.

Cannock.—The Urban District Council have decided to appoint an engineer to advise the Council with regard to using their provisional order for electric lighting.

Pontypool.—The Guardians have obtained assent to the proposal to light the workhouse by electricity, and Messrs. Alger and Son have been instructed to proceed with the work.

Wigan.—The "demand" indicators in stock at the works are to be exchanged for meters on the terms stated by the engineer, and subject to an agreement to be prepared by the town clerk.

Levenshulme.—The electricity department of the Manchester Corporation have informed the Council of their ability to supply electricity to the district for lighting purposes by Sept. 7.

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Tonbridge.—Sixty-five applications have been received for the post of electrical engineer, at a salary of £150 a year. Mr. J. A. B. Horsley, assistant to Mr. R. Hammond, has been appointed.

Bedwellty.—The question of the Council applying for a provisional order for supplying electricity for power and lighting purposes within the district will be discussed at a special meeting on Sept. 29.

Burnley.—An offer from Messrs. Watney, electrical engineers, to convert the hydraulic lift at the infirmary into an electric lift at a cost of about £230 is before the House Committee of the Guardians.

Newcastle.—Mr. W. B. Woodhouse, A.M.I.M.E., who was formerly chief assistant, has been appointed resident engineer at the Neptune Bank power station of the Newcastle Electric Supply Company.

Barnsley.—The Council have decided to apply for borrowing powers of £4,500 for additional electric light, in consequence of the probable requirements of the Barnsley and district light railway and other customers.

Trunk Telephone Wires.—The trunk lines are shortly to be considerably increased in number, the Treasury having recently sanctioned the money for the provision of over 70 new wires to the most busy provincial centres.

Caerphilly.—The District Council have decided to write to three electrical engineers for terms for reporting to the Council on the advisability of supplying the district with electric light and for applying for a provisional order.

Wakefield.—The Guardians intend to apply for sanction to borrow £1,850 for additional electric lighting, including that of the space between the infirmary to the new workhouse buildings, and the drives and walks about the same.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in Cape Town Consolidated Tramways and Land Company's 400,000 shares of £1 each, fully paid, Nos. 1 to 400,000.

Temple Church.—The electric light at the Temple Church having been found inadequate, the present installation is being doubled, and the lighting arrangements will be completed in time for the reopening of the church early in October next.

Ebbw Vale.—The terms of the sliding scale of the South Wales Electrical Power Distribution Company have been approved by the District Council, and it was decided to request the manager to meet the Council to consider the question of supplying the district.

Birkdale.—We are informed that the electric lighting authorities are in the pleasant position of being nearly overwhelmed with applications for the light. Consequently it has been decided to extend the cables along Oxford, Westbourne, Waterloo, and Lancaster roads, and other roads if necessary.

Nantwich.—Colonel Langton Coke has held an enquiry into the Urban District Council's application for sanction to borrow £12,505 for electric lighting purposes. The Council are of opinion that they will save £3,000 in carrying out the electric lighting scheme before their water supply, etc., schemes.

Lanchester.—The Esh Parish Council have arranged with the Hamsteels Colliery Company for lighting Quebec with the electric light, and the Council are not averse to the extension of the electric lamps as far as Wilk's-hill in place of the present lights providing satisfactory terms can be arranged.

Great Harwood.—The Council have received notice that the undertakers under the Rishton, Great Harwood, and Clayton-le-Moors Electric Lighting Order are unable to comply with the terms of Section 9 of the order, together with an offer to transfer, for a consideration, the powers to the Council.

Removal.—Messrs. Rosling and Fynn, Limited, Trafalgar Works, Bradford, have moved their plant and offices to new works, also styled Trafalgar Works, and situated at Thornbury, Bradford. These works have been laid out on the most modern lines, with a view to cheapen and extend the manufacturing capacities and stock of dynamos and motors.

Grimsby.—The Corporation have decided to reduce the price of electricity from 5d. to 4½d. per unit from Oct. 1. The table of discounts varies, but all consumers of over 500 units will get at least a reduction of 12½ per cent., and smaller consumers will get 10 per cent. The price of power for heating and cooking is 2½d. per unit, with discount.

Dollars and Pounds.—We have received from the Fairbanks Company, City-road, E.C., for review a little table for converting American dollars into English pounds, which they are publishing at a price of 6d. each. The items from one cent to 5,000dol. are set out. A few useful rules for converting metric measures and weights into English are attached.

Telegraphy.—The German postal authorities are experimenting with a new rapid transmission apparatus, which is described as an improvement made by Mr. Donald Murray upon the Wheatstone apparatus. By its means 12 telegrams, six in each direction, may be sent with one single wire. The message is printed by the receiver in letters, instead of the Morse dots and dashes.

Dewsbury.—An enquiry has been held into an application of the Corporation for sanction to borrow £10,000 for the extension of the electricity works, rendered necessary to meet the demands of the British Electric Traction Company, which had agreed to take energy from the Corporation for the running of their electric cars. There was no opposition, and the proceedings throughout were formal.

The September "Smart Set."—Amongst much that is clever and amusing, but principally pleasant to read, we note "A Friend of Cara's," by Louise Betts Edwards, and "The Story of Jees Uck," by Jack London, the latter an Alaskan yarn, powerful and well written. It is a speciality of this magazine that its stories don't leave you with a nasty taste in your mouth after you have finished them.

Rosario.—It is reported that a contract has just been entered into between the Argentine Government and the Creusot Company, of Paris, for the construction of the port of Rosario. A period of six years is allowed to the firm to build about 3½ miles of quays and docks, with electric cranes and a railway line, besides a corn elevator of 1,000,000 bushels capacity. The cost of the extensive works is estimated at £2,200,000.

Greenock.—Bailie Cameron, at the last meeting of the Corporation, drew attention to the Bill to amend the provisions of the Electric Lighting Act, 1882, in regard to the amount and repayment of loans, and stated that the Corporation had agreed to support that measure. He thought that the measure should be retrospective. In their own case, if they had had the benefit of this Bill, it would have made a difference of nearly £1,000.

Reading.—Messrs. Warwick Bros. recently installed in their timber works a motor of 50 h.p. for driving circular saws, wood-planing and moulding machinery, etc., the power being derived from the 400-volt continuous-current mains of the Reading Electrical Supply Company. The contract for the work was given to Messrs. A. Herbert and Co., of Reading, and the motor is of Messrs. T. Harding Churton and Co.'s multipolar standard "R. M." type.

Huddersfield.—The Council have resolved to apply for sanction to borrow £5,000 for the purchase of motors and appliances for the purposes of the Huddersfield Corporation Act, 1892. There has been an increase equal to 22 per cent. in the consumption of electricity as compared with last year, the units metered being 10,515. The question of the "inglorious termination" of the telephone motion adopted at the previous meeting of the Council, will be further discussed at the September meeting.

Wakefield Mines.—An extensive electrical hauling and pumping plant will be shortly installed at the Manor Haigh Moor Collieries, Wakefield. The plant will consist of a steam-engine, with 18in. diameter cylinder, dynamo with a capacity of 50 kw., and 60-h.p. motor, together with a large hauling gear and a set of three-throw ram pumps driven direct by motors. The contract also includes the construction and erection of 1,800 yards of heavy cable, and has been let to A. Hirst and Son, Limited, of the Crescent Works, Dewsbury.

Literary Notice.—We are informed that the series of articles on "Ignition Devices for Automobiles," by S. R. Bottone, which have been running through the pages of the *English Mechanic*, will shortly be published in book form by Mr. Gilbert Pitman, with the addition of an introductory chapter treating specially on structural details, choice, and management of the motorcar. Mr. Pitman will also immediately publish in one volume the "Amateur Electrician's Workshop," recently contributed serially to the *Young Engineer* by the same author.

Hornsey.—At the last meeting of the Urban District Council the special committee as to the supply of electricity reported upon a report of Mr. Robert Hammond on a supplemented scheme for electric lighting in consequence of a demand for the supply of electricity in roads not included in the first scheme adopted by the Council. This proposed an expenditure of £47,400, for which amount it was recommended that application be made to the Local Government Board. After some discussion it was decided to call a special meeting of the Council to consider the matter.

Cable Steamers.—Messrs. David J. Dunlop and Co., engineers and shipbuilders, Port Glasgow, last week launched the twin-screw steamer "Iris," for cablelaying and repairing purposes, to the order of the Pacific Cable Board. The dimensions are: length, 285ft.; breadth, moulded, 40ft. 6in.; depth, moulded, 25ft.; gross tonnage, about 2,300 tons. The vessel has been built to Lloyd's highest class as a spar deck steamer, and is fully equipped. Four cable tanks are provided for the required cable capacity. The ceremony of naming the vessel was performed by Mrs. Seton, wife of the Postmaster, G.P.O., Glasgow.

Tynemouth.—Mr. E. A. Sandford Fawcett has held an enquiry into the application of the Corporation for sanction to borrow £31,000 for purposes of electric lighting. The original loan was £34,850, which has been exhausted. The expenditure up to the present time has been £53,976. The Corporation supply current to the Tynemouth and District Electric Traction Company, Limited, under an agreement, and also for public and private lighting, for which there has been a greater demand than anticipated. They have also undertaken to supply current to the Tyneside Tramways and Tramroads Company, under an agreement for seven years, for their portion of line within the borough.

London Gazette.—The partnership existing between E. E. Prestwich and L. N. Burt (trading as Prestwich and Burt), electrical and mechanical engineers, Kingston-on-Thames, has been dissolved by mutual consent. The partnership existing between J. A. Bauer and L. E. Schramm (trading as the Electrical and General Engineering Company), 17, Gracechurch-street, E.C., has been dissolved by mutual consent. The partnership existing between C. W. Webster, A. L. Rhodes, and S. W. England (trading as Rhodes and Webster), City Electrical Works, Paradise-street, Bradford, has been dissolved by mutual consent. A receiving order has been made out in the estates of W. Morton and W. T. Sampson (trading as Morton and Sampson), Trinity-buildings, Corporation-street, Warrington, on debtor's petition.

South Africa.—The opinion expressed in the statement drawn up by the Commissioners of the South African Trade Committee dealing with the prospects of trade in South Africa, that "the trend of things since the British Government has been established is, generally speaking, in the direction of British goods," seems in a fair way to become confirmed in a practical manner. Tenders were recently called by the

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Bloemfontein Corporation for electrical plant, and we are informed that Messrs. Ferranti Limited, of Hollinwood, Lancashire, were successful in obtaining the order for a large complete central-station switchboard to the specification of Mr. Robert Hammond. The system is a three-phase one, generating currents at 2,200 volts pressure. Messrs. Ferranti are supplying the gear designed on their well-known cellular pattern. It may be mentioned that the same firm are also supplying two large engines for the Cape Town Corporation tramways.

Hucknall Huthwaite. - The secretary of the Notts and Derbyshire Electrical Power Company attended the last meeting of the Urban District Council in reference to the proposal which has been made that the Hucknall Council should purchase electricity in bulk and retail to customers in the parish. He stated that if the Council thought well to go in for a provisional order the company would do all in their power to assist them. The cost in bulk for from 50,000 to 100,000 units would be 2d. per unit, which could be retailed at 4½d. per units. It would be necessary for the Council to erect a transforming station and put down mains for the supply of the current, which would cost together about £1,500. The place of the local generating station was not definitely settled, and he could not say definitely whether the company would pay any part of the expense of the order, but it was most likely that they would do so. We understand that draft agreements are under consideration.

Falmouth.—Electricity is the leading feature of the Royal Cornwall Exhibition, and Messrs. Tangye, of Birmingham, have supplied a powerful generating plant, including a 25-h.p. engine and dynamo. Mr. F. H. Headley, of St. Austell, has undertaken the supervision of this department, and some of the best firms in the county are exhibiting the newest machinery and accessories. The Post Office, through the influence of Sir Wm. Preece, is showing a collection of modern telegraphic apparatus. The adaptation of electricity to domestic requirements is shown in an improvised bedroom and dining-room fitted with suitable furniture, and containing a domestic telephone, electrical shaving pots, hair curlers, and kettles. The hall is very beautifully decorated with ornamental electric lamps. Mr. George Tangye contributes an interesting collection of ancient documents, letters, and pictures bearing on mining, engineering, and scientific questions from 1777 to 1809. The show of oil and water colours and photographs is up to the usual standard, and there are some fine specimens of art needlework. Sir Wm. Preece delivered a lecture on "Wireless Telegraphy." The exhibition will close on Saturday, Aug. 30.

Accidents.—On Thursday the electric light once failed during the performance at the Exeter Theatre. The sole cause of the mishap was, we understand, the giving out of three fuses in the electric light circuit box in the theatre—a circuit which also supplies Pennsylvania, Northernhay, and other districts, the lights of which also went out. The defect has now been remedied. Shortly after eight o'clock on Tuesday the extensive electric station of the Islington Borough Council in Eden-grove, off Holloway-road, Upper Holloway, was the scene of an outbreak of fire that at one time threatened to assume serious proportions. The ground floor, which contained a large quantity of electrical machinery, was damaged by fire, and the rest of the premises by heat, smoke, and water. Practically the whole of the electric lights in the district were extinguished, and Holloway was plunged in darkness, with the result that many shopkeepers had to close their shops. The light was again available as usual by Wednesday evening. An outbreak of fire was discovered at the premises of Messrs. W. Rowntree and Sons, Scarborough, early on Monday. An alarm was given, and before very serious damage was done the conflagration was extinguished. The outbreak was due to an electric current not having been switched off. It was used for heating an iron, which became red hot, and set fire to the table upon which it was lying. The adjourned inquest concerning the death of Hugh Hamilton Hart, who was killed by the fall of a coal elevator at the Leeds Corporation electrical works, has been concluded. The jury brought in a verdict of accidental death, adding a rider that death was practically caused by insufficiency of scaffolding.

Trowbridge.—At the last Council meeting it was stated that applications had been received for the leasing of the provisional order for the electric lighting of the town, but in view of a proposed scheme for supplying electricity in bulk to surrounding towns from Radstock the subject was deferred for future consideration. This refers to a syndicate which has been formed, and, according to the *Wilts Chronicle*, all the required capital obtained for erecting an extensive electrical generating plant at Radstock. This locality has been chosen in consequence of being the centre of a coalfield from which coal may be obtained at a comparatively cheap rate. From the central works cables are proposed to be laid to towns within a 15-mile radius requiring electrical supply. Thus Trowbridge, Bradford-on-Avon, Westbury, Frome, Bath, Warminster, and possibly Melksham, Shepton Mallet, Wells, etc., will come within the scope of the new works. It is confidently anticipated that electricity can be generated and supplied at a price 50 per cent. less than it would cost a local authority to work a plant of its own. In other words, if Trowbridge, by means of its own plant, could sell electricity at 3d. per unit, the syndicate or company would be able to supply it at 1½d. per unit. So far, only one Corporation have threatened opposition, the Bristol Municipality having intimated their intention of trying to prevent the necessary parliamentary powers being obtained. At Bath, where the electric light works have caused the expenditure of a lot of money, the proposals of the syndicate are being followed with keen interest.

Sheffield. The Corporation propose to apply to the Postmaster-General for a license to establish a municipal telephone system in Sheffield. Mr. Bennett estimates the cost at £103.550, which includes £24 each for the proposed 3,000 completed subscribers' instruments (£84,000); 50 miles junction route, carrying 800 miles of 100lb. copper wire (£7,550); and 1,500 partially completed lines at £8 each (£12,000). The wires are to be laid underground on all the main routes. The cable would be of the most approved air-space type drawn into cast-iron socket and spigot pipes. This cable would be led to poles at suitable points, whence bronze wires, weighing 40lb. to the mile, would be distributed. These wires will be mostly laid overhead, but in some cases, in the centre of the town, it will be possible to lay them underground. The Rotherham lines would also be laid underground. In order to prevent the overhearing of conversation all wires will be on the metallic circuit system. Switchboards will be provided at Sheffield, Rotherham, Oughtibridge, Stocksbridge, Penistone, Mexborough, Millhouses, Banchief, Eckington, Ecclesfield, Dronfield, Woodhouse, and where ever else required. The tariff for an unlimited number of calls ranges from £5. 5s. to £6. 10s., with an additional £1 for every additional quarter mile; or £3. 10s. per annum, with a toll of 1d. per outward call for a one-mile radius from a switchboard, with an additional £1 for every additional quarter mile. Mr. Bennett estimates that the working expenses would be somewhat between Glasgow and Guernsey in 1901; those in the former, including Post Office royalty, interest, sinking fund, and terminal fees, were £3. 10s. 5d. per working line, and those in Guernsey £2. 17s. Even at the higher figures, the proposed 3,500 lines would cost only £13,322. 18s. 4d., and would thus leave a profit of £4,846. 9s. 2d., the revenue being estimated at £17,169. 17s. 6d.

Shah's Visit.—The Shah of Persia, attended by his Grand Vizier and members of his suite, and accompanied by the Earl of Kintore (Lord in-Waiting to the King), Lieut.-Colonel the Hon. C. H. Legge, and Sir Arthur Hardinge, on Thursday, Aug. 21, visited the electrical works of Sir Hiram Maxim at Gillingham-street, London. His Majesty, during a stay of more than an hour, proved himself thoroughly alive to the importance of up-to-date appliances, and capable of quickly grasping the fundamental facts in everything he was shown. He was received by Sir Hiram Maxim, Mr. Jules de Meray (chairman), Mr. Thomas Wood (vice-chairman of the company), and Lieutenant Dawson (director of Vickers, Sons, and Maxim). Mr. de Meray, in thanking the Shah for his visit, assured him that he would see a most interesting branch of British industry, and would be able to note the immense advances that had been made in electrical appliances. To facilitate matters, Mr. A. W. Hill, manager of the above works, had prepared a case showing every stage in the manufacture of an incandescent lamp. After this was explained to his Majesty he visited each of the departments, and nothing seemed to give him greater pleasure or to excite his curiosity more than the new treating process which has quite recently been established at the works. The depositing department and the blow-room were next visited, and the visitors appeared greatly struck with the extreme rapidity with which the sealing of filaments in the bulbs was performed by the large number of girls at work. Visits were also paid to the plastering, testing, sand-blasting, and other processes, and finally his Majesty was biographed working a Maxim gun, from which he fired 300 rounds, this being one of five guns sent from the works of Vickers, Sons, and Maxim, of Erith. Before leaving, the Shah informed Sir Hiram Maxim and Mr. Demery that he was delighted with everything he had seen, and that he was only sorry he was unable to stay longer. His Majesty showed particular interest in a new Johnson-Maxim arc lamp.

TRACTION.

Wrexham.—The work of laying the tramway track within the borough has been nearly completed.

Wolverhampton.—The extension of the electric tramways to Bilston is expected to be ready for use in a fortnight's time.

Birkdale.—The construction of the tramway track in Liverpool-road is proceeding satisfactorily, and will soon be completed.

Coedpoeth.—The Bersham Parish Council have petitioned the Wrexham District Tramways Company to extend their lines to this place.

Metropolitan Railway.—Mr. William H. Brown has been appointed goods manager of the Metropolitan Railway—a new position.

Birmingham Appointment.—Mr. George Conaty, manager of the South Staffordshire tramways, has been appointed manager to the City of Birmingham tramways.

Guiseley.—A syndicate propose to proceed with an application to the Board of Trade for a provisional order for tramways in this district if the support of the District Council can be obtained.

Paris.—Nearly 8,000 motorcars are now in use in Paris and the neighbourhood, 3,800 of the cars having a registered speed of over 18 miles an hour. The number of licensed "chauffeurs" at the beginning of the month was 13,600.

Burton.—Colonel W. Langton Coke held an enquiry on behalf of the Local Government Board on Wednesday into the application of the Corporation for sanction to borrow £15,630 for extending the electric light works and mains so as to provide for the tramway load. It has transpired that £11,000 of the amount asked for is for additional generating plant. The intention of the Corporation is to provide 20 cars, 17 of which will be in service at one time.

South Lancashire.—The linking up of a number of mining and manufacturing towns and villages in South Lancashire by the South Lancashire Tramways Company is proceeding apace. The entire system, with its various junctions and branches, will cover nearly 80 miles, and, inclusive of equipment, will entail an outlay of nearly 1½ millions sterling. The lines will run from Parr, near St. Helens, to Swinton and Eccles, where connections will be made with the Salford Corporation's systems. Amongst other places which will be tapped by the South Lancashire Company are Newton-le-Willows, Haydock, Lowton, Leigh, Tyldesley, Atherton, Little Hulton, Astley, Boothstown, Worsley, and Walkden.

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Bolton.—The receipts on the Bolton Corporation tramways for the week ending Aug. 17 amounted to £1,664, compared with £1,593. 3s. 1d. in the corresponding period last year.

Halesowen.—An order has been made by the Light Railway Commissioners, and confirmed by the Board of Trade, authorising the construction of light railways in the district.

Huddersfield.—The last monthly report on the tramways shows the traffic receipts to be £4,639. 19s. 1d., which is an advance on the amount for the corresponding period last year.

Shoreham.—The Shoreham and the Southwick Urban District Councils have concluded agreements with the British Electric Traction Company with reference to the proposed tramways in their respective districts.

Middlesex.—Tenders for the construction of the first batch of 16 miles of light railways in the county of Middlesex will be advertised for this week, so that within a reasonable time the work will be commenced.

Greengates.—In response to a representation from the district, the Bradford Tramways Committee have resolved that the work of laying a line to that locality from the Idle terminus shall be taken in hand early next spring.

Steyning West.—The scheme of the British Electric Traction Company for a tramway from Worthing to Littlehampton is being supported by this Rural Council. A draft agreement between the two bodies is now being drawn up.

Automobile Record Broken.—A Reuter telegram from Trouville dated Aug. 26 says that M. Gabriel, driving a Mors motorcar, has succeeded in lowering the world's automobile record for a kilometre by 26⅖ seconds, travelling at the rate of 136¼ km. an hour.

Pemberton.—The Urban District Council give notice in the *London Gazette* of Tuesday of intention to grant a lease to the Corporation of Wigan of all the tramways in their district for a term of 21 years. The proposal is to reconstruct the lines for electric traction.

Mersey Railway.—The work in connection with the substitution of electricity for steam on the Mersey Railway is progressing rapidly, and it is confidently anticipated that the service will be completely transformed and electric trains running through the tunnel by the first week in December.

Dublin.—The project for the construction of an electric tramway from Slane to Dublin is said to be making good headway. Under the name of the Dublin and Slane Tramway Company, Limited, a company has been registered, with the nominal capital of £1,000, to carry out the scheme.

Manchester.—The school for training the employés of the Corporation electric tramways in their duties is now in full swing. We understand that a large number of drivers, guards, and ticket and traffic inspectors are now receiving regular instruction there, the average attendance being 130 per day.

Garston.—The running of the first car on the Garston section on Tuesday was witnessed by large crowds of inhabitants. The energy is being supplied from the generating station at Speke-road, Garston, where two Browett-Lindley engines have been laid down. It is hoped to open the line for traffic one day this week.

New South Wales.—The tramway revenue during the financial year just closed amounted to £631,757, as compared with £551,674, and the expenditure to £541,984, as compared with £462,471. The balance, after paying working expenses, amounted to £89,773, as compared with £89,203 for the previous year.

Mexborough and Swinton.—The Royal assent has now been given to the Mexborough and Swinton Tramways Act, under which powers are extended to construct tramways from the boundary of Rotherham through Rawmarsh, Swinton, and Mexborough. The construction of the tramways will be commenced very shortly.

Lancs.—A Laffan message from New York states that the death of Mr. Thomas Nevins, the American capitalist who was largely interested in electrical undertakings in this country, has resulted in the cessation of negotiations for the consolidation of the various tramway systems between Liverpool and Manchester and their conversion to the electric system.

Sunderland.—Contrary to expectation, the tramway men did not go out on strike on Sunday, as they had threatened, but they held a meeting, and deputed one of their number to send a statement to the Tramways Committee defending the position of the motorman who has been called on to pay for damage done to a milk-cart, with which the car he was driving collided.

Newcastle.—The Spital Tongues section of the city tramway system was opened for public traffic this week. A statement just issued by the city treasurer shows that the traffic receipts from the tramways from Dec. 16, 1901, the opening day, to March 25 last, amounted to £20,918, and the expenses to £10,694. The total cost of electrical energy during this period was £1,812.

Walsall.—A sub-committee has been appointed with authority to enter into such further contracts for granite setts as they may consider necessary in connection with the tramways. The contractors for the construction of the permanent way of the tramways are to commence their work immediately. The erection of the car-sheds and depôt at the Birchills has already been commenced.

Gateshead.—An electric tramcar which was running down High-street from Heworth, on Wednesday last week, left the rails at the foot of the incline, and dashed on towards Bottle Bank. The latter leads to the River Tyne, and there seemed every prospect of the car going into the water, for the driver could not stop or steer it. Fortunately it turned aside, and, crossing the pavement, knocked over a lamp-post, and ran into the brickwork of an hotel. Most damage was done to the pavement.

Bury.—The Tramway Committee have appointed a sub-committee to open tenders for the laying of the Knowsley-street, Heywood-street, Bolton-road, and Fairfield sections of the tramway routes. Negotiations are proceeding with the Whitefield District Council in regard to the question as to whether Bury or Salford shall lay, equip, and run cars through the district of the Whitefield Council.

Vienna.—The competition of the electric tramways in Vienna is having a similar effect on the cabs as in many towns in this country, notably Liverpool. A Vienna correspondent describes the situation there, so far as the cabs are concerned, as desperate. The greater speed of the electric cars has now drawn away most of their clients. A meeting of cabdrivers in the city has resolved to send a petition to the mayor and the Government asking for compensation, assessing the value of their licenses at £120 each, on the understanding that no future licenses be issued.

Bradford.—A series of small mishaps are reported to have occurred on the city electric tramways last Monday. The most serious resulted from the failure of the brakes to act promptly. In one case a car on the way down a hill ran into one of the tower vans used for repairing the wires, owing, it is reported, to the brakes not properly acting. The men on the tower escaped injury. In another case a car descending Sunbridge-road failed to immediately answer to the brake, with the result that it collided with another car which was standing at the foot of the hill. No person was injured.

Mexico.—A consular report from Mexico states that the motor is already an instrument of civilisation there, and the fact that the Mexican Minister of Public Works is an enthusiast on the new locomotion is said to be the reason for the recent schemes for the development of Mexican roads. All the roads in the federal district of Mexico City are to be put under thorough repair, and new roads of a length of 124 miles are to be built. The type of automobile most in favour is the cheap American carriage, valued at from £160 to £240, while there is a preference for the electric motor.

Nottingham.—The next few weeks will see the scheme authorised up to the present by the Nottingham Corporation for tramway extension in the city well on the road to completion. The Lenton route is practically finished, and work has already been started upon the Willford-road section. The wiring of the overhead equipment is well in hand, and should be ready within three weeks. Immediately afterwards attention will be concentrated upon the Wilford-road extension. Powers have now also been obtained in the Bill which has recently received the Royal assent for the construction of tramways along London-road, Forest-road, and Hartley-road, but instructions have not yet been given to proceed with these sections.

Lancs. and Yorks Railway.—With reference to our note in last issue as to the probability of the Cheshire Lines Committee adopting electric traction, it is now reported that the Board of the Lancs. and Yorks Railway Company have decided to electrify that portion of their system which runs between Manchester and Liverpool, in view of the expected competition of the monorail line, the construction of which, it is understood, will be pushed forward with all dispatch. The Lancashire and Yorkshire Railway enjoys great popularity in both cities, and it is felt that should this important scheme of electrification be carried out, there need be no fears entertained regarding the results of the competition of the new line when completed.

Aberdeen.—The tramway receipts last week amounted to £1,154. 11s. 1d., an increase of £218. 2s. 6d. compared with the corresponding week last year, while the expenditure was £358. 9s. 4d., a decrease of £27. 1s. The number of passengers carried during the week was 263,114, as against 216,526. The total receipts for 11 weeks of the financial year are £12,728. 13s. 1d., an increase of £3,055. 18s. 6d. on the corresponding period last year; while, as there is a decrease of £637. 6s. on the expenditure, the total advantage for the 11 weeks is £3,694. 4s. 6d. At a meeting of the Tramways Committee of the Town Council on Monday it was agreed to recommend that the electric tramway system should be extended to Ferryhill and Torry, as proposed in the Act of 1900.

Dewsbury.—An enquiry into the application of the Town Council for sanction to borrow £10,000 for the provision of additional plant at the electricity generating station has been held by Mr. R. H. Bicknell. The town clerk explained that the contract with the British Electric Traction Company involved the provision of extra plant equivalent to 300 kw. capacity, and also a reserve plant of 200 kw. capacity. The Corporation had already a reserve 100-kw. generator. Mr. Campion, electrical engineer to the Corporation, stated that it was proposed to put down one 300-kw. set and one 200-kw. set in addition to the 200-kw. plant that the Corporation already had. The trams would normally take about 200 kw. There was no opposition, and the enquiry terminated.

Tramways in Yorks.—An informal meeting of chairmen, vice-chairmen, and general managers of the Leeds, Bradford, and Halifax Corporation tramways has recently been held with the object of talking over proposals to so improve the traffic arrangements on the three systems as to render a through journey comparatively easy. It is hoped that by next spring a working arrangement will be possible. One suggestion is that there should be a through fare from Leeds to Hebden Bridge, though this would still necessitate a change of cars, the gauges being different. Another proposal involves the provision of waiting-rooms at the junctions, and the compilation of a time-table affording ready connection. The greatest extent of the united lines would be from Roundhay Park to Hebden Bridge.

Conference of Tramcar Builders.—At Manchester recently a meeting of delegates drawn from the tramcar workers of the United Kingdom Society of Coachmakers was held, when there were present representatives from all car-building centres. The statement was made that owing to the rapid development of the industry during the last two years, and the keen competition, it had been found necessary, in

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the interests of the contractors, employés, the corporations, and tram companies involved, that some uniformity of conditions of work should be drawn up. After full consideration the delegates drew up a series of conditions which at present prevail in some of the works, and it was hoped these would be found acceptable to the corporations, companies, and contractors concerned. With an idea of working in harmony with employers and reducing the possibility of a strike to a minimum, it was decided that an endeavour should be made to form a conciliation board. The conference also decided, owing to the large number of cases of lead-poisoning occurring in the coachmaking trade, to ask the different firms to carry out the Board of Trade regulations in relation to this matter.

Electric Tramways in Russia.—According to information received in London the question of constructing street electric railways in St. Petersburg and Moscow, which has been under consideration for a long time, has now been decided. It appears that a commission, presided over by the Ministers for Home Affairs, Finance, Communications, and War, and the Imperial Controller, was appointed by the Government some time ago to examine the various schemes submitted by competitors for the concession for the building of the electric lines, and the commission has now come to the conclusion that the project proposed by an American banking house and Engineer Balinski should be given the preference, apparently because they have undertaken to form a connection between the Russian and Finnish railway systems, and to construct a great railway bridge over the Neva. It is estimated that the capital expenditure would amount to 120,000,000 roubles for St. Petersburg and 150,000,000 roubles for Moscow, and in each case one-half of the total outlay would be provided by the issue of shares and the other half by the emission of bonds. The duration of the concession is 81 years, although the right of purchase by the authorities is reserved at the expiration of 25 years, and the electric lines are to be completed within five years from the granting of the concession.

Board of Trade Regulations.—At the invitation of the assistant secretary to the Board of Trade, representatives of corporations and companies operating tramways had a meeting on Friday last with representatives of the Board of Trade and of the Home Office at Whitehall-gardens, Westminster. The subject of conference was the proposed Board of Trade regulations, especially with regard to carrying a red light on the rear of all cars. Mr. Young, of Glasgow, who made the opening statement, pointed out that at night electric cars of the present day presented such a blaze of light that a red rear light was quite unnecessary, and, further, that on account of the adoption on all large systems of distinctive route colours, with lights at night coloured to correspond, a regulation requiring a red light on the rear of every car would be so confusing as practically to do away with the system of distinguishing route colours, which has been found so popular and convenient wherever adopted. Sir Herbert Jekyll, for the Board of Trade, explained at the outset that since the suggestion had come from the Home Office, and his department had no special views on the matter, he would allow Mr. Cunninghame, as representing the Home Office, to deal with it. Mr. Cunninghame, after hearing the various speakers, said in effect that his department had no desire whatever to fetter or harass electric tramways, but quite the opposite. Their idea, if it could be carried out, was to have all road and street vehicles carrying a red light on the rear. He saw, however, from what had been put forward by this influential deputation that there might be a difficulty in making such a rule quite general, and in any case they would now consider whether electric tramway cars should be excepted in the event of such a rule as proposed being adopted. He mentioned that in any case the Home Office would not deal with the rules applicable to Scotland.

Glasgow.—A special correspondent of the *Glasgow Herald* has made an interesting analysis of the report and accounts of the Glasgow tramway undertaking for the year ending May 31. The year under review is the first during which electric haulage was in use on a large scale. In the previous year only about five miles of route were worked electrically, but in the course of the past 12 months all the old lines were electrified, and 8½ miles of new route opened, bringing the total up to 52 miles. Another fact to be noticed is that for half of the year reported upon the traffic was exceptional, owing to the international exhibition. The analysis deals in the first place with the cost of working. During 1900-1 the cars on the five miles of electric route then open ran a mileage of 1,319,977, and carried 22,066,591 passengers. The electric car mileage for 1901-2 was 11,935,099, and 155,243,378 passengers were carried. In the former year the expenditure per car mile, including renewal and depreciation, was 8·45d.; in the latter 7·57d., a saving of nearly 1d. per car mile. Excluding renewal and depreciation allowances, the figures work out at 6·08d. per car mile for 1900-1, and 5·3d. for 1901-2—a figure "surpassed in economy by very few lines in the country." The power station expenses per car mile fell from ·93d. to ·41d. Practically the entire saving in the power station expenses is attributed to economy in the handling and consumption of fuel. The receipts for 1901-2 (which amounted in the gross to £614,413) worked out at 11·73d. per car mile, as against 14·62d. in the preceding year, so that the ratio of expenses to receipts was for last year 64 per cent., and for the year before 58 per cent., or omitting allowances for renewals and depreciation, 45 per cent. and 42 per cent. respectively. The writer explains that the lower percentage in 1900-1 was due, not to lower expenses, but to abnormal receipts on the Springburn section owing to the overcrowded state of the cars. The Tramways Committee have been able out of revenue to write off the whole horse-traction plant capitalisation and to renew the old tracks. The greatest week's revenue during the exhibition was £14,278 in the week ending Sept. 28. But after the exhibition closed, and, despite winter weather, the receipts only twice fell below £10,000, and each week in May last they were near £12,000. Before another year is over it is probable that nearly all the additional lines authorised, about 17 miles length, will be finished and in operation. The extension of the Duke-street line to Carntyne has now been opened. It will be 10 days or so before the Cathcart extension can be ready for traffic.

The Tramways Act.—The Board of Trade report of the proceedings under the Tramways Act, 1870, during the session of 1902, was issued on Tuesday as a parliamentary paper. The report states that the number of applications made for provisional orders was 18—viz.: Aberdare Urban District Council, Bournemouth Corporation, Brighton Corporation, Cheadle and Gatley Urban District Council, Chiswick Urban District Council, Heywood Corporation, Leeds Corporation, Lees Urban District Council, Mountain Ash Urban District Council, Pontypridd Urban District Council, Southampton Corporation, Southport Corporation, Stockport Corporation, Sunderland Corporation, Todmorden Corporation, Walker Urban District Council, West Riding (Knottingley Extension), and Wolverhampton Corporation. All the applications included power to construct new or extension tramways, and, with one exception—viz., West Riding—were promoted by local authorities. The aggregate length of the proposed tramways was 22 miles 9 chains of double line and 34 miles 35 chains of single line and the estimated expenditure was £666,192. The Todmorden and the Walker applications were not proceeded with by the promoters. Local enquiries were held in two cases—viz., Aberdare and Mountain Ash—with the result that those schemes, to both of which considerable opposition was offered, were rejected. A local enquiry was ordered also into the Chiswick application. At the opening of the enquiry it was announced that the promoters had made an arrangement with certain objecting parties, which would involve the withdrawal of the application. The enquiry was therefore not proceeded with, and the application dropped. In the cases of Bournemouth and Pontypridd applications, meetings were held at the office of the Board of Trade for the consideration of the respective applications. The Board decided against the line proposed in the Bournemouth order; while the Pontypridd order was approved, with certain modifications. Twelve applications were granted, and provisional orders made by the Board of Trade, and submitted to Parliament for confirmation. The number of orders applied for since the passing of the Act down to the present is 580. The Board of Trade made 439 orders, and 420 of these were confirmed by Parliament. The fees received with the applications amount to £20,300.

Sheffield Improvements.—The largest and most important scheme which the Corporation of Sheffield have at present in hand is undoubtedly the tramway extension and street widening. A short survey of the work now in progress has appeared in one of the local newspapers, from which we take the following points: The Hillsbrough route is being entirely reconstructed. The whole line is three miles in length from Snig-hill to Hillsbrough, and the track is to be continued round Hillsbrough Park to join the Owlerton route. Nearly two miles of this route will be paved with wood. A start is to be made almost at once with the extension from Hillfoot Bridge along Penistone-road to Shalesmoor, giving an alternative route to Owlerton. Work is also actively proceeding on the Chesterfield-road route from Heeley to Norton Woodseats, an extension of 1¾ miles. Most important work is proceeding in Sheaf-street, where the department is engaged in making a connection between the Commercial-street and Broad-street lines, thus obviating the long detour which the Intake cars now have to make across Lady's Bridge and along Blonk-street. The work is very complicated, and necessarily proceeds slowly. Some idea of the engineering difficulties to be overcome may be gathered from the fact that no fewer than five double junctions come in the short length now under construction. Sheaf-street is being widened to 70ft., and a much better corner is being made from Commercial-street into Sheaf-street. As soon as the Midland Railway Company can carry out their agreement with the Corporation for widening the upper end of Sheaf-street, it is expected that the lines will be carried along past the station (which, it may be remembered, is to be brought forward some distance and practically doubled), and joined up with the line which is to come down Furnival-street from the Moorhead, and also with the line which runs along Queen's-road to Heeley. When this is done there will be a circular line in the centre of the city touching at both stations, the Wicker and the Moorhead, and it is very likely that cars will be continually running round this circle, affording a most useful means of quick transit from one important business centre to another. With regard to the Upwell-street and Owler-lane extension, the track is almost completed. Besides the laying of track for the Tramways Committee, the city surveyor's department has a good deal of building work on hand. At the Tinsley depôt a brassfoundry, sand furnace, and offices are in course of construction, at a cost of about £7,000. This is part of the scheme whereby the Tramways Committee intend to do their own work of building cars and the larger repairs incidental to the working of a big system. At Kelham Island power station the large enginebed for the new Cole, Marchent, and Morley engine is practically completed, and a set of stables is almost ready for the accommodation of the animals who draw the breakdown wagons and superintendents' traps. At the Queen's-road depôt preparations are being made for large extensions, to cost about £15,000. More provision is to be made for the storage of cars, and workshops are to be erected. This is to be an enormous depôt when complete, with accommodation for 150 cars. Tinsley can take 90, so that for a short time the room will be slightly in excess of requirements. But when the committee starts building in real earnest, and when the cars now on order are delivered, there will be no room to spare. As the Tramways Committee have decided not to proceed with the Glossop-road and Clarkehouse-road extension to Brocco Bank, the surface of Clarkehouse-road, which is in a ruinous condition at present, is to be relaid immediately. Numerous works of street widening are also being carried out in conjunction with the tramway extensions.

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PROVISIONAL PATENTS, 1902.

AUG. 18.

18113. An automatic clutch or guard to be attached to trolley head of electric cars. John William Lord Nuttall, 196, Ashton-road, Oldham.

18148. Improvements in electrical fire-alarm apparatus. James Percival Robertson, 77, Chancery-lane, London. (Complete specification.)

18172. Proceeding to manufacture the active mass of electrodes for lead accumulators. Friedrich Wilhelm Schmidt-Altwegg, 30, Frederick street, Birmingham.

18173. An electric ladder. Albert G. Witney, 1,322, Wolfram-street, Chicago, United States.

AUG. 19.

18174. Electric earthing device and main or other circuit cut-out. Alfred John Beaumont, 16, Stone-gate, York.

18188. An improvement in starters and controllers for electric motors. Harry Scott Nowell, 68, Hunton-road, Erdington, Birmingham.

18226. An improved apparatus for indicating the presence of leaks on electric circuits. Reuben James Bott, 11, Southampton-buildings, Chancery-lane, London.

18228. Improvements in electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

18229. Improvements relating to field coils for dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

18230. Improvements relating to devices for making and breaking electric circuits. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

18246. Improvements in and relating to electric switches and the like. Denis Ripley Broadbent, 322, High Holborn, London.

18253. An improved weatherproof and conducting casing and cover, specially adapted for use upon telephone transmitters and receivers. Paul Hardegen, 6, Lord-street, Liverpool. (Complete specification.)

AUG. 20.

18279. Improvements in electric tramcars. Joaquim Antonio de Macedo, Leventhorpe Hall, near Leeds.

18316. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.)

18317. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.)

18318. Improvements in means for varying the voltage of delta-connected polyphase electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert H. Armstrong and Jonathan E. Woodbridge, United States.)

18319. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Richard Fleming, United States.)

18320. Improvements in controllers for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edgar F. Dutton, United States.)

18321. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles W. Stone, United States.)

18322. Improvements in fuseless rosettes for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Herbert C. Wirt, United States.)

18323. Improvements in lightning arresters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Thomas J. Johnston, United States.)

18324. Improvements in systems of dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank H. Jeannin, United States.)

18325. Improvements in method of winding coils. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Julius W. Lundskog, United States.)

18326. Improvements in means for preventing creeping of electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander D. Lunt, United States.)

18327. Improvements in starting devices for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Robert H. Read, United States.)

18328. Improvements in systems of motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.)

18329. Improvements in operating dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank H. Jeannin, United States.)

18334. Improvements in or relating to electric switches. Gerald William Partridge, 46, Lincoln's-inn-fields, London.

18330. Improvements relating to armatures for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry G. Reist, United States.)

18331. Improvements in means for regulating dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles R. McKay, United States.)

18341. Improvements in telephone installations having a central microphone battery. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

AUG. 21.

18359. An improved trolley head or conductor for electric wires on railways, tramways, and the like. Jasper James Carter, 3, Vergemont Hall, Clonskeagh, co. Dublin.

18372. Improved method of and means for actuating by electricity the points of electric tramway rails and the points of the overhead wire. John Frederick Wood, 9, Tempest Hey, Liverpool.

18420. Improved electric heater for liquids. Frank Herbert Briggs, 322, High Holborn, London.

18441. An improved joint for broken trolley wires and the like. Henry Nicol Thomas, 18, Southampton-buildings, Chancery-lane, London.

AUG. 22.

18461. Improvements in and relating to portable incandescent electric lamps or torches. George Pearson, 70, Chancery-lane, London.

18464. An improved apparatus or device for use in applying bituminous or similar composition to conduits for electric cables, or to drain pipes, or like goods, to form jointing rings thereon. William Oates and Henry Ling Roth, Palatine-chambers, Market-street, Halifax.

18465. Improvements in electric igniting apparatus for automobiles and the like. Václav Klement, 62, St. Vincent-street, Glasgow. (Complete specification.)

18469. Improvements in or connected with the electric lighting of trains. James George Willcox Aldridge and Arthur William Ranken, 40, Chancery-lane, London.

AUG. 23.

18523. Improvements in trolley arms for electrical traction by overhead wire. Hedley Oliver, 81, Sandy-road, Seaforth, Liverpool.

18532. Improvements in china frames for branching electric wire conductors. Eduard Kellerer, 8, Avenue Ledru Rollin, Paris.

18533. Improvements in arc lamps. Thomas Ward, jun., and John Henry Weeks, 128, Colmore-row, Birmingham.

18552. Improvements in or relating to electrical ship log apparatus. Thomas Ferdinand Walker and Thomas Sydney Walker, 55, Chancery-lane, London.

18575. Improvements in or relating to the electro-deposition of zinc. Heinrich Feith, 322, High Holborn, London.

18580. Improvements in telegraphic apparatus for double transmission by pulsatory and continuous currents. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Albert Cushing Crehore, United States.)

18586. Improvements in electric fuses or cut-outs. Harry Leonard Morse, 45, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 11.

1901.

16419. Frogs or points and crossings to be used in connection with the conductors of electric tramways or railways. Nicholson.

16810. Relay and methods of employing the same in connection with multiplex telegraphy, telephone systems, and the like. Pedersen.

17383. Safety devices for guard wires of trolley wires and other conductors. Munro.

18831. Electric telegraphs for use on board ships and for other purposes. Evershed and Vignoles, Limited, and Evershed.

19828. Track construction of electric railways or tramways operated on the conduit system. Chapman.

20193. Process of covering electric conductors or wires with insulating material, or producing small tubings and apparatus therefor. Heyl-Dia.

20612. Electric switch and circuit breaker. Veritys, Limited, and Selby.

20752. Means of adjusting the height of suspended articles, such as electric lamps and the like. Wilkinson.

21056. Electric arc lamps. Jandus Arc Lamp and Electric Company, Limited, and Jones.

1902.

5618. Wireless telegraphy. Cervera.

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11523. Method of and means for transmitting electrical energy in installations for traction purposes. Déri.

12581. Electromagnetic traction or driving apparatus for railways, lifts, machine tools, and other appliances. Zehden.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	Aug. 23	4,702	4,867	− 159	163,503	151,615
Blackburn Corporation	,, 22	794	853	− 59	18,315	14,950
Blackpool Corporation	,, 21	2,535	2,725	− 190	22,852	23,821
Blackpool-Fleetwood Tramways	,, 23	1,912	2,421	− 509	10,561	11,224
Bolton Corporation	,, 21	1,952	2,032	− 80	53,612	49,335
Bradford Corporation	,, 24	3,688	1,361	+ 2,327	94,262	31,264
Bristol Tramways Company	,, 24	4,995	4,123	+ 872	—	—
Carlisle Tramways Company	,, 23	212	228	− 16	5,936	5,553
Central London Railway	,, 23	5,482	5,409	+ 73	51,582	46,616
City and South London Railway	,, 24	2,645	1,697	+ 948	22,141	14,609
Cork E. T. and L. Company	,, 21	1,016	577	+ 459	13,353	15,706
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 23	320	335	− 15	7,373	7,270
Dublin & Lucan Electric Railway	,, 24	171	138	+ 33	1,110	1,188
Dublin U. T., electric cars	,, 22	3,909	4,149	− 240	—	—
Dublin S. District, Electric	,, 22	1,036	1,187	− 151	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 23	11,685	13,824	− 2,139	—	—
Halifax Corporation	July 30	2,573	2,600	− 27	21,516	—
Huddersfield Corporation	Aug. 16	1,308	1,133	+ 175	—	—
Hull Corporation, E. S.	,, 23	1,726	1,726	—	37,090	35,620
Liverpool Corporation	,, 9	11,347	10,344	+ 1,003	307,582	281,848
Liverpool Overhead Railway	,, 24	1,670	1,778	− 108	—	—
Newcastle-on-Tyne Corporation	July 12	2,688	—	—	—	—
Portsmouth Corporation	Aug. 23	2,581	1,400	+ 1,181	—	—
Sheffield Corporation	,, 24	4,267	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Sunderland Corporation	,, 24	1,386	1,562	− 176	25,873	23,840

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £13 increase.

Barcelona Ensanche y Gracia, £70 decrease. Barcelona £311 increase.

Brisbane, £558 increase (month of June, £10,187; increase, £1,813).

Buenos Ayres and Belgrano Electric (month of June, receipts £12,229; increase £478), £166 increase.

Calcutta, £246 increase.

Cape Town (month of June), receipts, £14,148; expenditure, £6,689.

Isle of Thanet Electric, £110 increase

Mexico Electric (month of July), receipts, £20,300; expenditure, £12,600.

Perth Electric, £172 increase.

Port Elizabeth (month of June), receipts, £3,849; expenditure, £1,891.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-½
—— Ordinary, 1-125,000	1 ..	½-½
British Insulated Wire, Ord., 1-70,000	5 ..	7¼-7¾
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¾-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	103-105
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	1½-2
—— 4½ per cent. 1st Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15½-16½
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2½-3
—— 5 per cent. Debentures	100 ..	101-106 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1⅝-2¼
—— 5 per cent. Debentures	100 ..	78-83
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-5¾
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20¼-21¼
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14¼-15¼
Telegraph Construction and Maintenance	12 ..	38-41
—— 5 per cent. Bonds	100 ..	102-105
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	104-107
—— ,, ,, deferred	100 ..	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	72-74
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	127-130
—— ,, ,, ,, '96	100 ..	126-129
—— ,, ,, ,, '01	100 ..	121-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	90-93

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	½-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	103-106
Bournemouth and Poole, Ordinary	10 ..	11½-12¼
—— 4½ per cent. Cum. Pref.	10 ..	9½-10¼
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	9½-10
—— 7 per cent. Preference	5 ..	9⅝-10
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, ,, £10 Ord.	6 ..	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	8¼-9¼
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-5¾
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6¾
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¾-6¼
—— 4½ per cent. First Deb Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¾-11¼
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¾-2¼
—— 6 per cent. Pref.	5 ..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	96-99
Metropolitan, Ordinary	10 ..	15-16
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	13½-14½
Oriental, 1879	1 ..	—
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	97-100
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14¼-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	5¾-6¼
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	103-105 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	12¼-13¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅛-1¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	10¾-11¼
—— ,, ,, ,, ,, ,, ,,	5 ..	3-3½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	108-110
—— ,, ,, Prov. Crts.	50 ..	81-83
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	14s. ..	¾
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	70 p.c. ..	70 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	92-96
—— Preferred, 590,001-790,000	3½ ..	4⅜-4⅞
—— Deferred Stock	100 ..	54-58
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum. Second Pref.	10 ..	10-12
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-99
—— 4 per cent. Deb. Stock, Red.	100 ..	102-106
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Whitworth Scholarships.—It is announced that the following candidates were successful in the competition for the Whitworth scholarships for this year—*i.e.*, Messrs. W. M. Selvey, of London; L. Bairstow, of Halifax; J. V. Robinson, of West Hartlepool; and A. Baker, of Gosport, Hants. The scholarships are of the value of £125 a year each, and tenable for three years. In addition to the above, 30 candidates have secured in the competition exhibitions of £50 a year each, tenable for one year.

Electricity for Airships. — One of the most attractive features of the St. Louis World's Fair, which is now being organised, will be the aeronautic competition. It will be of interest to electrical inventors to know that there is to be a prize of £600 offered for "a successful attempt to drive an airship motor by energy transmitted through space, either in the form of electric radiation or in some other form of electrical energy, to an actual amount of $\frac{1}{10}$ h.p. at the point of reception, and at a distance of at least 1,000ft." The test must be made on the exhibition grounds by experts satisfactory to the jury.

Wireless Telegraphy.—Mr. Marconi claims to be able to maintain an uninterrupted communication by wireless telegraphy between Ferrol, at the north-west corner of Spain, and his Poldhu station, in Cornwall, a distance as the crow flies of nearly 500 miles. According to a message from Ferrol, dated Aug. 30, he stated in conversation with a number of Spanish telegraphists, who visited him on board the Italian cruiser "Carlo Alberto," that he was in daily communication with England. Mr. Marconi added that he had solved the problem of the independence of several simultaneous messages, and was able to keep up communication with his English station at the same time that men-of-war were exchanging messages by wireless telegraphy in the same region.

Inversion of Zinc Sulphate.—The temperature of inversion of zinc sulphate determined by the electrical method differs considerably from that obtained by solubility measurements, and the difference has been ascribed to the presence of the mercurous sulphate in the Clark cell, by which the inversion temperature is lowered. In investigating the subject, Messrs. H. T. Barnes and H. L. Cooke have therefore constructed a cell of H-pattern, containing zinc sulphate over a 10 per cent. zinc amalgam, and have found that the inversion temperature is still lower than that derived from the solubility, and is almost unaffected by the addition of mercurous sulphate. The cause of the difference cannot therefore be ascribed to the presence of the mercurous sulphate.

Telegraphy in the Cameroons.—A proposed extension of the telegraph system in the Cameroons was recently the subject of a petition to the German Imperial Chancellor, Count Bülow, whose decision in the matter has now been made public. The reply received by the German Colonial Society states that the Government recognises the importance of establishing an extended network of telegraph or telephone lines, but that the obstacles in the way of speedy action being taken in this direction lie in the financial dependence of the protectorate, whilst at the same time there is no justification for the allocation of sums of money to that purpose which are out of proportion to the undeveloped economic position of the colony. Nevertheless, the Imperial Post Office and the Colonial Office have jointly endeavoured to further the institution of telegraphic communication in the Cameroons, and as an instance the Chancellor points out that as the telephone line between Victoria and Buea has been completed, the work of establishing a telegraph line between Duala and Buea has now been taken in hand. The colonial estimates for 1903 will include a proposal for connecting Duala and E'deg by means of a telegraph system, but further action will depend upon the circumstances of the case.

Velocity of Electrolytic Decomposition of Oxalic Acid.—As a result of his investigations into the velocity of electrolytic decomposition of oxalic acid in the presence of sulphuric acid, Mr. T. Akerberg has found that when a solution of sulphuric acid containing oxalic acid is electrolysed between polished platinum electrodes, the oxalic acid is scarcely decomposed. When platinised electrodes are used, the oxalic acid is readily decomposed. The decomposition is, therefore, a secondary process, which is catalytically influenced by the platinum black; it is a purely chemical oxidation effected by the electrolytically separated oxygen. In concentrated solution, with low current densities, or at high temperature, the decomposition follows Faraday's law, but in more dilute solution the reaction is unimolecular, and consequently the oxidation is carried out by atomic oxygen. The constant for reaction velocity between 15deg. and 55deg. varies almost proportionally with the temperature.

Radioactive Bismuth-Polonium.—Mr. W. Marckwald, in a paper on this subject abstracted in the current number of the *Journal* of the Chemical Society, states that the presence of some new element, polonium, in ordinary radioactive bismuth has been established. When a solution of the chloride is electrolysed, the metal which is first deposited is much more radioactive than the original substance, and even when a polished rod of bismuth is placed in a solution of the chloride, a small, extremely active, metallic deposit is formed on the surface of the bismuth, owing to the difference in potential between the new element and metallic bismuth. After three days the whole of the active element has become deposited, and the solution shows no radioactivity. The deposit contains small amounts of chloride, which can be removed by sublimation; the metallic bead thus obtained dissolves in nitric acid, and the solution exhibits most of the reactions characteristic of bismuth ions. The active rays emitted by the metal and its solutions differ from radium rays, as they are incapable of passing through paper and other obstacles. The author hopes to obtain sufficient of the new metal to determine its atomic weight. The activity of the specimens of polonium does not diminish even after several months.

The Telephone in the Temple.—In view of the present-day popularity of the telephone, and the enormous facilities for the quick and easy transaction of business which it offers, it is surprising to find that the Inner Temple, the City home of one of the largest bodies of barristers in London, should be entirely without telephonic communication of any sort. That this is not the fault of the National Telephone Company is vouched for by the fact that in years gone by they have made repeated overtures to the Benchers of the Temple for permission to lay their wires within its ancient and historic precincts, but these have always been rejected more for sentimental reasons than any other. With the introduction of the Post Office telephones, however, wiser counsels seem to have prevailed. Acting under pressure of the tenants on the one hand and the General Post Office on the other, the Benchers of the Inner Temple have now consented to allow Post Office telephones to be introduced into the sacred area, and the work of laying the cables is soon to be commenced. The present time being the period of the Long Vacation, when only a court sits now and again, there is plenty of

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opportunity for the workmen to get on quickly with the installation, and it is hoped to have a certain part, if not the whole, of the Inner Temple in telephonic communication with the outside world before the lawyers return for the winter term at the end of October.

Standard Cells.—A paper by Jaeger on this subject was recently presented to the German Electro-chemical Society, of which the following is an abstract: A standard cell must represent a reversible chemical system, and would theoretically have the best forms if the electrolyte is also present in solid form—for instance, solid crystals of zinc sulphate with water of crystallisation in the Clark cell. The depolariser is best when solid and a good conductor. When mercurous sulphate is used there are complications due to its solubility. The author gives some results of tests of Clark cells and Weston cells obtained in the German Reichsanstalt, where nearly every year a greater number of Clark cells and Weston cells (with solid cadmium sulphate) are compared for E M.F., and the ratio of the E.M.F. of these two cells is determined. This ratio has not changed in four years by more than 0·0001. The average of all the measurements in these four years is as follows: the ratio of the Clark cell at 0deg. C. to that of the Weston cell at 20deg. is 1·42280; the ratio of the Clark cell at 15deg. C. to that of the Weston cell at 20deg. C. is 1·40669. In the cadmium cell made by the Weston Company the electrolyte is not saturated, and is not present in solid form; its E.M.F. is nearly independent of the temperature, and is higher by about 0·0005 volt than that of the cell with solid form at 20deg. The E.M.F. of the latter is 1·0186 volt.

Magnetic Experiments on Metals. — A long investigation of the connection between the magnetisation and the mechanical deformation of the ferro-magnetic metals has just been concluded by Messrs. H. Nagaska and K. Honda, of Tokio. From the results published it seems that in reversible nickel-steel, such as is used for scales on account of its small expansion, mechanical elongation in the direction of magnetisation produces an increase of magnetism. On the other hand, the same substance stretches on being magnetised, especially when it is annealed instead of being hard drawn. Iron, steel, nickel, and nickel-steel increase in volume by magnetisation, but cobalt shows contraction. The greatest volume change was observed in a nickel-steel containing 29 per cent. of nickel, in which it is in a strong field 40 times that of iron. As regards the Wiedemann effect, the twist produced by the combined action of circular and longitudinal magnetisation in iron, nickel, and nickel-steel increases with the longitudinal field strength, and reaches a maximum, whence it decreases gradually as the field is further increased. The sense of twist in iron and nickel-steel is opposite to that in nickel. The transient current produced by twisting a longitudinally magnetised wire, and the longitudinal magnetisation caused by twisting a circularly magnetised wire, are reciprocally related to the twist produced by longitudinal and circular magnetisations.

Manufacture of Metallic Carbides.—A method of preparing the carbides of the alkaline earth metals—*i.e.*, barium, strontium, and calcium—has been patented by Limb, of Lyons, which consists in heating the sulphide or sulphate of the metal whose carbide is required together with carbon and some metal which easily combines with sulphur in the electric furnace. It has been proposed before to heat mixtures of alkaline earth sulphides or sulphates with carbon in an arc furnace; but not only does such a progress demand a current of very high voltage, it also takes place somewhat slowly and by no means quantitatively. The feature of the present invention, accordingly, is the addition of a metal to the previous mixture, which metal combines with the sulphur and assists the decomposition. Tin or lead may be employed in order to gain the advantage of their ready fusibility, which makes the charge a better conductor of heat; or iron, or its oxides, may be similarly adopted. For instance, 100 parts of barium sulphate are roasted with 34 of coke, when barium sulphide mixed with an excess of carbon results. The product is powdered, incorporated with 36 parts of iron filings, and ignited in an electric furnace. Using the oxide of iron, the proportions are 100 parts of barium sulphate, 43 of coke, and 35 of ferric oxide. The residue is treated with water, preferably hot, when 10 parts by weight of acetylene are liberated, and can be employed for any desired purpose, while 100 to 120 parts of barium hydroxide (caustic baryta) pass into solution, and can be crystallised out. Forty parts of manganese oxide may be substituted for the iron. Either direct or alternating currents are permissible in the furnace; the former tends to set sulphur free.

The Calcium Carbide Industry.—The vast possibilities of water power in connection with the manufacture of merchandise is well illustrated by the many and varied industries which have sprung up like mushrooms in the neighbourhood of the Niagara Falls, where two companies in particular are engaged in harnessing the waters and using the power thus obtained in the generation of electrical energy. At the present time there are many industries which have in them great possibilities, and which are undeveloped simply because of the great amount of power required to produce a comparatively small amount of finished product. Of these the calcium carbide industry is a notable example, and although the amount of power required in the carbide furnace is very great, the manufacture of calcium carbide has been undertaken at Niagara on a large scale. The process of manufacturing the product in the electrical furnace is very efficient. The necessary condition to produce calcium carbide when the two materials, quicklime and carbon, are placed together is an intense heat, and this can only be obtained in the electric furnace. The temperature required is about 6,332deg. F., at which chemical reactions take place which are unknown in the ordinary furnace. In practice about 5,900 horse-power hours are required to produce one ton of calcium carbide, yet one ton of carbide will generate 11,500 cubic feet of acetylene gas, and this on combustion will give off 14,500,000 British thermal units of heat. It is thought that the great efficiency of the process of storing the energy of the electric current as latent heat in calcium carbide, together with the cheapness and the abundance of the raw material needed for its manufacture, and the simplicity of the devices and the electrical apparatus, will make the calcium carbide industry an important factor in the successful development of water power.

Technical Education.—The extent to which local authorities have applied funds to the purposes of technical education in England and Wales during the year 1900-1, is shown in a return just issued by the Board of Education. The total amount thus expended was £1,051,422, which is exclusive of the sums allocated to intermediate and technical education under the Welsh Intermediate Education Act, 1889. The amount raised by loan on the security of the local rate under the Technical Instruction Acts was £152,833. The "whisky money," or the residue received under the Local Taxation (Customs and Excise) Act by the councils of counties and county boroughs in England last year, was

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£924,359, of which £863,846 was appropriated to educational purposes, and £60,515 to relief of rates. Of the 49 county councils in England who have made returns, 40 are applying the whole of the "whisky money" to technical education, and the remainder only a part of it. Again, of the councils of the 62 county boroughs, 56 are devoting the whole and six only a part of the residue to this purpose. Further, two county councils and the councils of 24 county boroughs, 99 boroughs, and 195 urban districts in England are making grants out of the rates under the Technical Instruction Acts, and 28 local authorities are devoting funds to technical education out of the rate levied under the Public Libraries and Museums Acts. As regards Wales, the total amount of the residue to the 13 county councils and the councils of the three county boroughs in the Principality and Monmouth last year was £44,358. These local authorities are devoting the whole of it to intermediate and technical education, chiefly under the Welsh Intermediate Education Act, 1889. In addition, the councils of nine counties, three county boroughs, five boroughs, and nine urban districts are making grants out of the rates under the Technical Instruction Acts. The total amount expended in Wales on technical education under the Technical Instruction Acts during the year was £44,791. 4s. 9d.

Speed Trials.—The German military railway between Berlin and Zossen is, we understand, soon to be the scene of more speed trials, this time with steam locomotives When the recent electric tests came to an end, mainly on account, it was said, of the bad state of the track, the German Society of Mechanical Engineers took it into their heads to try what steam-engines could do on the same road, and they accordingly framed particulars of a prize contest, looking to the confusion of the advocates of electric traction. The specification issued by this society calls for an engine and train having a capacity for 100 passengers, to be capable of a speed of 75 miles an hour for three consecutive hours without stops for fuel or water. The conditions of the contest here laid down do not appear to be of a very searching character, but it will be remembered that it is to take place on the track that has been so much impaired by the high speeds reached in the electric trials, and another important feature is that economy of fuel will be taken into consideration. In view of the air resistance found by the recent tests of electric traction, it is proposed to box in the entire train so as to form a species of flexibly-jointed sheet-steel projectile with sharp point and smooth sides. The boiler locomotive is to be provided with a heating surface double that of the standard German engine, the aim being to secure very great steaming capacity with usual economy of fuel, so as to obtain the requisite speed with the smallest possible weight and resultant strain on the track. While the results of this contest in steam cannot but be interesting, we fail to see any useful purpose they can serve. We know that a speed of 75 miles an hour is often attained by steam locomotives, but we also know that no railway company would elect to take the responsibility of running engines regularly at such a high speed with comparatively so little gain to the efficiency of their service. Again, the specification calls only for a train with a capacity for 100 passengers, which would hardly meet the requirements of any large railway system. In a word, with a locomotive and train specially planned for the purpose the problem involves no material difficulties whatever, and supposing the feat be successfully accomplished, we cannot see that matters will be advanced in any important particular.

Instruction in Electrical Engineering.—In large engineering works, such as those at Crewe, where the huge locomotives for the London and North-Western Railway Company are turned out, the employés have not, as a rule, much opportunity of acquiring knowledge outside the particular work on which they are engaged. They are thus not so able to keep time with progress as they otherwise would be. Many of the larger engineering and railway companies are now taking steps to remedy this backward state of things, by making provision for the better education of their workmen in the walk of life they are called upon to follow. Among the foremost of these is the London and North-Western Railway Company, whose latest action in the matter might well be followed by other railway companies in the country with advantage. In the case in question, the younger workmen at the Crewe works are to be given the opportunity of obtaining a complete technical training which will enable them to do their work with economy and efficiency. Having an eye to the future, the directors of the company have decided to include electrical engineering in the instruction which their employés will be enabled to receive, and they are now having a laboratory fitted up at the Mechanics' Institution at Crewe with that object. That the men may be encouraged to attend the classes and thus gain knowledge, which, having regard to the great tendency there is towards electric traction at the present time, must prove invaluable to them in the future, the company proposes to devote every Wednesday afternoon to the work of the laboratory, and those in the works who show a proper interest in their duties, and are anxious to take advantage of such an opportunity, will be given facilities to attend the laboratory on these days without pecuniary loss to themselves. It is the unselfish hope of the directors that the work which will be accomplished in connection with the new laboratory will enable them to turn out from Crewe young men who will later on be capable of taking even higher positions in the scientific world than had hitherto been possible. We see no reason why this should not be, for, leaving Crewe with a good elementary knowledge of science, the students could attend the classes at the Manchester Technical School or any such other institution for more advanced work.

Improvement of Motor Meters. — Prof. Elihu Thomson has just patented in the States an improvement in motor meters, the object of which is to simplify and cheapen the construction and render the operation of the meter uniform over all ranges of load. The organisation of the meter is set out by Prof. Thomson in his specification, but the most important claim he makes for his invention is that the organisation may be so modified as to make the registration of the meter substantially accurate, both at light loads and up to the maximum loads for which the meter is designed. The method adopted is described thus: A retarding magnet system comprises, in addition to the damper which slows down the speed of the meter motor at all times, an auxiliary damper, consisting of an electromagnet carrying a current varying with the load in the consumer circuit, and provided with an iron core so proportioned that its magnetisation will be raised to or near the point of saturation as the meter load approaches a maximum. The magnetisation of this auxiliary damper is, of course, nil at zero load; but as the load comes on its damping tendency rapidly increases until, when the load approaches a certain value, where the core of the electromagnet approaches saturation, the curve representing the retardation due to the auxiliary damper becomes flattened, and the effect of the said damper thereafter substantially the same as that of a permanent magnet. With such a construction the meter is so adjusted that it registers with substantial accuracy at full load when the core of

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the auxiliary damper is saturated. As the load falls off, that part of the retardation which is due to the auxiliary damper falls off at first slowly, and later at an increasing rate as the magnetisation falls below the bend in the "curve of magnetisation," until finally when the load reaches its minimum value it becomes practically nil. By properly designing the electromagnet constituting the auxiliary damper, its effect may be made to exactly compensate for the frictional resistance of the moving parts of the meter, so that the curve of registration will be substantially a straight line up to the maximum load for which the meter is designed, it being understood that beyond this load the curve of registration is likely to fall off somewhat, probably by reason of the disproportionate counterbalancing effect of the counter E.M.F. generated in the meter armature at such loads.

Reduction Methods.—Mr C P. Townsend in the *Electrical World* describes two patents dealing with the reduction of oxides, the one granted to Mr R. C. Contardo, of Santiago, depending upon the heat developed by the arc, and the other to Dr. F. C. Weber, of Chicago, upon the reaction, either exothermic or endothermic, of aluminium The methods differ utterly in character, but are alike in that the object of the improvement in either case is to bring the reaction under complete control. In the direct production of iron or steel from the ore three elements are to be considered—namely, a source of heat, a reducing agent, and a carbon supply. In the ordinary blast furnace the combustion of carbon performs these three functions, whereas Contardo's plan is to render them entirely independent of one another. To this end the temperature is reached through the agency of an arc, so protected from the charge that the carbon of the electrodes cannot enter into the reduced metal. The reducing agent is a gas which cannot influence the carbon content, and the carburetting agent is another gas, the quantity of which is subject to exact regulation. The apparatus comprises a stack, smelting hearth, and a crucible. The carbons extend diametrically through the smelting chamber, and are protected from the charge by an angular refractory cover. The stack is provided with the usual charging bell and gas outlet and the crucible with a tap or cast In operation the ore, unmixed with any reducing agent, but containing a suitable flux, is charged into the stack, and the heat conveyed to it by radiation from the arc and by convection by the reducing gas, hydrogen, or carbon monoxide, introduced through the flues. Through the same flues flows a hydrocarbon gas in quantity determined by the desired carbon content of the resulting product. In the second patent Dr. Weber attributes the occasional explosive violence of the "thermite" reactions largely to the presence of water, free or combined, in the reducible oxide, and avoids the difficulty by a preparatory treatment through the agency of electrically applied heat; for initiating the reaction, it suffices to fuse a portion of the aluminium, and this is accomplished by its inclusion in a second circuit. The objects attained are thus a regulation of the reaction and the avoidance of a contamination of the product by the base of an easily reducible oxide such as is ordinarily used, with aluminium or magnesium, for producing the initial high local temperature.

Decline in United States Electrical Exports—It will be news, indeed, to those who never tire of spreading alarmists reports to the effect that America is gradually taking away from England her legitimate trade in electrical machinery and the like, to learn that the official figures for the exports of electrical machinery from the United States for the past year show a falling off of about 7½ per cent. on the previous year's exports. This is only in respect of electrical machinery, and we have it on the authority of the United States journals themselves that, taking into consideration the exports of electrical appliances, including telegraph and telephone instruments and all other instruments and apparatus for scientific purposes, the decline is somewhere in the neighbourhood of 26 per cent. The figures issued are for the fiscal year ended June 30 last, and in that period the total exports amounted to £1,802,301, of which £1,075,949 was in respect of electrical machinery and £726,352 in respect of electrical appliances. Notwithstanding the enormous falling off in the exports which is shown in the official returns, Great Britain and the British Colonies continue to be by far the best customers of the United States for electrical machinery. Thus, the United Kingdom contributed no less than £514,699 last year, as compared with £552,146 the previous year, and £313,730 in 1900. Next in order comes British North America, which imported electrical machinery from the United States last year to the tune of £229,526, which is an increase of no less than £68,042 over the figure for the year 1901. It is noticeable in connection with this heavy increase that the difference between the sum given for 1901 and that for 1900 is only £1,200, which indicates in a lively manner the great progress British North America has made in the last year in the use of electrical machinery. British Australasia contributed a sum of £112,654 to the grand total, being an increase of about 35 per cent. on the previous year. The next highest figure is that given for the British East Indies, amounting to £41,608. In this case a decrease is shown of £21,808 as compared with the year 1901, but this is to be accounted for to some extent by the fact that an abnormally large quantity of electrical machinery was imported into the East Indies in the 12 months from June 30, 1900, to June 30 the following year. Exports to other countries are represented by the following figures: Mexico, £39,352; Europe (excepting France and Germany), £34,680; Japan, £25,955; Africa, £14,149; Argentina, £12,341; Germany, £8,600; and France, £7,851.

American Engines.—Our readers will remember the great excitement which was caused by the contract for the steam-engines for the Glasgow Corporation tramway station in 1899. The specification then issued by the consulting engineer for the work recommended extremely large working parts for these 4,000-h.p. engines, and the question arose as to whether the experience of English engine builders was to be utterly thrown on one side in the decision as to who should have the contract. The result was that two of the engines were made by the Allis Company, of America, and the other two by Messrs. John Musgrave and Co., of Bolton. This latter firm, however, accepted the heavy parts recommended by the consulting engineer. These engines have now been tried by Prof. Barr, so that the facts concerning them should be shortly available. The manager of the tramway department, Mr. John Young, however refuses to give the figures from the report of Prof. Barr until they have been approved by the Corporation. In spite of this our contemporary *Engineering* had an article on the subject a fortnight ago, in which the general results are claimed to be given. The correspondence, however, in the last week's issue of our contemporary shows that the article is more noted for its blind advocacy of American engine design than for the accuracy of the figures said to be extracted from Prof. Barr's report. We do not propose to go into the matter fully at the present time, as the report of the expert is required before we can do so. It is claimed, however, for the Allis engines that they have a mechanical efficiency of 96 per cent., and that the efficiency of the engine and dynamo together is 92 per cent. These

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figures we doubt. On the question of steam consumption, however, as expressed per indicated horse-power, the probable error in the measurement of the output of the electrical generator does not appear. It is claimed that these 4,000-h.p. engines require 12·2lb. of steam per indicated horse-power hour. With the efficiency above given, this is equal to 17·16lb. of steam per kilowatt-hour. We are surprised to find that *Engineering* is pleased with this result. We would refer the editor of our contemporary to the results obtained by an English engine of one-quarter the output of those at Glasgow, *i.e.*, the Wallsend Slipway Company's engine in the Neptune Bank power station of the Newcastle-upon-Tyne Electrical Supply Company. This engine on trial at 1,030 i h p. only took 10·35lb. of steam per indicated horse-power hour and 17·1lb. per kilowatt-hour. Considering the comparatively smaller size of the Wallsend engine, these figures put the American engines out of court. We believe, too, that the steam consumption trials on the Glasgow engines at no load will prove the efficiency figures given above to be incorrect.

Electrical Mining Equipment.—In the course of a long article in the current number of the *Electrical World* Mr. Leon M. Hall gives some very interesting details of the application of electricity to mining operations. As an instance of the progress which is being made in this direction, he takes the case of the Comstock Lode mining properties, which until about two years ago were all worked by steam. This has now been supplemented in most cases by electricity, and power is transmitted 35 miles to the properties, a dozen or more of which have put down electrical machinery for carrying on their operations. The power plant is situated on the Truckee River, and is capable of developing nearly 6,000 h.p. Current is generated at 500 volts, and is raised to 24,000 volts by means of transformers, at which potential it is transmitted 33 miles over a double circuit to a sub-station at Virginia City. Here the voltage is lowered to 2,300 volts, and at this potential the current is supplied to the mines. The various purposes to which it is put, both on the surface and down the mines, are enumerated by the author, who describes in detail the electrical equipment of one of the most important shafts in operation The electrical machinery on the surface consists of three induction motors of from 30 h.p. to 200 h.p., operating respectively an electric hoist, a single-stage air-compressor, and some circular saws There are also other smaller motors for driving tools in the machine shop, and for operating rock-breakers; three power transformers, transforming from 2,000 volts to 440 volts, and one lighting transformer, which reduces the voltage to 110 volts. For lighting purposes on the surface there are two arc lamps and 50 incandescent lamps. The installation underground includes three 225-h.p. motors, operating at 2,300, and geared to three duplex double-acting pumps located on the 2,150ft. level, and two smaller motors for driving fans. Several transformers reduce the voltage of the current to 440 at different depths, and there is also a 3 kw. lighting transformer on each level. Some 250 16-c.p. incandescent lamps scattered through the workings underground give an adequate illumination The power is brought into the works over two separate circuits Oil-break switches are used on the cable circuits and upon all of the 2,200-volt motors. The compressed-air plant, which is driven by a 100-h.p. motor, supplies air for drilling and for a number of underground hoists. The electric hoist at the surface is a decided departure from usual practice in deep-mine hoisting plants, and embodies what is commonly known as the balanced, continuous, or tail-rope system. It consists essentially of a main driving drum and an idler, around which is wrapped a 1⅛in. plough-steel wire rope. The drum is geared to a 200-h.p variable-speed induction motor, which operates at a maximum speed of 580 revolutions per minute, moving the cages through the shaft at 1,250ft. per minute The plant above briefly described is said to be one of the best and most complete mining installations in the world, and its operation has been entirely satisfactory both in regard to economy and to reliability.

Fixation of Atmospheric Nitrogen.—We have previously written in these columns about this new electrochemical development, when we announced a month or two ago that the electrical fixation of atmospheric nitrogen was being exploited by a company at Niagara Falls in the States. The first description of the process and the apparatus employed which we have seen, however, is that published in the *Electrical World* for the 2nd inst. From the information given in our contemporary, we gather that the basic principle of the process depends upon phenomena discovered more than 100 years ago, and admitted as a fact of academic interest only. The production of oxides on a commercial scale by means of the electric spark, however, has only been accomplished within the last two or three years. The high-voltage direct-current arc is more favourable to the process than the alternating-current arc It has been found best to use a voltage of about 10,000, and allow it to jump electrostatically through the air a short distance, thereby establishing an arc, and then rapidly separating the contacts until the arc breaks. To produce this power, a specially-designed direct-current series arc machine is used, which is capable of operating a device, the joint invention of Mr Chas. S. Bradley and Mr. B. R. Lovejoy, making 414,000 arcs per minute. The device itself consists of a box of metal provided with openings to admit the air and properly circulate it, and containing rows of fixed contacts. Each of these contacts is insulated with great care, and to each is connected a wire, passing first to an inductance and thence to the positive pole of the dynamo. The negative pole is a revolving cylinder, equipped with properly spaced projections which come very near but do not touch the fixed contacts in the surrounding box. This cylinder is driven by a vertical electric motor at 500 revolutions per minute, and as there are six sets of contacts in line with the fixed contact on the wall of the cylinder, each fixed contact, therefore, provides 3,000 arcs per minute. The air is driven through the apparatus at the rate of about five cubic feet per arc contact per hour. In the apparatus illustrated in our contemporary there are 138 contacts—six rows of 23 each. The air passing from this machine emerges laden with 2½ per cent. of oxides of nitrogen, and by simply leading these gases through water in sprinkling towers, well known to chemical processes, there results nitric and nitrous acid. The latter rapidly evaporates and recombines with water again, the result being that ultimately all of the fumes are converted into nitric acid. If these gases are brought into contact with caustic potash, KOH, saltpetre, KNO_3, is the result; and if brought into contact with caustic soda, NaOH, nitric soda, $NaNO_3$, is the result. In fact, it is easily possible to form almost any of the nitrates by this simple combination with appropriate bases. It is estimated that over 1,000,000 tons of nitric acid are manufactured every year by treating natural nitrates with sulphuric acid, and the promoters of the above process claim that they can produce the same product at figures which will control this business, especially as the nitric acid thus produced is chemically pure, which is by no means the case with commercial nitric acid to-day.

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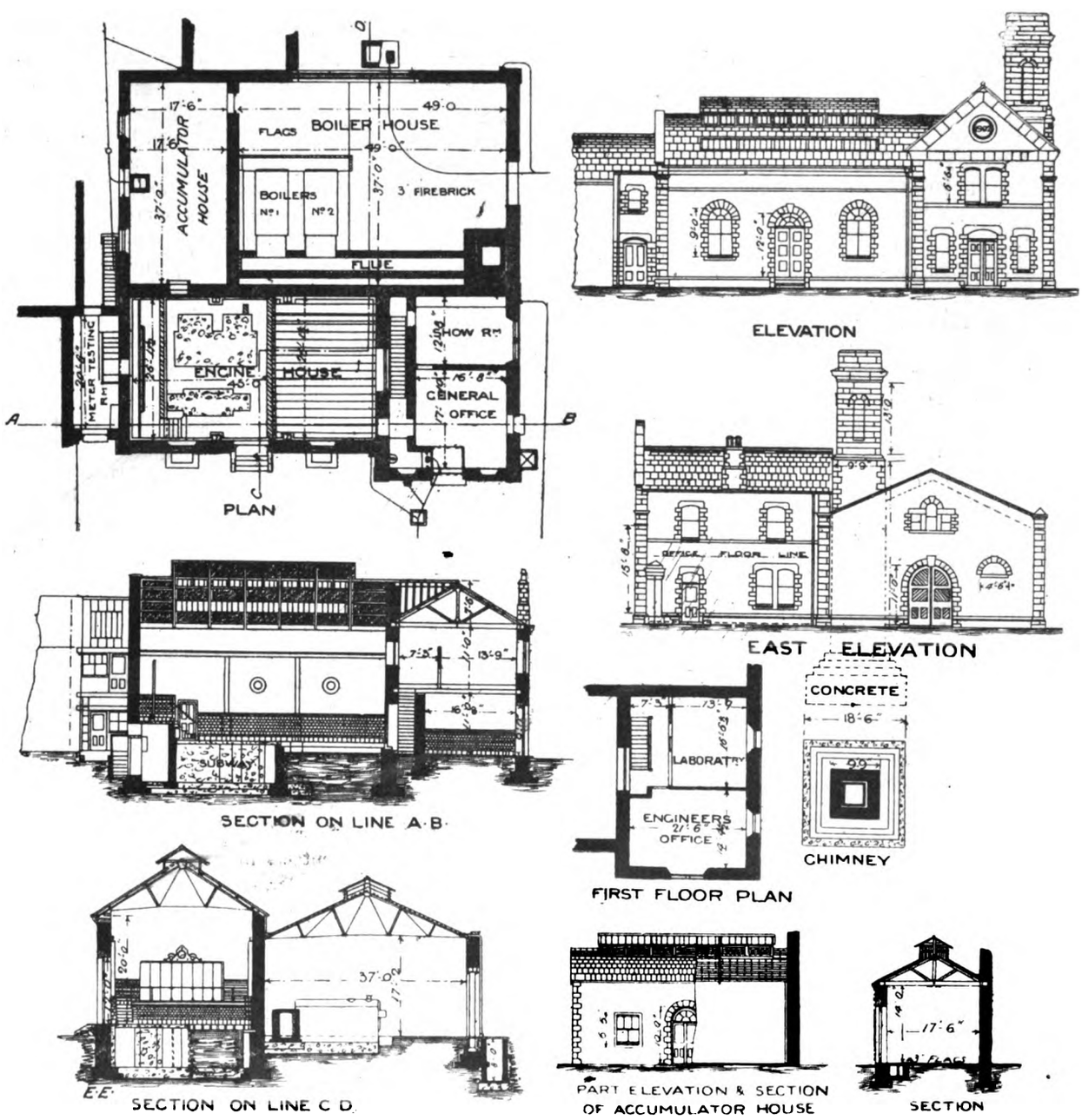
KENDAL ELECTRICITY WORKS.

The old town of Kendal, in Westmoreland, which has the distinction of being one of the oldest boroughs in the kingdom, having received its charter in the reign of Queen Elizabeth, has just shown that it is moving with the times by opening its own electricity supply station. The opening ceremony took place on Wednesday, the 6th ult., at 8 p.m., when the Mayoress (Mrs. Gilkes), a name well known to most of our readers in connection with turbines, switched on the current to the town in the presence of the members of the Corporation and other guests. After an inspection of the station and its machinery, the chairman of the Electric Light Committee (Mr. Alderman Monkhouse) gave a short account of the history of the scheme, and then called on Mr. A. H. Dykes (of Messrs. Handcock and Dykes, the consulting engineers for the work) to give a description of the system and plant. At the invitation of the Mayor and Mayoress, the company next sat down to dinner in the engine-room, which had been very tastefully decorated. After the usual loyal toasts, Mr. Dykes was called on to propose the toast of success to the undertaking.

The question of providing a supply of electricity for Kendal was first considered by the Corporation in 1897, and in January, 1898, Messrs. Handcock and Dykes, of 1, Victoria-street, Westminster, consulting engineers, were instructed to report on the prospects of a municipal electricity undertaking. In their report, dated April 12, 1898, they stated that they were of opinion that such an undertaking was advisable, and recommended putting down a station capable of supplying 5,000 8-c.p. lamps or their equivalent for private lighting, and 30 enclosed arc lamps for public lighting of the main streets. They proposed that the water power in the pipe line between Fisher Tarn and the low reservoir should be utilised by means of turbines for driving dynamos, and that there should be an auxiliary plant, with storage batteries in the town. Their estimate of the total cost of such a scheme, including buildings, plant, mains, public lamps, and all legal and engineering fees, was £17,818. They also recommended that the charge for current should be on a sliding scale—namely, 8d. per unit for the first hour's use per day and 2d. per unit afterwards—pointing out that one man might have a large number of lights on the premises which he used only for a short time each day, whilst another man might only have a few lights which, however, he used long hours. Both might at the end of the quarter have consumed the same number of units, but whilst the latter man had only entailed on the station a small outlay for the proportion of the plant and mains necessary to supply his lights, the former was responsible for a very much larger proportion. As the greater part of the cost of supplying current was the standing charges, interest, and sinking fund



FIGS. 1 AND 2.—Plan and Elevations of the Buildings of the Kendal Electricity Works.

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payments, it was obvious that one man ought to be charged considerably more than the other.

In January, 1899, a further report was received from the engineers in accordance with the instructions of the town clerk, showing how the scheme would be modified by reducing the size of the "compulsory area," omitting part of the street-lighting, and dispensing with the water power from Fisher Tarn, that source of power being not then available. In that report they still recommended making provision for 5,000 8-c.p. lamps connected, and proposed a steam-power plant at a total cost of £15,015, stating that they felt sure that within the first year a load of 2,500 lamps would be obtained. However, it was decided, to commence with, to only put in a plant capable of running 2,500 lights, the estimates for the whole of the plant and mains, exclusive of buildings, being £8,160. Instructions were then given to the engineers to prepare specifications for the plant and mains, and the design of the necessary buildings was entrusted to Mr. Ritson. The provisional order was obtained in 1900.

In due course tenders were received, and the contract given to Messrs. Johnson and Phillips, of Charlton, for the whole of the station plant at £4,975; and to Messrs. the British Insulated Wire Company, Prescot, for the mains, meters, and services at £3,000—making a total of £7,975. The work has been carried out by the two firms in question in a most satisfactory manner for the above sums, and the whole plant, although small, is a most complete and up-to-date one, a striking feature being the simplicity of design and the small amount of labour required in the station.

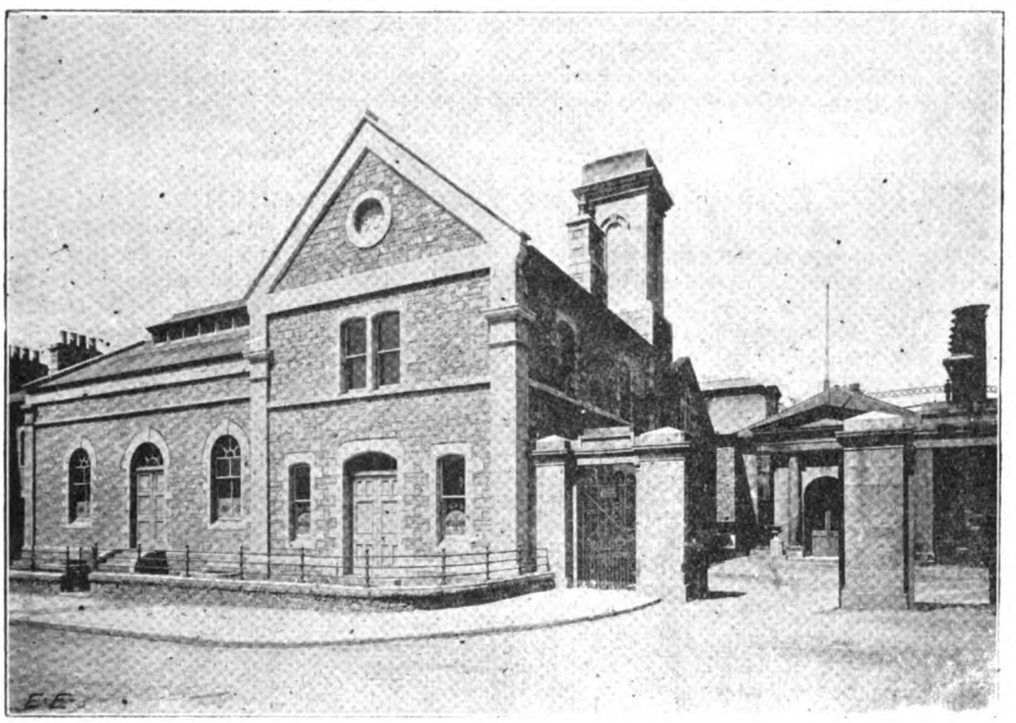

FIG. 3. General View of the Kendal Electricity Works.

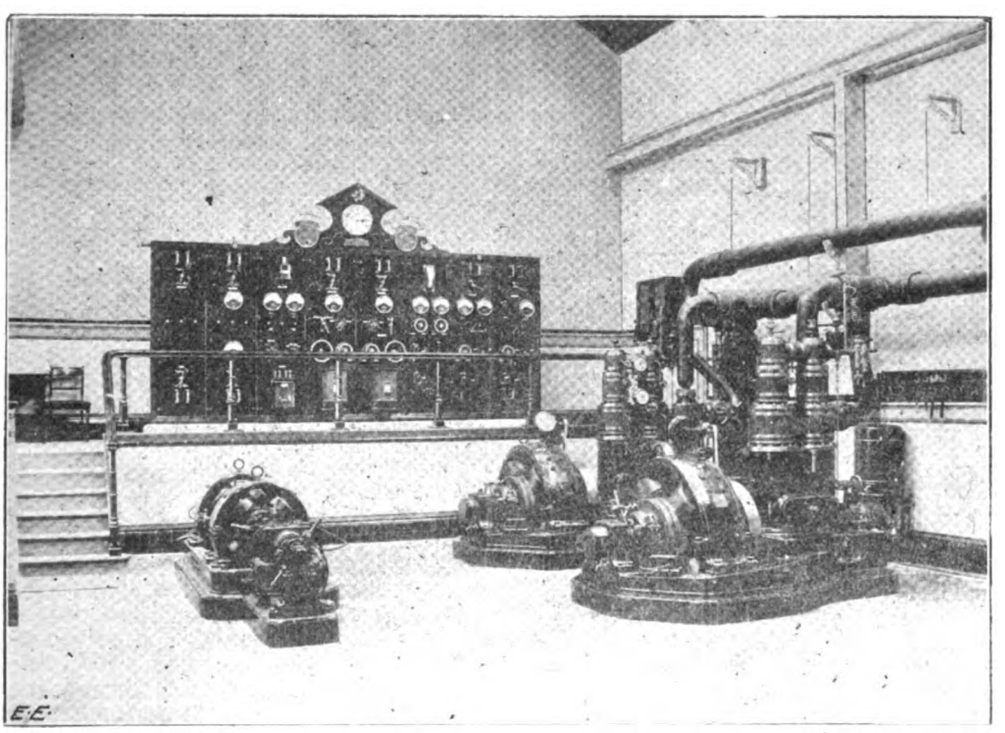

FIG. 4.—The Engine Room of the Kendal Electricity Works.

The buildings, erected by Messrs. W. Dixon and Sons, of Kendal, are of a most handsome description, and allow for considerable extensions of the plant. That this additional space will soon be required, is evident from the fact that on the opening night the total number of 8-c.p. lamps connected, or their equivalent in arc lamps and motors,

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amounted to 2,496, thus more than fulfilling the prediction of the engineers, who have accordingly had to advise the Corporation to immediately put in hand additional plant to prevent any failure of supply during the coming w nter. The buildings (Figs. 1 and 2) which have been designed by Mr. T. N. Ritson, A.M.I.C.E, the Corporation gas, water, and electricity engineer, are situated at the gasworks. They are built entirely of local limestone. The elevation facing Parkside-road (Fig. 3) has an imposing and pleasing effect, the masonry being relieved with dressed stone pilasters and ashlar work. At the east end is a two-storey building, to be used as offices and showroom. The engine-room (Fig. 4) is 49ft. long by 28ft. wide, the roof being supported by steel principals, and is boarded and panelled in pitch pine. The switchboard is elevated 3ft. 6in. above the floor line. A subway extends over the whole area of the engine-room, giving access to underneath the switchboard and to the engine and dynamo foundations. The floor, which is tiled, is formed of expanded metal and concrete. The interior walls of engine-room are neatly and artistically finished with a tiled dado 5ft. high. The boiler-house is 49ft. long by 37ft. wide, the roof principals being of steel. Like the engine-house, it is lofty, well lighted and ventilated, and ample provision has been made for future extensions of plant. The chimney is 50ft. high, and is built partly of cement and partly of dressed freestone, and is provided with a loose firebrick lining throughout, which admits of an annular air-space between the masonry and brickwork. The accumulator-house is 39ft. long by 17ft. 4in. wide, is lofty, and well lighted from the front and roof, and is also well ventilated. Meter-testing room, stores, and overhead water-tank are also provided, the whole proving a most complete, well-arranged, and up-to-date installation, reflecting the greatest credit upon the designer.

The scheme approved by the Corporation provided for a three-wire, continuous-current network radiating from the station, no feeders being used.

In the boiler-house (Fig. 5) there are at present two single flue, dry-back boilers, by Messrs. J. Fraser and Sons, Millwall, each easily capable of evaporating 2,500lb. of water per hour, with hot feed and draught of ¾in. water-gauge, at a consumption of best Welsh coal of not more than 1lb. per 10lb. of steam from and at 212deg. F. Ample space is left for additions to be installed in the future as required. At the base of the chimney shaft is fixed a 55in. Sturtevant induced-draught fan, driven by an enclosed steam-engine, the engineers preferring to save the cost of a tall chimney, which would only be earning its costs for an hour or two a day, and to use a little steam during hours of full load in order to produce the necessary draught mechanically.

For boiler feed, a 4½in. by 2½in. by 4in. stroke Hayward Tyler duplex hot-feed pump, driven by steam, is provided, to deliver 800 gallons per hour, and in addition to this a three-throw electrically-driven plunger pump of 500 gallons capacity per hour. The motor for this latter is compound wound, with shunt and series regulating resistances to vary the speed 15 per cent. either side of normal. The armature can be put across the outers at 440 volts, or one side of the three-wire system at 220 volts, this giving maximum economical speed. A 2in. Kennedy hot-water meter is provided to measure the amount of feed water, which is heated by a Berryman feed heater supplied with exhaust steam from the engines.

In the engine-room (Fig. 4) there are at present two Willans high-speed engines, each of 50 b.h.p., while ample space is left for extensions. The dynamos are of Messrs. Johnson and Phillips's make, six-pole shunt-wound machines, each of 36 kw. capacity, connected in parallel across the outers, supplying current at 450 volts at about 400 revolutions per minute. A balancer-booster set is installed, consisting of two motors and two dynamos all direct coupled, but with independent armatures. The boosters give 30 amperes at any voltage from 10 to 90, and the balancer motors 50 amperes from one side to the other when working on the bars at any voltage from 220 to 250. The battery consists of 240 L. A. 7 Tudor cells in glass boxes, half being connected on either side of the three-wire system, and each half gives 21 amperes for 10 hours, with final voltage across the whole battery of 400 volts. They are capable also of an emergency discharge of 90 amperes for 30 minutes—*i.e.*, of supplying about 1,300 8-c.p. lamps alight at once.

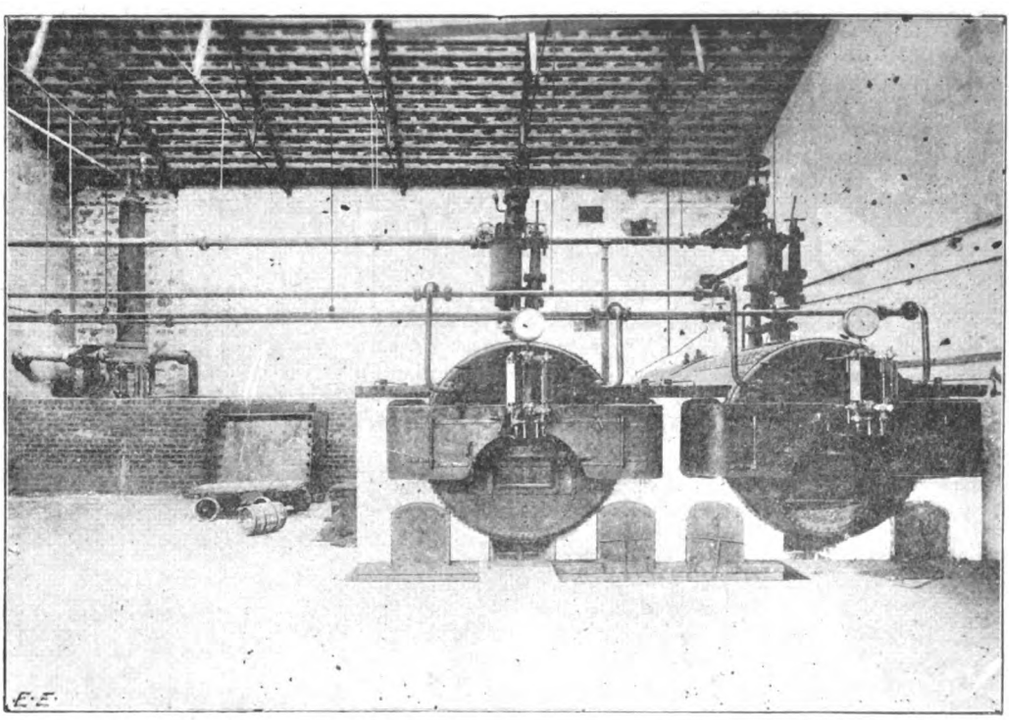

FIG. 5.—The Kendal Boiler House.

A hand-power travelling crane is provided in engine-room, taking the full span of the room, designed to lift up to three tons. The gantry rails are carried on longitudinal steel joists fixed to each gable wall, and supported at intervals on steel stancheons.

The main switchboard, mounted on a raised platform at end of engine-room, presents a handsome appearance, and is exceedingly simple to work. It consists of separate slate panels for each of the two dynamos, the two batteries, and the feeders. The main voltmeters, connected by pilot wires to the centre of distribution in the town, are of illuminated dial pattern, and there is a Kelvin electrostatic voltmeter which can be connected up to any of the voltmeters on the board for the purpose of checking them. The battery switches are mounted in the wall of the meter-testing room behind the engine-room, being worked by gearing off the main board. All the resistances are fixed in the fireproof cellar below the board.

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The mains are three-core, clover-leaf pattern, made and laid by the British Insulated Wire Company, insulated with impregnated paper and lead covered. They are laid solid in wooden trough filled in with insulating compound. There are two mains, each ·15 × ·08 × ·15 square inch section, leaving the station, and running on either side of the main street up to the top of the town, a distance of nearly a mile, with branches of ·1 and ·05 square inch up the side streets. There are five disconnecting pillars at various parts of the town by which any section of the main can be quickly cut out for testing or in the event of a fault, the mains on either side of the roads being cross-connected at these points, so that if a section has to be cut out the others are not affected. The service connections are made partly in British Insulated Wire Company's cast-iron service boxes with fuses, and partly by means of wiped joints direct on to the cables.

The meters are the Vulcan type, supplied by Messrs. Geipel and Lange. Current is supplied at present at a flat rate of 6d. per unit for lighting and 3d. per unit for power. There are at present 44 consumers connected, having just under 2,500 8-c.p. lamps, and a large number of others will shortly require a supply. The motor load to commence with, amounted to 10 h.p. divided between four motors, but it is understood that a number of manufacturers contemplate installing motors, and, indeed, an extension of the mains has already been decided on to reach one motor user who is just beyond the compulsory area.

There can be little doubt, therefore, that very shortly the station will reach the output of 5,000 lamps originally contemplated, when, as predicted in the engineer's report, the financial result should be quite satisfactory. The fact that in Mr. Gilkes the Corporation have a mayor who is himself an engineer, and a pioneer in the district in the matter of electric plant, has naturally been of great assistance in carrying through the scheme. Mr. Ritson, the borough engineer, who has acted as resident engineer under Messrs. Handcock and Dykes for the engineering part of the work, and has been responsible for the building, is unfortunately just leaving the town to take up a corresponding position at Ramsgate, but he leaves it with the satisfaction of knowing that the undertaking has made a satisfactory start, and is likely to prove one of considerable importance to the town.

NOTES ON THE TESTING OF TRAMWAY MOTORS, AND AN INVESTIGATION INTO THEIR CHARACTERISTIC PROPERTIES.*

BY MICHAEL B. FIELD, MEMBER, A.M.I.C.E.

(Concluded from page 305.)

We have then, with 50 amperes on the first notch, speed = 17 miles per hour, and a negative acceleration of 2·6 miles per hour per second on the level, or two miles per hour per second on a 3 per cent. down grade. Similarly for 35 amperes, if we follow the 35-ampere ordinate till we meet the current curve, then horizontally to the right till we cut the $\frac{n}{R}$ line and drop vertically downwards on to the speed scale, we arrive at 13·4 miles per mile. Then travelling to the left after meeting the current curve till we cut the retarding force curve, then vertically again on to the "level grade" line, and again horizontally on to the vertical negative acceleration axis, we get for 35 amperes a value of 1·65. The mean retardation between 50 and 35 amperes is therefore 2·12 on the level, and the change of velocity 3·6 miles per hour. We may still continue graphically to find the time interval required and space traversed. Refer to Fig. 16. Mark off on the vertical scale the mean negative acceleration, 2 12, and the change of velocity, 3·6 miles per hour. Join the former point with the point denoting one second on the time scale and draw a parallel through 3·6, when we find the time interval 1·7 seconds. Now mark off on the lower vertical scale the mean velocity during the interval—*i.e.*, mean of 17 and 13·4, or 15·2 miles per hour. This, it will be seen, corresponds to 22·3ft. per second. Hence join this point with the point on the time scale denoting one second, and draw parallel through 1·7 seconds, giving the result of 38ft. as the distance traversed during the interval in question. We should then take, say, 28 amperes, and, proceeding as before, find the new time interval and other values corresponding to the range 35-28 amperes, and so on, constructing the various curves as we go. The writer personally prefers not to make use of Fig. 16 at all, but to plot current, time, and velocity as determined from Fig. 15 on a separate sheet and obtain the space-curve by integrating the velocity time curve.

The acceleration diagram is somewhat different (see Fig. 17). Horizontally "total amperes" and acceleration scales are constructed, with a speed scale (not reversed) to the right as before, volts and tractive effort being plotted vertically. The ampere-volt characteristic for 10 miles per hour is then drawn in (dotted) This is first doubled in the vertical and then in the horizontal direction, two new curves, marked "total volt-ampere" and "total ampere-volt characteristic," being obtained. With 500 volts as the radiating point straight lines are drawn denoting the

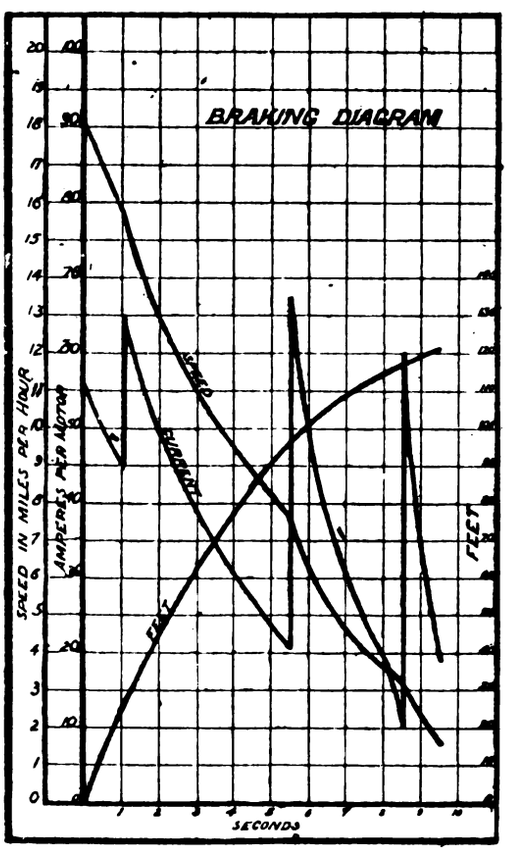

FIG. 20.

total C R drop in the circuit for the different values of the resistance on the various notches, the volt drop being measured vertically downwards from the horizontal passing through 500 volts. Measuring from the zero line upwards we get back E.M.F., or 500—C R. The upper characteristic gives the volts for two motors in series (with the same current C) if running at 10 miles per hour; hence by drawing parallels on to the speed axis we obtain the true speed at which the car is running.

An example will make this clear. Total current is 50 amperes, controller on R_2—*i.e.*, second series notch. Resistance = 5·02. Following the ordinate for 50 amperes vertically till it cuts the R_2 line, we find the length intercepted between the horizontal zero axis and R_2, or back E.M.F. = 249 volts, the C R drop being 251—viz, the portion intercepted between the R_2 line and the horizontal drawn through 500 volts. Following the same ordinate upwards to the dotted curve, we see that 50 amperes give a back E.M.F. of 580 volts, hence two motors in series give 1,160 volts—*i.e.*, the point on the upper characteristic; 1,160 volts on the vertical axis, on the right-hand side of diagram, is therefore joined with 10 miles per hour on the

* Paper read before the Glasgow Local Section of the Institution of Electrical Engineers.

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speed scale, and a parallel drawn through 249 volts, giving an actual speed of 2·15 miles per hour. When working with the parallel notches we use the lower characteristic, since for any value of total current the amperes per motor are only half, and the voltage for any current on this curve is the same as for half the current measured on the dotted curve.

Accelerations, time intervals, and distance traversed are found exactly in same way as in the braking diagram. We have here, therefore, all information available for building up the whole acceleration diagram and computing the current consumption. Figs. 18 and 19 show the actual time-current and time-speed curves for the various controller notches, for motor P: (1) when braking on the level; (2) when braking on 4·5 per cent. down grade: (3) when accelerating on level; (4) when accelerating on 4·5 per cent. up grade. They have all been calculated on the time-interval method above described, and on the assumption that no slipping occurs. These curves enable us to formulate any programme whatever during the braking or accelerating periods on the given grades. We can, in fact, fit the various curves together in any way we like, and determine the current consumption, and time-speed curves for rapid accelerations or gradual accelerations. We have only to remember that the initial speed on any one notch must be the final speed on the

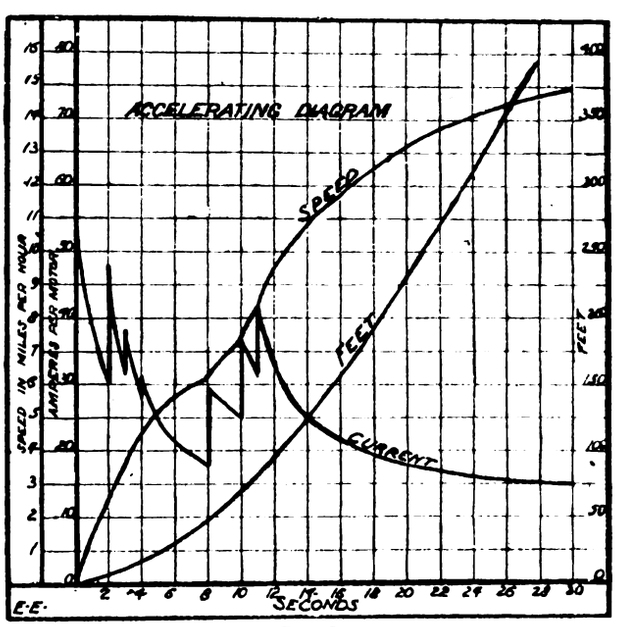

Fig. 21.

previous notch, and to postulate the length of time interval to be allowed on each notch, in order to pick out the right portion of the current and speed curves. Figs. 20 and 21 illustrate this, and need no further explanation. These considerations are, of course, of the greatest importance when dealing with heavy, quick-service railways for city traffic with frequent stops, such as tube railways, etc. American engineers, moreover (especially those who sell car wattmeters), claim that with ordinary tramways variations amounting to from 20 to 30 per cent. in the total energy required by different motormen to drive the same car over the same route under the same conditions are not uncommon.

[*Note* 4.—Extract from *Electrical World and Engineer*, Dec. 16, 1890: "Mr. Charles Hewitt, engineer of the Union Traction Company of Philadelphia, contributed a brief paper under the title of 'The Motorman as an Element of Street Railway Economy.' Tests were made by him by placing a wattmeter on a car without the knowledge of the motorman, and then having that car run on a number of routes by a number of different motormen. . . . The results showed that the number of passengers carried had an almost inappreciable effect on the watt-hours per car mile, and that the variations in the amount of energy consumed depended almost entirely on the motorman. The watt-hours per car mile varied very greatly for different motormen, but were nearly constant for the same motorman. They indicated that the usual test of a motor made in this way is really a test of the

Table I.—Test of Tramway Motor, Type P.—Table of Observed Readings at 500 Volts.

No. of reading.	Motor. Volts.	Motor. Amps.	Generator. Volts.	Generator. Amps.	Motor field.* Volts.	Motor field.* Amps.	R.P.M.	Remarks.
1	523	23·8	491	15	12	23	643	
2	504	30	461	23	15·2	30·5	631	
3	500	34·5	451	26·5	17·5	35	504	
4	497	40·3	439	32	20·7	41	463	Res. of motor armature at 20deg. C. = ·414 ohm.
5	484	45·2	420	36	23·5	46·5	441	
6	488	50·3	416	40·7	25·5	50·5	422	
7	485	54·7	406	44·3	28	55	409	Res. of gen. armature at 20deg. C. = ·414 ohm.
8	475	60·5	387	50·3	31	61	380	
9	483	65 2	387	53·3	33	64	372	
10	484	70·2	380	58	36·7	69·5	361	Res. of motor fields at 20deg. C. = ·414 ohm.
11	475	76	360	62·8	40·5	75·5	336	
12	476	81·5	351	68	43·7	80	325	
13	461	85·2	329	71·3	48	88	303	
14	456	92	314	77	51	90·5	289	
15	468	98·5	314	82·7	54	95	283	
16	465	107·5	297	90	62	108	260	

* These readings taken simultaneously.

Table II.—Table of Observed Readings at 250 Volts.

No. of reading.	Motor. Volts.	Motor. Amps.	Generator. Volts.	Generator. Amps.	Motor field.* Volts.	Motor field.* Amps.	R.P.M.	Remarks.
1	246	15·5	228	10	9	15·5	365	
2	255	19·5	231	14	11	19·5	325	
3	243	27·8	204	21	15·5	28	250	
4	249	40	193	32	22	40	211	
5	258	49·7	189	40·3	27·4	50	200	
6	253	59·2	169	48·3	32·2	59	170	
7	251	69·2	153	57·3	39·5	71	157	
8	251	87·5	121	74·3	51·8	89·5	129	

* These readings taken simultaneously.

Table III.—Test of Tramway Motor, Type Q.—Table of Observed Readings at 500 Volts.

No. of reading	Motor. Volts.	Motor. Amps.	Generator. Volts.	Generator. Amps.	Motor field. Volts.	Motor field. Amps.	R.P.M.	Remarks.
1	503	21·5	463	15·4	14·6	21·5	630	
2	497	32	445	24·9	21	31	525	
3	506	35	443	28	23	34 5	517	
4	496	39·3	425	32·5	26·3	40	480	Res. of motor armature at 20deg. C. = ·423 ohm.
5	494	45·2	415	36·5	29·5	45	452	
6	484	50·7	396	42·5	33·8	51·5	425	
7	490	55·2	393	46·1	36·2	55·5	415	Res. of gen. armature at 20deg. C. = ·408 ohm.
8	490	60·1	385	51·9	40	60 5	398	
9	471	65·7	360	54	43·4	65·5	369	
10	475	71·6	350	61·7	48·6	72·8	351	Res. of motor fields at 20deg. C. = ·519 ohm.
11	476	74·8	347	63·1	50	75·1	347	
12	467	79 9	328	67·4	54	80·1	323	
13	471	86·9	320	74·2	59	87·5	311	
14	461	93·7	302	77·5	65	95	295	
15	455	101·4	281	84·9	68	99·8	275	

Table IV.—Table of Observed Readings at 250 Volts.

No. of reading.	Motor. Volts.	Motor. Amps.	Generator. Volts.	Generator. Amps.	Motor field Volts.	Motor field Amps.	R.P.M.	Remarks.
1	255	16	229	10·4	10·9	16	382	
2	250	19·5	219	14·4	12·9	19·5	320	
3	251	30·5	203	25·1	20	31	250	
4	255	42	187	35·5	27·5	42·5	210	
5	249	51·7	166	44·3	33·5	51·5	185	
6	254	64	152	55·5	42·6	65	170	
7	256	71·8	139	62·2	46·5	70	155	
8	247	81·3	110	70·5	55·2	81·5	129	
9	253	86·5	103	74·2	61·2	87	122	

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TABLE V.—Table of Calculated Losses, Efficiency, etc., at 500 Volts. Motor, Type. P.

Number of reading.	Input (kilowatts).	Output (kilowatts).	Total loss (kilowatts).	C^2R loss in motor at test.	C^2R loss in generator armature.	Friction and iron losses in motor at test.	Corrected friction and iron losses for 500 volts and 20°C.	Efficiency at 500 volts and 20° C.	Speed in miles per hour; 30in. wheel. Gear ratio = 4·86.	Tractive effort at tread of 30in. wheel in pounds. Gear ratio = 4·86.
1	12·45	7·37	5·08	·58	·10	2·20	2·11	78·2	11·33	413
2	15·12	10·60	4·52	·91	·25	1·68	1·68	83·6	11·61	543
3	17·25	11·95	5·30	1·21	·33	1·88	1·90	83·0	9·35	770
4	20·03	14·05	5·98	1·65	·48	1·88	1·92	83·5	8·67	975
5	21·87	15·12	6·75	2·08	·60	2·04	2·15	82·7	8·53	1,101
6	24·55	16·93	7·62	2·57	·77	2·14	2·24	82·4	8·11	1,284
7	26·53	17·99	8·54	3·04	·91	2·30	2·43	81·7	7·93	1,416
8	28·74	19·46	9·28	3·72	1·17	2·20	2·38	81·7	7·55	1,645
9	31·49	20·67	10·62	4·32	1·31	2·50	2·66	80·6	7·27	1,817
10	33·97	22·04	11·93	5·01	1·56	2·68	2·85	79·8	7·04	2,000
11	36·10	22·61	13·49	5·87	1·83	2·90	3·16	78·6	6·72	2,234
12	38·80	23·86	14·94	6·75	2·14	3·03	3·31	77·8	6·52	2,444
13	39·27	23·46	15·81	7·38	2·35	3·04	3·46	77·2	6·33	2,611
14	41·96	24·17	17·79	8·60	2·74	3·23	3·75	75·9	6·16	2,848
15	46·09	25·96	20·03	9·86	3·16	3·51	3·96	75·0	5·86	3,168
16	50·00	26·73	23·27	10·73	3·75	4·40	5·03	72·1	5·46	3,567

TABLE VI.—Table of Calculated Losses, Efficiency, etc., at 250 Volts. Motor, Type P.

Number of reading.	Input (kilowatts).	Output (kilowatts).	Total loss (kilowatts).	C^2R loss in motor at test.	C^2R loss in generator armature.	Friction and iron losses in motor at test.	Corrected friction and iron losses for 250 volts and 20° C.	Efficiency at 250 volts and 20° C.	Speeds in miles per hour; 30in. wheel. Gear ratio = 4·86.	Tractive effort at tread of 30in. wheel in pounds. Gear ratio = 4·86.
1	3·81	2·28	1·53	·24	·05	·62	·71	76·3	6·90	215
2	4·97	3·23	1·74	·39	·09	·63	·60	80·2	5·91	333
3	6·75	4·28	2·47	·79	·20	·74	·79	79·0	4·83	572
4	9·96	6·17	3·79	1·63	·47	·85	·84	77·8	4·02	978
5	12·82	7·62	5·20	2·51	·75	·97	·82	75·7	3·67	1,289
6	14·96	8·16	6·80	3·60	1·08	1·06	1·08	72·3	3·22	1,671
7	17·37	8·76	8·61	4·71	1·52	1·19	1·35	68·3	3·02	1,967
8	21·97	8·99	12·98	7·78	2·56	1·32	1·43	63·3	2·58	2,720

TABLE VII.—Table of Calculated Losses, Efficiency, etc., at 500 Volts. Motor, Type Q.

Number of reading.	Input (kilowatts).	Output (kilowatts).	Total loss (kilowatts).	C^2R loss in motor at test.	C^2R loss in generator armature.	Friction and iron losses in motor at test.	Corrected friction and iron losses for 500 volts and 20°C.	Efficiency at 500 volts and 20° C.	Speed in miles per hour; 30in. wheel. Gear ratio = 4·86.	Tractive effort at tread of 30in. wheel in pounds. Gear ratio = 4·86.
1	10·81	7·13	3·68	·51	·12	1·53	1·54	82·0	11·64	381
2	15·90	11·08	4·82	1·24	·31	1·64	1·67	83·6	9·81	685
3	17·71	12·40	5·31	1·345	·39	1·79	1·79	83·2	9·73	752
4	19·49	13·81	5·68	1·70	·53	1·78	1·82	84·3	9·01	924
5	22·33	15·15	7·18	2·24	·67	2·14	2·20	81·8	8·54	1,088
6	24·54	16·83	7·71	2·82	·90	2·00	2·11	82·1	8·15	1,283
7	27·05	18·12	8·93	3·35	1·06	2·26	2·36	81·0	7·96	1,412
8	29·45	19·98	9·47	3·97	1·35	2·03	2·12	82·6	7·64	1,633
9	30·95	19·44	11·51	4·74	1·46	2·66	2·92	78·7	7·44	1,747
10	34·01	21·59	12·42	5·63	1·90	2·45	2·67	79·0	7·04	2,019
11	35·61	21·90	13·71	6·14	1·99	2·79	3·04	77·8	6·94	2,107
12	37·31	22·11	15·20	7·01	2·27	2·96	3·32	76·6	6·65	2,313
13	40·93	23·74	17·19	8·29	2·75	3·08	3·42	75·8	6·35	2,607
14	43·19	23·40	19·79	9·64	3·00	3·58	4·12	73·5	6·24	2,773
15	46·14	23·86	22·28	11·29	3·60	3·70	4·48	72·0	6·11	3,003

TABLE VIII.—Table of Calculated Losses, Efficiency, etc., a 250 Volts. Motor, Type Q.

Number of reading.	Input (kilowatts).	Output (kilowatts).	Total loss (kilowatts.)	C^2R loss in motor at test (kilowatts).	C^2R loss in generator armature (kw.)	Friction and iron losses in motor at test.	Corrected friction and iron losses for 250 volts and 20° C.	Efficiency at 250 volts and 20° C.	Speed in miles per hour; 30in. wheel. Gear ratio = 4·86.	Tractive effort at tread of 30in. wheel in pounds. Gear ratio = 4·86.
1	4·08	2·38	1·70	·28	·05	·69	·68	77·0	6·95	225
2	4·88	3·15	1·73	·42	·10	·61	·62	79·9	5·95	329
3	7·66	5·10	2·56	1·02	·32	.61	·62	80·3	4·65	662
4	10·71	6·64	4·07	1·94	·63	·75	·75	77·0	3·87	1,059
5	12·87	7·35	5·52	2·93	·98	·81	·85	73·9	3·55	1,353
6	16·26	8·44	7·82	4·50	1·54	·89	·92	70·1	3·22	1,751
7	18·38	8·65	9·73	5·66	1·98	1·05	1·08	66·9	2·92	2,068
8	20·08	7·76	12·32	7·26	2·49	1·29	1·41	62·4	2·58	2,471
9	21·88	7·64	14·24	8·22	2·75	1·64	1·74	59·4	2·40	2,691

TABLE IX.

Motor, type P.	
Back E.M.F. of A.	Generated E.M.F. of B.
499	498
473	472
465	463
456	454
438	437
437	435
428	427
413	410
417	412
413	407
398	389
393	382
374	362
362	350
368	352

TABLE X.

Motor, type Q.	
Back E.M.F. of A.	Generated E.M.F. of B.
479	471
462	457
468	457
453	441
444	433
428	417
429	416
424	411
399	387
396	381
394	379
379	362
376	357
358	341
334	323

TABLE XI.—Rapid Acceleration on Level.

Notch.	Time. Seconds.	Initial current.	Final current.	Mean current.	Current consumption.	Initial velocity.	Final velocity.	Mean velocity.	Distance covered. Feet.
No. 1 Series..	1·5	56	30	43	64·5	0	1·95	·98	2·15
No. 2 ,,	0·5	50	40	45	22·5	1·95	2·8	2·38	1·75
No. 3 ,,	0·5	56	40	48	24·0	2·8	3·6	3·20	2·35
No. 4 ,,	10·0	50	14·5	19·9	199·0	3·6	7·1	6·05	88·70
No. 1 Parallel	0·5	51	49·4	50·2	25·1	7·1	7·35	7·23	5·30
No. 2 ,,	0·5	71	64	67·4	33·7	7·35	7·85	7·60	5·57
No. 3 ,,	20·0	110	29	40	800·0	7·85	15·0	12·90	378·00
Totals ...	33·5				1,168·8				483·82
Slow Acceleration on Level.									
No. 1 Series..	10	56	16	23·8	238·0	0	5·1	3·56	53·5
No. 2 ,,	5	19·5	16·5	18·0	90·0	5·1	5·8	5·5	40·3
No. 3 ,,	5	18	16	17·0	85·0	5·8	6·5	6·2	45·5
No. 4 ,,	5	16·7	15·5	16·1	80·5	6·5	6·8	6·7	49·0
No. 1 Parallel	10	53·2	34·4	43·8	438·0	6·8	10·4	8·2	120·1
No. 2 ,,	5	43	35·0	39·0	195·0	10·4	11·9	11·2	82·1
No. 3 ,,	5	41	34	37·6	188·0	11·9	13·6	12·8	93·5
Totals	45				1,314·5				484

motorman. Omitting extremes, the saving of all motormen who were as good as the best, amounted to 43 per cent. The results showed what an important factor the motorman really is in the amount of power consumed by the cars, and how important it is to properly instruct the motormen in the most economical use of the controller." Shortly after the inauguration of electric traction on the Springburn route in Glasgow, wattmeter readings were taken with different drivers, and variations from 860 to 1,080 watt-hours per car mile were observed under conditions as nearly equal as possible. In February, 1898, car wattmeters were installed on all the cars of the Nashville Street Railway Company in America, with the result that a reduction of 39 per cent. of the power consumed was effected within the first three months. This system possesses such physical features as give the greatest scope for the skill of a motorman to come into play. In level towns such reductions cannot of course be expected]

Of course, bad habits on the part of the motormen, such as applying the brakes before the current has been completely cut off, not cutting off the current soon enough before a recognised stopping place, and thus failing to get any benefit from the kinetic energy in the car, or starting the car with the brakes partly on, etc., may largely account for these discrepancies. Every motorman is supposed to have sufficient commonsense to attend to these points, but over and above that, considerable waste may occur owing to too gradual acceleration. Table XI. gives one an idea of the extent of this. We see that on the level the current

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TABLE XII.—Rapid Acceleration on 4·5 per cent. up Gradient.

Notch.	Time. Seconds.	Initial current.	Final current.	Mean current.	Current consumption.	Initial velocity.	Final velocity.	Mean velocity.	Distance covered. Feet.
No. 1 Series ..	2·0	56	40	48	96·0	0	1·3	·7	2·05
No. 2 ,,	1·0	65	45	55	55·0	1·3	2·5	1·9	2·79
No. 3 ,,	1·0	65	45	55	55·0	2·5	3·3	2·9	4·25
No. 4 ,,	5·0	55	33·5	40	200·0	3·3	4·4	4·1	20·45
No. 1 Parallel	2·3	75	71	73	299·0	4·4	4·8	4·6	16·20
No. 2 ,,	3·0	130	76	100	300·0	4·8	7·2	6·0	26·40
No. 3 ,,	16·0	130	67	72	1,152·0	7·2	9·4	9·1	215·00
Totals ...	30·3				2,157·0				287·14

Slow Acceleration on 4·5 per cent. up Gradient.

No. 1 Series ..	10	56	33	36	360·0	0	2·1	1·7	24·5
No. 2 ,,	5	52	34	43	215·0	2·1	3·3	2·7	19·8
No. 3 ,,	5	45	33	39	195·0	3·3	4·0	3·7	27·1
No. 4 ,,	5	40	33	36·5	182·5	4·0	4·4	4·2	30·8
No. 1 Parallel	10	75	68	71·4	714·0	4·4	5·2	4·8	70·4
No. 2 ,,	5	120	70	83·0	415·0	5·2	7·6	6·8	49·8
No. 3 ,,	5	110	80	95·0	475·0	7·6	9·2	8·8	645
Totals ...	45				2,556·5				286·9

TABLE XIII.—Braking.

Current range.	Resistance.	Speed range calculated from formula.	Speed range true.	Time interval calculated from formula.	Time interval true.
160 to 140	8·92	2·11	1·78	·515	·434
140 to 120	,,	,,	1·96	·615	·571
120 to 100	,,	,,	2·14	·868	·881
100 to 80	,,	,,	2·32	1·152	1·268
80 to 60	,,	,,	2·14	1·674	1·697
60 to 40	,,	,,	2 32	1·973	2·165

The speed range and time interval corresponding to a given current range are directly proportional to the total resistance in circuit.

Motors in Series.		Accelerating.			
80 to 70	5·02	·421	·431	·136	·140
70 to 60	,,	·462	·475	·182	·187
60 to 50	,,	·528	·535	·264	·267
50 to 40	,,	·643	645	·435	·436
40 to 30	,,	·874	·830	·891	·847
30 to 20	,,	1·447	1·340	2·780	2·580
Motors in Parallel.					
160 to 140	1·58	·620	·68	·201	·220
140 to 120	,,	·702	·74	·277	·290
120 to 100	,,	·834	·83	·417	·415
100 to 80	,,	1·064	1·06	·719	·716
80 to 60	,,	1·528	1·62	1·560	1·652
60 to 40	,,	2·680	2·24	5·160	4·305

consumption, as worked out from a combination diagram such as Fig. 21, may be at least 13 per cent. higher when accelerating gradually than when the acceleration is moderately rapid. On the up grade the difference indicated by Table XII. is 18 per cent. In each case the same distance is passed through, and practically the same final velocities are reached, so that the comparisons are as fair as can be It is needless to point out that a lengthened period of acceleration really implies running for a greater length of time on the resistance notches, which is manifestly inefficient.

In conclusion, I will merely add a few approximate formulæ for calculating the time intervals corresponding to given current ranges, which are convenient if one desires to determine roughly the curves shown in Figs. 18 and 19 by calculation. The formulæ are based on the assumption that $\frac{n}{R}$ can be represented by the expression $\alpha + \beta C$ (see Note 2). This will be found to be very nearly correct for up-to-date tramway motors over a considerable range It cannot, of course, be pushed too far, but the formulæ here given must be used with discretion, the values of α and β being determined for each type of motor considered.

Let V = supply voltage;
C_1 C_2 = higher and lower limits of current range (total current);
E_1 E_2 = the back E.M.F.'s of motor with currents C_1 and C_2 at speed n;
r = total resistance in circuit;
T = mean effective tractive effort, or retarding effort producing acceleration, either positive or negative as case may be, corresponding to range $C_1 - C_2$;
ω = acceleration;
n_1 n_2 = initial and final speeds corresponding to C_1 and C_2;

then in case of applying the electric brakes

$$n_1 = r\left(\alpha + \frac{\beta C_1}{2}\right)^*$$

$$n_2 = r\left(\alpha + \frac{\beta C_2}{2}\right)$$

$$n_1 - n_2 = \frac{r\beta(C_1 - C_2)}{2} \quad . \quad . \quad . \quad . \quad (1)$$

$$\text{time interval} = \frac{r\beta(C_1 - C_2)}{2\omega} \quad . \quad . \quad . \quad (2)$$

In the case of acceleration—

$$\left.\begin{matrix} \frac{n}{2E_1}(V - C_1 r) \\ \frac{n}{2E_2}(V - C_2 r) \end{matrix}\right\} = \text{initial and final speeds, motors in series,}$$

$$\left.\begin{matrix} \frac{n}{E_1}(V - C_1 r) \\ \frac{n}{E_2}(V - C_2 r) \end{matrix}\right\} = \text{initial and final speeds, motors in parallel.}$$

But $\frac{2nC_1}{E_1} = \alpha + \beta C_1$ and $\frac{2nC_2}{E_2} = \alpha + \beta C_2$, motors in series;

also, $\frac{nC_1}{E_1} = \alpha + \frac{\beta C_1}{2}$ and $\frac{nC_2}{E_2} = \alpha + \frac{\beta C_2}{2}$, motors in parallel.

Hence

$$n_1 - n_2 = (C_1 - C_2)\left\{\frac{V\alpha}{4C_1C_2} + \frac{\beta r}{4}\right\} \text{ motors in series . (3)}$$

$$n_1 - n_2 = (C_1 - C_2)\left\{\frac{V\alpha}{C_1C_2} + \frac{\beta r}{2}\right\} \text{ motors in parallel (4)}$$

And the time intervals in the two cases are expressed by

$$\frac{C_1 - C_2}{\omega}\left\{\frac{V\alpha}{4C_1C_2} + \frac{\beta r}{4}\right\} \quad . \quad . \quad . \quad . \quad (5)$$

$$\frac{C_1 - C_2}{\omega}\left\{\frac{V\alpha}{C_1C_2} + \frac{\beta r}{2}\right\} \quad . \quad . \quad . \quad . \quad (6)$$

In the case of the 12-ton car before referred to, using the values 0·554 and 0·0237 for α and β respectively, we can write:

Braking— $n_1 - n_2 = 0{\cdot}0118\, r\,(C_1 - C_2)$;

$$\text{time interval} = 8\,03\ r\frac{(C_1 - C_2)}{T}.$$

Accelerating—

(5) becomes $\frac{(C_1 - C_2)}{0{\cdot}00147\,T}\left\{\frac{69\,2}{C_1C_2} + 0\,0059\,r\right\}$.

(6) ,, $\frac{C_1 - C_2}{0{\cdot}00147\,T}\left\{\frac{277}{C_1C_2} + 0{\cdot}0118\,r\right\}$.

Table XIII. gives a comparison of a few values, calculated from the above formulæ, with the correct values. I have now to acknowledge my indebtedness to Mr. G. Braid for the help he has given me in the preparation of the various tables and figures included in this paper. I further wish to mention that the results of actual tests have been appended here, not so much on account of the information they contain in themselves as to exemplify the methods of testing and investigation with which the paper treats.

Iron and Steel Institute.—The annual meeting of the Iron and Steel Institute was opened at Düsseldorf on Wednesday, the delegates receiving an enthusiastic welcome from the Governor and the President of the Association of German Ironworkers. The announcement that Mr. Andrew Carnegie has been elected to succeed Mr. Whitwell as president of the association on the expiry of his term of office in May next, was made and was received with every expression of satisfaction.

* N.B.—In Fig. 10 current *per motor* is plotted with *total* resistance; we are here dealing with *total* current and *total* resistance.

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STAITE AND PETRIE'S ELECTRIC LIGHT—1846-1853.

BY J. J. FAHIE, M.I.E.E.

(Continued from page 301.)

On July 12, 1848, another patent, No. 12,212, was taken out by Messrs. Staite and Petrie, but for reasons which will be explained in the latter's memoir, the name of Staite alone appeared as the patentee. The specification, which is a voluminous document, deals with 15 claims, to most of which we need only refer in a cursory way, as they are now of little interest.

The first six claims have to do with the construction of batteries on what is called the *perfluent* principle, to distinguish it from the *percolating* system proposed by Prof. Daniell and others. According to the latter system, the exciting fluid is supplied to and discharged from each of the cells in separate streams, or series of drops; the liquid as it becomes exhausted, though not entirely so, dropping out through an orifice in the bottom of the cell, while its place is supplied by fresh drops descending from above. According to the new or perfluent method, the liquid is supplied in one stream only, which passes continuously through the series of cells, entering by the first and passing out through the last, where it is collected and subjected to various chemical processes for the obtainment of valuable by-products.*

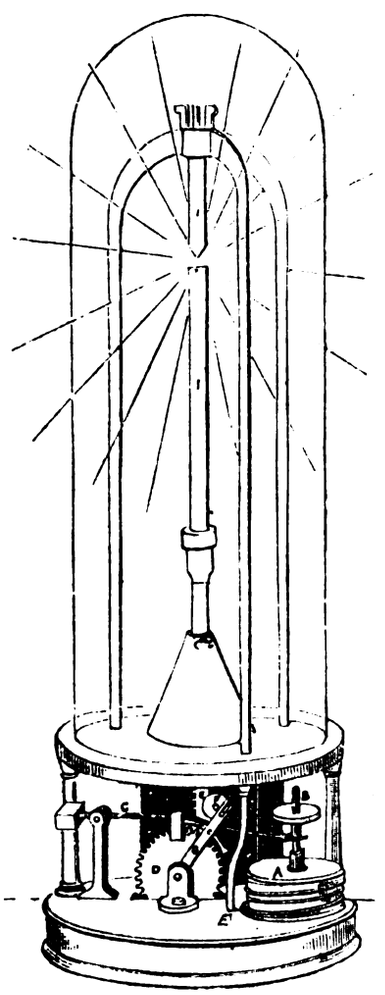

FIG. 5.

The seventh claim describes a galvanometer for indicating the strength of the current passing through the electrodes, consisting of a hollow electromagnet coil, in which an iron rod or plunger moves up or down according to the strength of the current. A prolongation of this rod moves up or down in a glass tube, graduated to various consumptions of zinc per minute in the cells.

Claims 8 and 9 describe Petrie's method of preparing and hardening iron for permanent magnets.

* Many people after Staite and Petrie applied themselves to the same problem of a self-supplying battery. Slater's, Higgins's, Hauck's, and Camacho's are modern examples of the perfluent principle.

Claim 10 deals with new forms of lamps: (1) A modification and simplification of the mechanism of the electromagnetic regulator, as described in the previous patent of July 3, 1847. Fig. 5 shows this improvement so clearly that little need be said by way of explanation. A is the electromagnet coil; B a brass continuation of the soft iron bar, which enters the coil from below, and is sucked up more or less according to the strength of the current; C is a counterbalanced double click working in the ratchet wheel, D. E is the rack in gear with the ratchet wheel for raising or lowering the electrode; and F is an eccentric (revolved continuously by the clockwork, K) which drives the ratchet wheel by means of the lever, G, in one direction or the other, according to the position of the click, which itself is determined by the position of the iron bar or plunger. When the lamp is alight and the current normal, the plunger stands at such an elevation as to disconnect the wheel, D, from the click and the clockwork, so that the electrode is stationary. When the current diminishes through a too great separation of the carbons, the plunger falls and allows one end of the click to gear into the wheel, which is then driven by the lever, G, in such a direction as to raise the electrode. Should, on the other hand, the electrodes be too near together, the current increases in the coil, the plunger rises (is sucked up more), and allows the other end of the click to catch in the wheel, which now is turned in the opposite direction, and lowers the carbon.

(2) Substituting for the upper electrode a disc or circular carbon, to which is imparted a slow motion by gearing with the clockwork of the regulator. Impinging on the periphery of this disc is a metal scraper, which keeps the edge clean and free from the particles of carbon projected upon it from the other electrode.

(3) Employment of iridium for lamps, which is claimed as specially suitable for small incandescent lights. After showing how the iridium is prepared, and stating that platinum and copper in small quantities may be added to facilitate the annealing, the specification says: "For lighting purposes I use either a thin slip of iridium or a combination of iridium with platinum, or iridium with copper, or a spiral coil of iridium instead of a solid [? straight] strip. Fig. 6 shows the arrangement. "To prevent the dissipation of the heat of the loop, *a*, I sometimes pass the holders, *b b*, through a block of glass, *c c*, or some other similar bad conductor of heat, so that the heat and light may be developed with as little loss by radiation as possible."

Claim 11 describes applications of the automatic electromagnetic mechanism for intermitting the light for lighthouse and signalling purposes. Under this head it is said: "The coil may have its attractive action augmented by making certain parts of the case (on which the wire is wound) of soft iron in place of brass. The exterior circumference of the case is also cooped round with bits of iron, fitting like the staves of a cask, and kept in position by bands of vulcanised caoutchouc; or a cylinder of iron may be slipped over the end of the coil and envelop it."

Here we have what is probably the earliest recognition and application of a fact which has been rediscovered and applied in recent years in the construction of arc lamps, and for exactly the same purpose as designed in 1848—namely, to increase (and equalise) the pull on the plunger over the whole extent of its stroke.

Claim 12 is curious, and reads as follows: "My invention consists in improving the intensity of the electric current by including in the circuit a long coil of insulated copper ribbon wound on an iron core, whereby I am enabled to reduce the number of cells employed. A hollow cylinder of iron or a number of bits of flat iron bar are placed around the coil (outside) like the staves of a cask, and are held together by elastic bands of vulcanised caoutchouc."

Colonel Bolton* classes this amongst "patents for impossible results," but I am not so sure that he is right. It is now well known that an arc lamp burns better, or at least more steadily, when a resistance wire is included in its circuit. May not a resistance *cum* inductance wire have the same effect?

* *Journal* of the Institution of Electrical Engineers, vol. 8, p. 279.

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Claim 13 provides a metallic tube for holding the lower carbon when required to be long, so as to prevent breakage, and at the same time to reduce the resistance of the electrode to a minimum.

Claim 14 describes an improved mode of preparing the carbons, into which we need not enter, as it is little more than a combination of the methods previously patented. The claim concludes as follows: "I preserve the electrodes so made from damp or other injury by coating them with tinfoil, which also gives them greater strength and makes them better conductors. Before using the carbons, so as to prevent the liability to cracking when suddenly heated, I fix them in the lamp ready to light, and pass the current through them without allowing the mechanism to separate them. This heats them gradually, and drives off any damp that may be in them."

The fifteenth and last claim is one on which great stress was laid at the time by Staite and some of his contemporaries, as it seemed to show that the waste products of voltaic batteries could easily be made of as much value (as articles of commerce) as the elements used in the cells, and that, consequently, the light produced would cost little or nothing.*

On Oct. 12, 1848, Staite and Petrie's improved lamp was for the first time shown publicly in London at a conversazione at the Western Literary Institution, Leicester-square; and on the 30th of the same month a larger exhibition took place at the Hanover-square Concert Rooms, "which was attended by artists, scientists, engineers, gas directors, the proprietors of patent lights of every kind, and a multitude of highly intelligent and respectable persons."

From amongst the many paper cuttings preserved by Staite referring to this event, we take the following from the London *Sun* of Nov. 2: "An exhibition of this wonderful invention took place at the Hanover-square Rooms on Monday evening. Mr. Staite, who was ably assisted by his colleague, Mr. William Petrie, C.E., explained at some length, and apparently with much satisfaction, to the large and highly appreciative audience the properties and construction of his lamp, the result of which is that a light may be obtained at a trifling cost—not more than 1d. per 100 wax candle-power per hour, or one-twelfth the price of gas. The consumption of carbon is about ½in. per hour. There is no fear of combustion, and the heat is vastly disproportionate to the light emitted Thus, although the light shown was said to be equal to 900 wax candles, the heat was estimated not to exceed that of a common Argand burner.

"A gentleman present drew atttention to an occasional flickering in the light, which Mr. Staite said was due to iron impurities in the carbon, which, with all his care, was not yet perfectly pure as it ought to be. It was a mere accident, which he hoped in time to obviate, and was in no way incidental to the system.

"The battery power used consisted of 44 cells of the inventors' modification of Callan's cast-iron arrangement, exposing a total of 11½ square feet of zinc surface.

"In small lights for rooms the inventors state that they would dispense altogether with the use of carbon, using another material, which will enable them to dispense with the automatic regulating mechanism entirely, and by means of which a light of from one to forty or more candle-power can be placed on the drawing-room table."

On the night of Nov. 28 the light was shown from the portico of the National Gallery, Trafalgar-square, as to which the *Morning Chronicle* of the next day said: "A better site could not have been selected, and the novelty of the exhibition soon attracted a multitude of spectators who filled the streets and terrace opposite the Gallery, as well as the square below. On starting the lamp the large open space was filled with a flood of light which paled the gas lamps not only in the square, but for some distance down Whitehall. So intense was it that when thrown upon the crowd one could scan the countenances of those who were most distant from the Gallery, and discern the cut of a man's coat or the pattern of a lady's dress at the outskirts of the crowd. Every now and then the light was thrown on the Nelson column, bringing it out with all the clearness of daylight."

A few days later a second exhibition was arranged at the same place, whereat "there was a large attendance of scientific gentlemen and noblemen." The *Illustrated London News* of Dec. 9 has a half-page illustration of this display, showing the light through a large white globe with rays all around. A simple tin reflector was used for directing the rays as required.

In the next few years, 1849 to 1853, many exhibitions and lectures on the electric light were given by Messrs. Staite and Petrie, and as the subject became popular, independent lecturers all over the country took it up. Among the Staite papers I find references to Mr. Pepper, the inventor of ghosts in our boyish days; Dr. Bachhoffner, of the old Polytechnic Institution, who claimed to have delivered over 1,000 lectures on the subject; William Sturgeon; Robert Hunt, author of "The Poetry of Science;" Prof. Grove, and others.

It will be a surprise to most of my readers to learn that the brothers Mayhew were early in the field, not only as lecturers, but as inventors of electric lamps. Early in March, 1849, they delivered lectures in Guernsey and Jersey, and doubtless in other places. One of their Jersey *posters* is now before me, an extract from which will give an idea of the lecture: "Theatre Royal, Jersey—To-morrow, March 7, 1849, the Messrs. Mayhew will exhibit the electric light by means of an entirely new electric lamp recently invented by themselves. A lecture explanatory of the subject will be delivered by Mr. Henry Mayhew, the original editor and projector of *Punch*.

* * * * *

"The light will be produced from a battery of 250 pairs of plates, exposing 1,800 square inches of zinc.

* * * * *

"The production of the electric light will be explained, and the difficulty pointed out of constructing an apparatus capable of producing a steady and continuous light. Illustrations will be given of the intense heat of the voltaic arc by melting silver, copper, and iron; and as a further illustration, there will be exhibited the curious and beautiful experiment (as lately shown by Dr. Faraday in London) of coking the diamond!

* * * * *

"The difference of the electric light from all other artificial lights will be explained, and illustrated by its production under water, and in a vacuum.

"The lecture will conclude with reasons why the electric light should be produced at less cost than any other light."

The *Jersey Times* of March 9 gives an epitome of the lecture, from which I will make but one extract. After the experiment of coking the diamond, the lecturer went on to say: "My brother and myself feel confident that we shall eventually be able to turn charcoal into diamonds. I have already formed crystals from powdered charcoal, but they had not the shape or solidity of diamond. Still, I hope to overcome the difficulty; indeed, in a common tallow candle, bright hectagons of light are formed resembling diamonds."*

Returning to the exhibitions and lectures of Messrs. Staite and Petrie, I can only describe (and that very briefly) the more important ones, referring my readers for fuller information to the Staite papers, which I hope will soon be accessible in some public library.

Many private exhibitions of the various forms of lamp and mechanisms were given in London to scientific men, gas engineers, and others interested in the lighting industries. At one of these, in March, 1849, a triple-revolving electrode lamp was shown in action. Of this a spectator writes: "The result was highly gratifying to all, and served to prove that it is possible to supply an indefinite number of electrodes from one common current." After referring to the perfect action of the single-flame lamp, the

* It should be noted that Mr. Petrie did not share this belief; but so thought De Moleyns in 1841, as also Watson in 1852, Stille, of Göttingen, in 1863, Slater in 1880, and, doubtless, others. For every shilling's worth of material used in the battery Watson hoped to get half a crown in the shape of valuable pigments!

* Prof. Silliman wasted a good deal of time on the same quest in 1823. See his *Journal of Science*, vol. xvi., p. 157.

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spectator goes on to say: "No less interesting was the small bracket lamp. The light is produced by passing the current through a coil of iridium wire prepared for the purpose, which is rendered so white hot as to be raised to a high state of incandescence, evolving a steady and beautiful light."

Besides these private views the light was shown publicly in London on several occasions between November, 1848, and July, 1849 — at Crosby Hall, Bishopsgate-street, November, 1848, and July, 1849; at the Cattle Show, Baker-street Bazaar, December, 1848; at the Western Literary Institution, Leicester-square, December, 1848; at her Majesty's Theatre, Haymarket, in ballets of "Electra, or the Lost Pleiad," April, 1849, and "Les Plaisirs de l'Hiver, ou Les Patineurs," July, 1849; and on the north tower of Hungerford Suspension Bridge for 14 consecutive evenings, May-June, 1849, from 9 to 12.

In reference to the latter display, "An Old Professor," writing to the *Mechanics' Magazine*, June 9, 1849, says: "The light was exhibited with and without a reflector. When the reflector was used and the beams sent in any particular direction the effect was almost supernatural. The Houses of Parliament, Nelson's column, the tower of St. Martin's Church, St. Paul's dome, the bridges and steamboats, were rendered as conspicuous as by daylight; and when directed along the bridge itself, Hungerford Market and the crowds assembled appeared as if illuminated by a sunbeam."

These displays, as well as those at the National Gallery, were under the direction of Mr. Petrie, and amongst the distinguished men who came to see them were Profs. Faraday, Cumming (the naturalist), Wheatstone, Forbes, and De la Rive. The latter was charmed with the experiments, and afterwards wrote that "they appeared to me to prove that, both as regards its intensity and its directability, the electric light will be especially precious for lighthouses." The lamp used on these occasions was that described in the fourth patent, and yielded a light equal to about 750 standard candles.

During all this time, as may be supposed, Messrs. Staite and Petrie were profiting by the experience gained in the actual working of their inventions at so many places and under such various circumstances, and were remedying any defects in the working of the mechanisms and in the manufacture of the carbons; all with a view of preventing the occasional flickering which hitherto attended the light.

A fifth patent, No. 12,772, in the joint names of Staite and Petrie was sealed Sept. 20, 1849, and enrolled March 20, 1850. This also is a very lengthy document, and extends to 18 claims, of which we can give only the briefest *résumé*.

Claims 1 to 9 and 16-17 cover various mechanical devices in galvanic batteries for the automatic supply of fresh and the removal of waste liquids for subsequent treatment as commercial products; modes of preparing the plates, the saline solutions, etc., all of which are now of little interest, though at the time when engineers had the battery as the only source of electric power, every little change that promised an improvement in either its power or its constancy was eagerly sought for.

Claim 10 deals with processes for working up waste grains of iridium into a form suitable for making pen-points, or for the filaments for incandescent lamps.

Claim 11 describes a self-acting rheostat or equaliser, whereby the current strength is maintained automatically, so that whatever may be the variations of battery power, or of resistance in other parts of the circuit, the necessary compensations are automatically made, and, consequently, the current circulating is always constant. The instrument consists of a spiral of fine platinum wire, so arranged as to be immersible more or less in mercury, in which it is moved up or down by a connection with a bar of soft iron movable in a coil or solenoid traversed by the battery current.*

Claim 12 describes a dial balance galvanometer for indicating the strength of the current, which is an adaptation of Petrie's galvanometer of 1840, and hardly an improvement on that already mentioned in claim 7 of the fourth patent.

* Foucault had a somewhat similar contrivance in his first lamp, only it was not automatic

Claim 13 describes a differential galvanometer, the coils of which are wound reversely for the purpose of neutralising the electromagnetic effects of the current on the needle.

Claims 14 and 15 describe improvements in the mechanism for supporting and moving the shaft which carries and adjusts the lower electrode, resulting in the more accurate regulation of the carbon points.

Claim 18 relates to the prevention of sparks when breaking contact in galvanic circuits. "A thin platinum wire may still convey some portion of the current after the main circuit is broken, or a series of sufficiently long conductors may break contact one after the other."

Apparatus both for incandescent (iridium) and arc (carbon) lamps, embodying all the latest improvements, was shown on four consecutive evenings at Crosby Hall early in January, 1850, and was noticed in the Press as a great advance in point of continuity and splendour of the light. Thus the *Mining Journal* of Jan. 19 says: "Although little has been said of late respecting the electric light, attention has been kept alive to the subject, and some further advances and improvements made. Mr. Staite has lately given some private exhibitions, and we unhesitatingly say that he has made, since he was last before the London public, very considerable progress towards success. The cost of battery power and the necessity for constant and uniform action were difficulties which have hitherto appeared insuperable. A great portion of these difficulties—at all events the most serious of them—have, we think, been surmounted, and an electric lamp is now produced giving a white, brilliant, lasting, and steady light with little or no flickering. We last night attended a private view at Crosby Hall, and were highly gratified with the result. A self-acting regulating magnet is now employed, which is so sensitive to the least variation in the current that it instantaneously exerts its controlling action on the whole arrangement, and the light remains perfectly steady."

On Feb. 6, 1850, Messrs. Staite and Petrie read a paper on "Improvements in the Electric Light" before a crowded meeting of the Society of Arts, London.

The first exhibition out of London was at Ipswich on Dec. 14, 1849, then at Hadleigh, and then at Colchester, at which places lectures were delivered by Mr. Staite, and the light shown publicly on one or more occasions at each place. The Ipswich papers report that the iridium incandescent light was used on the lecture table. "Using a small two-plate battery a steady light of about three wax candles was produced that enabled the lecturer to read a very eloquent essay."

In May, 1850, Staite was in Sunderland, by invitation of the Commissioners of the River Wear, to test the applicability of the light for sea and dock purposes.

On June 3 the light was shown from the lighthouse on the south pier from 10 to midnight in connection with a revolving reflector. After throwing the light on various objects inland and noting the effects, the Commissioners proceeded to sea at 10.30, and the light was thrown on their track. The steamer steered due east, and the strongest beams of light were cast upon its course, but all around the brilliancy was remarkable. At a distance of three miles (some accounts say five) it was possible to decipher ordinary MS.—indeed, the captain might have brought his chart on deck and consulted it with great ease. After proceeding about seven miles the ordinary light on the north pier was no longer visible, but the electric light shone out with little diminution. The Commissioners then returned to the south pier, the reflector was removed, and the light shown as an open light until 12.30, when the experiments ceased.

On the following evening, and again on June 6, the light was shown at the same place and time, and with the same success.

The battery employed in the experiments at Sunderland, weighing, it is said, upwards of two tons, consisted of 54 (some accounts say 68) of Staite's large "concentric" cells—a central rod of carbon in nitric acid, then a cylindrical porous cell, outside of which was a zinc cylinder immersed in a salt solution, as hydrochlorate of ammonia or nitrate of potash.

By request of the Commissioners, Staite delivered a

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lecture on the electric light at the Sunderland Museum on June 10, and again in the theatre on June 15, for the special benefit of the working classes.

On June 12, at the request of the directors of the York, Newcastle, and Berwick Railway, the light was shown from 10 to midnight from the new central station, Newcastle, and again on the 25th from the summit of the old castle; and lectures were delivered in the Nelson-street Rooms on the evenings of June 17 and 26.

Staite next visited North and South Shields and Carlisle, at which places the light was publicly shown from various coigns of advantage and lectures delivered.

At the Carlisle lectures (as, indeed, at all his discourses) the iridium light was exhibited, and its value for mines and private houses demonstrated. He showed how the light could be varied from a few up to 100 candles by simply increasing the small battery power used, and for lights over 100 c.p. by using a larger coil of iridium. This light, he said, he had constantly in use in his laboratory, which it perfectly lighted up at a trifling cost per week, and in addition to its illuminating properties it diffuses an agreeable warmth, whilst emitting no deleterious vapours as in the case of coal gas and candles. It could also, he said, be applied to heating water and other purposes.*

Staite next visited Manchester, where he made a long stay, lecturing at the town hall, at the Mechanics' Institute, the Cosmorama, Free Trade Hall (where the light was nightly shown from Aug. 12 to Oct. 12), and at the Royal Institution. At the last-named place on Oct. 16, 1850, he delivered a philosophical discourse on "Voltaic Ignition and Illumination," which he treated in an admirable manner on the lines of Grove's "Correlation of Physical Forces."†

On the evening of Aug. 7, 1850, the light was displayed from the roof of the Mayor's country residence, Buile Hill, commanding a clear view for miles around. Although the day was fine the evening set in wet, and by nine o'clock, when the light was to be started, it rained heavily, and continued to do so during the exhibition, which lasted two hours. Nothing daunted the Mayor, Mr. John Potter, and his numerous guests ascended the roof. In a few minutes Mr. Staite proceeded to make his final connections, and in doing so "he unintentionally produced the most beautiful display of electric activity on a small scale. Fine lambent sparks of considerable brilliancy darted from the wire (the battery was on the ground floor) and flickered among the trees."

At length, the circuit being completed, the light burst forth with great brilliancy and with perfect steadiness, not the least flicker being perceptible throughout. The rain, which before was only felt, was now seen, and each drop as it passed through the rays was coloured, and assumed the appearance of a snowflake, producing a very singular effect.

After showing the light as an open light Mr. Staite put over it the Fresnel lens, and the effect was very grand. All the light which before was dispersed in all directions, above and below, was now thrown in a horizontal plane with a radius of nearly a mile. Mr. Staite then replaced the lens by a revolving reflector. The drops of rain as they dashed through the rays now seemed to be gems of crystal. Moths of a large size started amazed from their resting places and disported themselves, despite the cold rain, in the mimic sunshine, their wings assuming a tint of the richest gold, so that they shone like glow-worms. The light was thrown successively on various objects, near and far, and considering the inclemency of the weather and the makeshift arrangements on the roof, the experiments were highly successful.

As a result of these numerous exhibitions at Sunderland, Newcastle, Carlisle, and Manchester, a committee of scientific gentlemen was formed on Aug. 10, 1850, "to investigate and report upon the electric light with a view to its general adoption." The committee was composed of 28 members—all Manchester men—amongst whom we recognise the names of Dr. Charles Bell, Prof. Crace Calvert, the Fairbairns (father and son), Dr. Joule, and Messrs. Leigh (chemist), Naysmith, William Sturgeon, Cleminshaw (gas engineer), and Chadwick.

Staite submitted specimens of the apparatus, and Mr. Petrie, who was all this time busy in London making experiments, writing instructions, and superintending the manufacture of the lamps and their accessories, drew up a lengthy and valuable document on the scientific side of the question, and submitted it to the committee through Prof. Calvert.*

(To be continued.)

* Staite here refers no doubt to his idea of a "caloric locomotive," on the construction of which he was engaged about this time, and anent which he has preserved a cutting from the *Mining Journal*, end of May, 1850, as follows: "We have reason to believe that one of the grandest discoveries of the age in connection with electricity has just been effected by Mr. Staite. Efforts are being made to secure a patent with as little delay as possible, when we shall be enabled to lay before our readers the particulars of the invention." Evidently nothing came of the idea, for no patent was obtained.

† A full report of the lecture, as interesting now as when delivered 50 years ago, is preserved in the Staite papers. See also the Manchester *Examiner and Times*, Oct. 19, 1850.

FUTURE TYPES OF SWITCHGEARS.

BY W. E. WARRILOW.

The progress of electricity supply schemes for the distribution of power from large central stations has been so rapid within the last few years, that the ultimate design of the switching apparatus for such undertakings naturally gives rise to considerable conjecture. In America and on the Continent most of the large power schemes have been set on foot with particular attention to the engineering portions of the stations, these sections having engaged most of the energies at the disposal of the promoters of the project. It is quite true that the difficulties which they had to face in dealing with the problems of turbine and engine construction were sufficient in themselves to demand more than ordinary skill, and it is probably to this circumstance that the neglect of switching appliances is chiefly due.

The most prominent feature of the design of American and Continental switchboards is the amount of space allotted to them, especially in stations generating high-pressure three-phase currents. In such stations it is not at all uncommon to see special rooms built for the reception of all high-potential connections, these being jealously guarded from other than official inspection. The same also will apply to the switches or fuses, but more often to the former when they are electrically operated. It would almost seem, on making an inspection of the present designs of power switchgear, that this portion of the station were passing through the same phase of development which was so very noticeable with the early examples of central-station plant. These were all more or less of the belt or rope driven class, taking up a large amount of floor space, but as further advances were made they became replaced by the direct-coupled set. Such has also been the case with the switchgear, but it has not emerged from its straggling condition up to the present time. For small plants the condition of the switchboard is not of such great importance, but when the amount of power becomes many times multiplied, an entirely different aspect of affairs presents itself. Instead of the few lights required on a private installation, the power units make thousands of customers dependent upon them, and no matter how efficient they may be in themselves, their excellence is worth little if it is not continued through as efficient switching appliances.

In considering the future types of gear, there are several points in design which may be raised, though these may be reduced to two—the fundamental design of the gear and the purpose for which it is intended. In the former there may be said to be two classes—the gear without any rear connections and the gear with them. In the latter there are as many varieties as would fill a column to enumerate. The design is probably more important than anything else, though it is none the less controlled by the purpose of the gear. It may be said with truth, however, that the principal contest will be between the two types of gear above mentioned. As far as the purpose of the apparatus is concerned, the chief matter for settlement is whether the generators shall be

* This document, dated Sept. 25, 1850, and other important papers and letters appertaining to the enterprise, are still in the possession of Mr. Petrie, and will be preserved.

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run in parallel or on separate circuits, or a combination of the two. The separate circuit plan, which found great favour in most of the small stations of pioneer undertakings, has given way to what may be called a divided 'bus bar arrangement for all schemes, whether for one, two, or three phase working This admits of a group of units being run on a group of circuits with two 'bus bars, these being capable of connection in the centre by coupling switches, synchronising instruments being provided for paralleling purposes. Such a combination provides a medium between entire parallel running and supply on separate circuits, neither of these being all that could be desired in practice. With the divided 'bus bars, however, the station can be split into two halves, or it is possible to run the entire plant in parallel. Under the ordinary conditions of supply these conditions are all that is essential for efficient running, and any other combination is of little value in practice, as so much capital is expended in material which would rarely be made use of For very large schemes which employ but a few units of great capacity, there is little or no need for complicated switching appliances, as the number of circuits is generally small, and it is at the receiving end of the line, where the ramifications increase, that there seems more need for some method of isolation. In the majority of cases, however, this can only be effected by increasing the number of feeders from the main source of supply.

Quite a number of the American stations are fitted with a type of board which employs electrically operated switches in the high-pressure circuits, the switchman having to carry out all his operations on a small board, which is provided with a number of controlling switches, these being in the relay circuits of the main switches themselves. This arrangement is an excellent one from the standpoint of safety, but it carries with it many disadvantages. The ease of control is apt to cause disaster in the closing of a switch too soon or by mistake, the consequences from the latter being more far-reaching than the former. There is also a degree of uncertainty about the operation, the man having to take it for granted that he has closed or opened the right switch. This is obviated somewhat by the use of signalling devices, but here again the complications increase to such an extent that the design becomes a veritable nightmare of connections. The source of energy from which the controlling switches obtain their power is another weak point in the design, as failure at this point would entirely disorganise the switching arrangements. It is to be expected that a stand-by would be provided, but, as before mentioned, this method is not a correct one in practice, and tends to further add to the mental worries of those in charge of the plant.

In Continental designs it is more general to divide the gear into a number of parts arranged either in tiers, at one end of the engine-room, or on a gallery which forms a central point in the control, all the switches, fuses, etc., being placed in a basement below the main floor of the building. This has the same disadvantage which applies to the electrically controlled board, in that the principal portions of the board are stowed away out of sight, where they are likely to be neglected or prove a source of danger when it is necessary to carry out repairs. The engineer in charge can always feel more easy in his mind when he has men working on high-pressure connections directly under his eye than if they are employed in some dark corner of the building, where they will be left for hours together to carry on their work. With the lever method of control, there is, however, greater certainty of action, as the operation is mechanical throughout and the switchman can almost feel if his switch is "home." The chief disadvantage, however, is the effect which this system has on the design of the gear. The main switches and fuses by reason of their design are considered safer if placed in some chamber out of the reach of everyone, and such an arrangement necessitates the employment of some means of distant control. This at once splits up the gear and gives rise to the straggling connections which are so often to be met with abroad.

The cellular type of gear, which has up to the present been but little used outside this country, seems to embody most of the advantages which should be found in a satisfactory gear. In its design the principal feature noticeable is the small space occupied for the amount of power controlled. This is only possible with this class of board, as the entire switching appliances for a generator or a feeder, say, are collected together and arranged in one vertical line. With such a construction the switchman has only to concentrate his mind on this fact, and he will rarely make a mistake. Mistakes are, of course, not entirely unavoidable, but in cases where their possibility is reduced the chances of the commercial success of the apparatus are greatly increased, more so as in the manufactures under consideration the lives of men are at stake. In many instances when electricians have been killed in the performance of some risky operation on a switchboard, the man himself has come in for the full share of the blame, and the design of the gear has not been considered as having had much to do with the occurrence. Such a verdict cannot be regarded as altogether correct, for though familiarity may breed contempt in the most experienced worker, if the conditions are such as to nullify the man's indifference, then his chances of life are much improved. With high-pressure switchgears it is more than ever essential that the design of board which is as nearly "fool proof" as possible should be adopted.

At the present time, it seems that the concentrated form of board is the only one which will conform to this condition, and it is to this type of gear that the power stations of the future will owe their ability to carry out supply on a large scale. Such a statement is, of course, based on the present aspect of affairs, and on a review of the manner in which the cellular board has so improved the conditions of high-pressure working that the system has become one of the recognised methods of supply.

In looking into the immediate future it is evident that the supply of electrical energy will be carried out from large centres of power, whence high-pressure currents will be transmitted to an area of many square miles. Under these circumstances, the controlling apparatus will need to be of exceptional design in order to ensure continuity of supply, safety to attendants, and freedom from fire. Now, such conditions cannot be met by any type of gear which employs cable connections at the back for the high-pressure circuits, and it is also doubtful if air-break switches or fuses can meet the requirements of the case for long together. In the former there are great possibilities of fire from overheating, and with the latter the flare set up on the opening of the circuit is likely to cause serious damage if the arc jumps to a neighbouring panel.

It is hardly to be expected that the power stations of the near future will be equipped with a perfect type of switchgear, but it is, nevertheless, highly probable that for such pressures as must be adopted on transmission schemes the controlling portion of the undertaking will be of the cellular type. The designs of most stations are being worked out with a view to concentration, and as long as this object is kept well in sight, the switchgear with the straggling connections and the dangerous back will be of little value. Though the controlling apparatus fulfils an important function it must do its work in a very little space; in other words, the space per kilowatt controlled must be reduced to a minimum. Consequently the design which has a controlling board here, a set of switches there, and a set of 'bus bars somewhere else, will not be tolerated. As long as these items can be collected into the amount of space occupied by one, say, there is no further need of the services of the scattered type of apparatus. The supply of electrical energy must depend greatly on the switching appliances, and it goes almost without saying that the pressing needs of competition will bring that type of gear to the front which carries out most successfully the essential conditions of this class of apparatus.

Blackburn.—During the week ending Aug. 22 the passengers carried on the Corporation tramways numbered 138,260, and the receipts amounted to £794. 3s. 1d., compared with 145,025 passengers and £353. 15s. 7d. receipts in the corresponding week of the previous year—a decrease of 6,765 passengers and £59. 12s. 6d. receipts. These figures cannot be regarded as somewhat unsatisfactory, but doubtless the exceptionally bad weather this summer has been one of the main causes for the diminution noted above.

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THE

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CONTENTS.

Notes	325	Questions and Answers	347
Kendal Electricity Works	330	Birkenhead Electricity Accounts	349
Notes on the Testing of Tramway Motors, and an Investigation into their Characteristic Properties	333	Legal Intelligence	349
Staite and Petrie's Electric Light—1846-1853	337	Companies' Meetings and Reports	350
Future Types of Switchgears	340	Appointments Vacant	350
Surface-Contact Systems	342	Contracts for Electrical Supplies	351
Correspondence	343	Traction Notes	352
Islington Fire	343	Lighting Notes	355
Forthcoming Events	343	Provisional Patents, 1902	358
Some Notes on Electric Wiring	343	Specifications Accepted	359
Trade Notices and Novelties	345	Companies' Stock and Share List	359
		Traffic Returns	360

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SURFACE-CONTACT SYSTEMS.

During the last week or so two more towns in the United Kingdom have decided to adopt surface-contact systems of electric traction for their tramways. The first of these is the Swansea Corporation. The electric trams in this town have up to the present been worked with the overhead trolley, with which the Tramway Committee are not satisfied. The result of the committee's investigation after a visit to Wolverhampton is the adoption of the Kingsland mechanical surface-contact system. A route three and a half miles long with double track is to be equipped. The other case is Torquay, where, owing to the proximity of the sea to the tramway track, a conduit system would be equally objectionable as the overhead. The committee evidently feared that the trolley system which would work would be unsightly, while the conduit system, which was open to no objection on æsthetic grounds, would not work, as the conduit would be filled with sand. This was found to be the case at Blackpool, where the first conduit tramway was laid down in the early eighties, and kept at work for a number of years in spite of many difficulties. This drifting of sand also put the Kingsland system out of court at Torquay. The deputation appointed by the Council have decided in favour of the Dolter system, and the Council have adopted their report. When these two towns have succeeded, like Wolverhampton, in getting their surface-contact system at work, evidence will be accumulated as to how far the raised contacts in the street surface interfere with the ordinary traffic. This interference—which will get worse as the road surface round the contacts wear—can, of course, be minimised by spending larger sums annually in patching the road. The Dolter system has been tried in Paris on the line from Neuilly-Porte-Maillot to Suresnes, where it has been at work on a short section since May, 1900. The experience gained there has induced some prominent electrical engineers in this country to take the system up, and it will without doubt enable the Torquay lines to be worked even more successfully than those in Paris. It is interesting at this time to compare the Lorain, the Kingsland, and the Dolter systems with the numerous other designs for surface-contact tramways which have not, as a rule, obtained a trial on other than short lengths of experimental lines. In the first place, one remembers that nearly all these other systems relied on electromagnets placed under the contacts in the street, and that these magnets were often energised at five hundred volts. There are no buried electromagnets in either of the above systems, the first and last of which operate the buried switches by magnetic fields carried on the car. In each case the skates collecting the current serves as the magnet poles, and the electromagnets are always energised when the car is running. With the Kingsland system no electromagnets at all are required, and the switch under each contact is operated by a mechanical striker, which runs in a slot beside one of the tramrails. The hammer blow when this striker hits the star wheel operating the switch is considerable, and it remains to be seen how far Mr. Kingsland's ingenuity will prevent this from being a drawback to the use of his system. In Wolverhampton most of the trouble has arisen from the large amount of scrap iron dropped in the streets from passing carts. We should expect much the same thing to happen in Swansea, and the scrap would give equal trouble with the contact system to be adopted there. The conclusion of the matter is still the same as when we last approached the subject—*i.e.*, that while the

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above systems are all quite feasible, the simplest is best, and that their commercial success entirely depends on the solution of the troubles arising out of details in construction.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEAM-TURBINES.

SIR,—Might I trespass on your valuable space devoted to "Correspondence" to ask if any of your readers know of a book on steam-turbines which they could recommend to me, as I am going to fit one up in the course of a few weeks, and should like to read up about them beforehand. I should also like to know the publishers of the book, as I have tried to find out about it, but cannot.—Yours, etc.,

ERNEST R. ALEXANDER,

113, High-street West, Leslie, Fifeshire, Aug. 31, 1902

ISLINGTON FIRE.

Various reports have appeared in the daily papers regarding the fire which caused a failure in the supply of electricity from the Islington generating station on Tuesday, the 26th ult., but we do not know that the full facts of the case have been published. The fire was first discovered at about 7.30 p.m. in the cable conduit at the works through which the feeders are taken to the main switchboard, but it was not until fully five minutes afterwards that the first fuse blew. Then, however, the fuses blew in rapid succession, due to the dead shorts caused by the destruction of the insulation on the feeders by fire. This, of course, necessitated shutting down the whole of the plant, which was done expeditiously, the staff acting admirably in the emergency, and redoubled efforts were then made to subdue the fire. Success attended these efforts, with the result that the fire was got well under control before the arrival of the fire brigade, which, nevertheless, made security doubly sure by a liberal use of water. It is to be noted that no fuse went until some time after the outbreak of fire was discovered, nor had the supply been interrupted, or, indeed, any disturbance indicating a short-circuit been detected on the switchboard instruments. Hence, although the actual cause of the outbreak was not apparent, the indications strongly disfavour the theory of an electrical fault as being the initial cause. On the other hand, the conduit in which the fire originated was of brick construction; but it is thought that a possible accumulation of rubbish and cotton waste carelessly or spontaneously ignited may have been sufficient to start the mischief in the cables themselves. Such an accumulation might, of course, have smouldered for some time before the fire was discovered. Another fact which lends strength to the assumption of a cause extraneous to the feeders themselves is that, although the latter were not separately enclosed in earthenware or other ducts, they were of the rubber-insulated concentric, double-steel armoured type, having their outers earthed, thus making it difficult to conceive of a short-circuit occurring without at once blowing the fuse of the faulty feeder. As regards the actual damage done by the fire, it remains to add that the whole of the feeders were affected, the portions in the short length of conduit leading to the switchboard being destroyed, while the switchboard itself was badly smoked, but otherwise undamaged. Under the directions of Mr. Albert Gay and his chief assistant, Mr. C. H. Yeaman, no time was lost after the fire had been extinguished in starting on repairs. Fortunately, the station lighting had not been affected, this being a separate supply from accumulators. The main switchboard was taken to pieces and thoroughly cleaned, and new lengths of cable substituted for the damaged sections. Rapid progress was made with the work, the first circuit being re-established by 6 p.m. on the following day (Wednesday) and the remaining private supply circuits by 10 p.m. on the same day, while the public arc circuits were switched on at midnight. It had been the first serious interruption in the supply from the works during the seven years of its existence, and was especially annoying to those in charge in view of the preparations, which, we understand, were actually in hand at the time, for enclosing the section of the feeders destroyed in Doulton conduits. This work was to have been completed about a fortnight hence, and was undertaken for mechanical reasons and not as a protection against the short-circuit assumed by some to have occurred, but of which there is absolutely no evidence in the station records.

FORTHCOMING EVENTS.

TUESDAY, SEPT. 9.

Institute of British Carriage Manufacturers.—Meeting at Oxford.

Sanitary Institute.—Congress and health exhibition at Manchester.

WEDNESDAY, SEPT. 10.

British Association.—Meeting at Belfast.

SATURDAY, SEPT. 13.

Association of Municipal and County Engineers.—Meeting at Shipley.

The following fixtures for meetings have also been made:

Municipal and County Engineers.—District meetings. Midland: Sept. 27, West Bromwich. Eastern: Oct. 25, King's Lynn. Home: September or October, Aldershot.

Municipal Officers' Association.—District meetings at Birmingham, Liverpool, and Newcastle are being arranged.

SOME NOTES ON ELECTRIC WIRING.*

BY GEORGE A. CLARK, ASSOCIATE MEMBER.

The existing state of matters in this important branch of the electrical engineering industry is extremely unsatisfactory, and the object of the paper is to point out a few of the more serious defects, and, where possible, suggest a remedy. It is not, of course, possible within the limits of such a paper as this to treat so widespread a subject in detail, or even to consider all the methods of distributing electrical energy now in use. The arrangements specially considered are those in common use in installations taking current from a supply company's mains, as probably with the increase of public generating stations the number of isolated plants will become less, and under any circumstances there should be no difference in the wiring of a building taking current from the public mains and a similar building with the generating plant on the premises, and the fact that there nearly always is a difference, and a very marked difference, tends to prove that something is not as it should be: either the supply companies rules are more stringent than necessary, or there is a want of proper supervision on the part of the fire offices or others interested in the private installations. Concentric systems of wiring with earthed return, though possessing some important advantages over the systems in which the return is insulated, cannot come into general use until the existing Board of Trade regulations be modified, and such systems will not, therefore, be considered in this paper. There are two distinct classes into which the defects to which reference has been made may be divided—namely: (1) defects or weak points in the systems of wiring in use; and (2) the state of matters for which the Board of Trade, city engineers, consulting engineers, architects, and measurers are responsible; and the second class is really the more serious of the two.

Defects in Wiring Systems.—The general introduction of high-voltage working (200 volts and upwards) has resulted in drawing the attention of electrical engineers to this long-neglected branch of their business, and we have now half-a-dozen systems to choose from, where two or three years we had one only. These changes have come upon us so rapidly that it is hardly to be wondered at that the advantages and defects of these new systems are as yet barely realised. All these new systems are the same in

* Paper read at the Glasgow Local Section of the Institutio of Electrical Engineers.

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principle in so far as they are all metal sheathed, and unquestionably such an arrangement is electrically better and safer than wood casing in which the conductors are separated by an inflammable fillet of wood, and in which the conditions necessary for the existence of high-resistance leaks are perfect. If we do away entirely with this inflammable fillet between the two conductors of opposite polarity, and substitute a metallic for the wood sheathing, we have the principle involved in all the new systems. In such an arrangement we depend entirely on the insulation of the cables alone, and if this insulation breaks down, we have low-resistance leaks or short-circuits, and the dangerous high-resistance leak apparently cherished by the fire office becomes an impossibility. Before considering the various systems individually, it might be stated that the majority of faults are due not so much to the inherent defects in the system used, as to the neglect of the proper and necessary precautions to ensure safety. In metal-clad systems the electrical continuity of the entire sheathing must be ensured, and this sheathing must be effectively earthed. To use wood casing in wet places, or to used lead-covered cables in the presence of certain fumes, or iron tubes in the presence of others, is merely to court disaster; while no system is proof against the use of defective material or careless workmanship The requirements of a perfect system are so many and so contrary that probably it is quite impossible to embody all these conditions in practice in any one system. It, therefore, becomes necessary to, in every case, select the system which most nearly complies with the most important requirements of the special case under consideration, and provide auxiliary precautions where the selected system is weak. The four systems most generally in use are screwed tubes, Simplex tubes, lead-covered twin cables, and wood casing, and it is proposed to examine these individually, and compare them with a perfect system.

The requirements of a perfect system are practically as follows: (1) efficient protection must be provided for the cables; (2) there must be no possibility of water getting access to the cables, either from internal or external sources; (3) there must be no danger of injuring the insulation of the cables during erection; (4) the electrical continuity of the sheathing must be absolutely ensured; (5) at all times the wiring should be accessible even when concealed; (6) the system must be cheap to instal; (7) it must be possible to add additional lamps easily; (8) it must not lend assistance to the wilful concealing of bad work; (9) it must be universally applicable; (10) the sheathing must be a substance not affected by any chemical combination; (11) in concealed work it should not be necessary to damage the building to any appreciable extent. This is a formidable list to face, and it will be seen that none of the four systems mentioned comply with all these conditions.

Screwed Tubing.—This system is externally watertight, but the danger of water formed by internal condensation gathering in the tubes has to be reckoned with. Mechanically the system is perfect. The electrical continuity is ensured. There is considerable danger of damaging the insulation of the cables, especially of heavy cables when drawing them into the tubes. The system is very costly to instal. It is exceedingly difficult to add additional lamps, and in old buildings it involves an excessive amount of cutting away.

Simplex Tubes.—This system is not watertight, the tubes having a seam. Being ventilated, there is little danger from internal condensation. It is, generally speaking, satisfactory mechanically, though not nailproof. Very much care is necessary to ensure metallic continuity of the metallic sheathing. There is danger of damaging the insulation of the cables when drawing them into the tubes. The system is cheap to instal. Additional lamps may be added without much difficulty, but in old buildings it involves a great deal of cutting away.

Lead-Covered Twin System.—This system is absolutely watertight, and there can be no internal condensation. It is mechanically weak. The metallic continuity of the sheathing is ensured. It is cheap to instal. Additional lamps are easily added, and old buildings may be wired with very little cutting away.

Wood Casing.—This system is not watertight, and is weak mechanically. It is suitable only for surface work in dry places. The first cost is reasonable, and additional lamps may be easily added. For purposes of comparison the following table has been prepared, in which an effort has been made to represent by figures the value of the different properties of a perfect system, and the extent to which these properties are realised in the systems under consideration:

Property.	Perfect system.	Screwed tubes.	Simplex tubes.	Lead-covered twin.	Wood casing.
1. Watertightness	20	20	10	20	—
2. Safety from internal condensation	10	—	5	10	10
3. Mechanical protection ...	15	15	10	—	—
4. Certainty of electrical continuity in the metal sheathing.....	15	15	5	15	—
5. Accessibility of cables in a completed job	7·5	5	5	2·5	7·5
6. First cost	10	5	10	10	10
7. Ease in making additions.	5	—	2·5	5	5
8. Freedom from cutting away in old buildings.	5	—	—	2·5	5
9. Difficulty of wilfully concealing bad work	5	—	—	2·5	1
10. Safety from danger of injuring the cables during erection	7·5	5	5	7·5	7·5
Total.....	100·0	65	52·2	75	46

Although it is a most interesting and instructive comparison it should be pointed out that this table is of less practical use, for the value which should be attached to the different properties depends entirely on the class of building to be wired, and differs in nearly every case. The defects in a system, as a system, may oftentimes be overcome without much trouble. For instance, the mechanical weakness of twin wiring can be readily got over by passing the cables through short lengths of gas barrel, where exposed to injury, by a careful arrangement of the tubes in a screwed tube job, or by lining the tubes internally with a suitable substance the danger of internal condensation may be modified. By the use of special devices the electrical continuity of the sheathing in the Simplex system may be improved. When, after due consideration of the requirements of a case, a system has been selected for a job, this system should be consistently used throughout, and if it be really necessary to combine two systems on one job the point of junction should be at the distribution box, from which circuits might be run on the two systems independently. The very worst arrangement possible is probably the Simplex-casing-twin-wire-compo-pipe combination. In all metal-clad systems, as has been already stated, we rely on the insulation of the cable alone, and in such systems much care must be paid to the joints. In one system of twin wiring now in use a mechanical method of jointing is used. The damaged portions of the wires, after soldering together, are insulated with mica discs from each other and from the top and bottom of the metal box in which the joint is made. Such a joint is electrically and mechanically safe, and as durable as the insulation of the vulcanised cable itself, and much more so than the ordinary unvulcanised lapped joints. The introduction of a similar arrangement in the tubing systems will be a step in the right direction. At the present time the use of pinching screws as a method of making electrical joints is increasing. This is a cheap, but not a reliable method, and should be discouraged, and as far as possible all joints should be soldered. An installation of wiring should be complete in itself without the fittings, and the fittings attached so that they may be taken down at any time when painting or papering, or for cleaning the fittings themselves. In twin wiring this has been done. The conductors of the twin cable are soldered to special sockets passing through an insulating piece contained in a fitting attachment box, so arranged that the end of the cable is hermetically sealed; the fitting is wired to a special plug. By this simple arrangement electroliers are as easily

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removed as table standards, and all loose ends of wires where fittings are not erected are dispensed with. The wiring is complete in itself, and absolutely watertight from beginning to end.

Having now examined and compared the advantages and defects of the systems in general use, and having suggested some lines in which further advance may be made, it is proposed to briefly consider the defects of the second class. A contractor carrying out an installation in Glasgow is subject to the terms of the specification prepared by the consulting engineer. The consulting engineer has to frame his specification to meet the requirements of the city engineer's "conditions of supply," and the city engineer has in turn to conform to Board of Trade requirements. Doubtless the consulting engineer, the city engineer, and the Board of Trade are all actuated by the same worthy object of ensuring a high standard in electrical work, but the question arises, have not important points been sacrificed to secure a questionable benefit? Take, for instance, a switchboard for use in Glasgow. Not only has each pole of a switch or fuse to be on a separate base, but even the panel to which the two middle wires in the three-wire system are connected has to be divided. The advantages thus obtained are not apparent, but the additional difficulties thereby caused in the arrangement and construction of the board are real. Electrical engineers have now had a very considerable experience of what is required to ensure a satisfactory and safe installation at from 200 to 250 volts, and it is surely now time that a committee, which might well be chosen from the Association of Municipal Engineers, be appointed at once and for all frame definite rules for the wiring of buildings, which rules would be officially recognised by the Board of Trade and be universally used. The first thing which will cheapen the cost of wiring is the standardising of all electrical accessories, and this remains an absolute impossibility so long as each city engineer and fire office superintendent is the author of his own regulations. There is surely no reason why a fuse has to be twice as long in Edinburgh as in Glasgow, or why if fuses in ceiling roses are dangerous in one town, they can be considered safe in another. It being once definitely decided that a certain fuse be 1in., 2in., or 3in. long, that ceiling roses are to be made with fuses or without, that switches are to have porcelain or brass covers, manufacturers will be able to produce accessories in larger quantities at cheaper rates. Wiring systems can be perfected in detail, and contractors will be able to keep a stock instead of a museum. It is unfortunate that the Board of Trade has allowed such variation in the voltages of public supply, but it is now too late to remedy this fault without excessive cost. With the exception of incandescent lamps and motors, it is, however, possible to standardise all other accessories. When this very desirable change has been accomplished the duties of the consulting engineer will be greatly modified. It will then be necessary for him only to select the system best suited to any particular case, specify the additional precautions necessary, prepare the scheme of distribution, satisfy himself as to the quality of all material used, and see that the work of erection is properly carried out. It is surely not necessary for consulting engineers to specify the maker of the various accessories to be used. It should be sufficient to state the conditions to be fulfilled, and allow the contractor to submit for his approval the standard articles used by him to meet these requirements. Take, for instance, incandescent lamps. The contractor has at the present time to stock 20 different lamps of each candle-power used, and it is surely unnecessary for consulting engineers to multiply this number by insisting on the use of certain makers' lamps, so long as the contractor is prepared to meet the conditions laid down The consulting engineer is an expert, capable of discriminating between good and bad, and he should impartially examine all material submitted to him. The practice of manufacturers' agents approaching consulting engineers with the object of having their products specified to the exclusion of all others is one which ought to be discontinued, and manufacturers only ought to deal with contractors, who are the purchasers. A consulting engineer having selected a system, prepared a scheme, examined and approved of the material to be used, and superintended the work of erection, the responsibility rests with him, and it is hardly fair to the contractor to withhold his profit for a year in case something should go wrong. If it be necessary that something be withheld, might it not be better that this something be the consulting engineer's fee, and that out of this any necessary repairs be made. This would probably raise the standard of electrical work, resulting in the engineer paying more attention to the details, and giving more personal attendance to the work, as well as discontinuance of the very dangerous practice of always accepting the lowest tender, however disproportionate to the other prices it may be. Contractors in general will not object to a reasonable sum, say 2½ per cent. on the contract sum, being withheld, and to such terms most of their sub-contractors would be perfectly agreeable. The common practice, however, of withholding 10 per cent. of a contract for 12 months might with very great advantage to contractors and manufacturers be discontinued. Supply companies and fire offices should appoint inspectors to examine work during erection. Too much faith is put by supply companies in a final insulation test, which, when all is said and done, is a very poor criterion of a job; and fire offices seem to expect that a contractor who has scamped a job will in filling in their form sign as it were his own death warrant. In order to safeguard the interests of the honest contractor who does his work well, whether there be a consulting engineer employed or not, if for no other reasons, proper precautions should be made to properly supervise all work, and this can only be done by visiting the work in course of erection. It is now time that architects and measurers desist from preparing specifications for electrical work, and either employ a consulting engineer or allow the contractors to prepare their own specifications. The efforts of these gentlemen is laudable in the extreme, but unfortunately the same cannot be said of the results of their labours. Architects might, however, render great service to the electrician by remembering that his cables or tubes require space as well as the pipes of the plumber and gasfitter, and by providing for these in his plans. Where tubes are used it is particularly important that, for the mains at least, straight runs be provided. There is perhaps no business more unnecessarily handicapped than this one in which we are all more or less directly interested, and we must bear in mind that to remedy the defects and difficulties which have been pointed out in this paper will require a very great effort, and there is surely nobody by whom this effort could be more appropriately made than the one of which we are members.

TRADE NOTICES AND NOVELTIES.

Cable-Testing Van and Measuring Instruments.

The accompanying illustration shows a cable-testing van, which is described in price-list No. 15 recently issued by the Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C. These vans are supplied complete with the necessary connections for taking up the following instruments, etc.: galvanometer (Deprez-d'Arsonval) battery of dry cells, 235 volts; insulation testing set with ratio coils, reversing switch, and shunts for the galvanometer; battery switch for dry battery; bridge for determining faults in cables; ratio coil for same; Wheatstone bridge; condenser, $2 \times 0{\cdot}2$, $1 \times 0{\cdot}1$ microfarads; moving-coil voltmeter; telephone receiver; thermometer; tools and tape measures. If preferred, an accumulator battery, 240 volts, having a capacity of 1·2 ampere-hours at a discharge rate of 0·1 ampere, can be supplied in lieu of the dry cells, in which case the following instruments are included in place of the switch for dry battery—viz.: moving-coil ammeter for one ampere; battery-charging switch, and battery switch with change-over switch for charging the battery at 110 volts. In the same price-list the following types of instruments as supplied by the firm in question are also illustrated and fully described: electromagnetic measuring instruments for direct and alternating currents, moving-coil instruments for direct current, dynamometric wattmeters, moving-coil instruments for alternating currents, induction instruments for alternating currents, electrostatic voltmeters, switchboard transformers for single and three phase currents, phase meters, instruments for insulation testing, instruments

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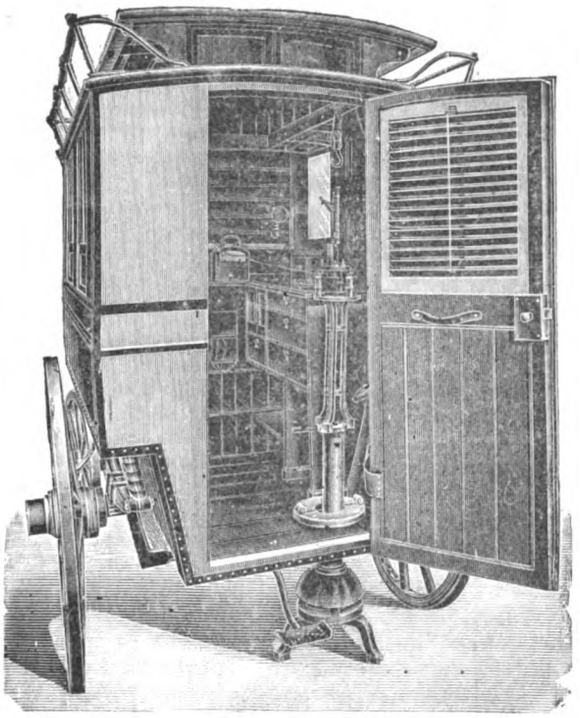
with alarm contacts, Wheatstone bridges, phase adjuster and sheet-iron tester, and rail bond tester. It may be mentioned that the sheet-iron tester listed is an instrument which serves to determine in a quick and ready manner the eddy-current and hysteresis losses in a sample of iron. It consists of a laminated

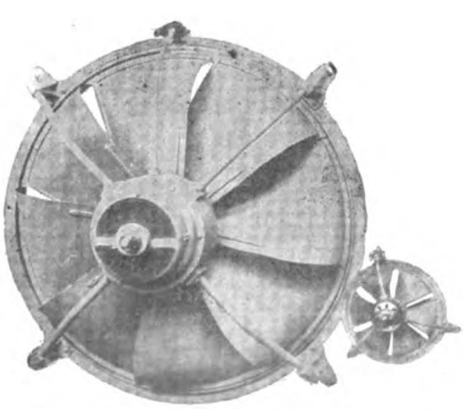


Cable-Testing Van.

iron frame encased in polished wood, and a magnetising coil in which the sample to be tested is placed. The total loss of energy is measured by means of a wattmeter, which also measures the energy required in the iron frame, which latter is magnetised by means of two special coils. The difference of the reading gives the losses. About 55 sheets, 1¼in. by 10¼in. and 0·5mm. thick, weighing 4lb., are required for a test.

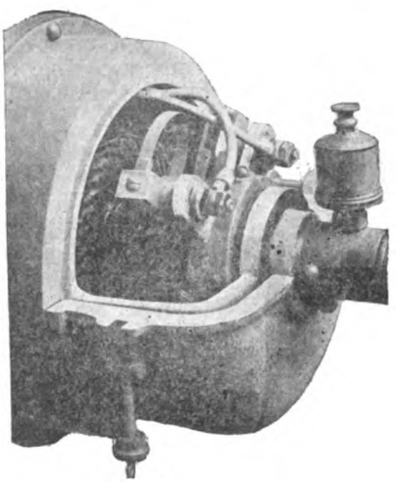
"Sun" Fans.

We have received from the Sun Fan Company, Limited, 4A, Thornton-road, Bradford, a copy of their new catalogue of electrically-driven fans, from which we reproduce the accompanying illustrations. "Sun" fans, we are told, are generally designed to move large volumes of air when running at moderate speeds, special fans and motors being built to overcome the considerable resistance met with in exhausting from or blowing through ducts, or in installations for drying purposes, etc. In the "Sun" combined fan and motor the fan is carried on the motor shaft, so that usually only two bearings are used. The motor is supported from a strong T-iron ring frame by three or more wrought-iron arms, one of which is of hydraulic tube, through which the wires to the motor are led to protect them



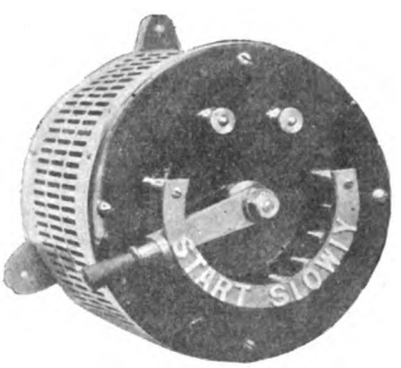
Sun Fan, 60in. diameter, with Ventilated Motor of Special Type for Fans over 40in. diameter. 12in. Fan alongside.

from danger of fouling the blades of the fan. For facility in driving or access, the motor may be placed on either side of the fan, or it may be fixed any reasonable distance away from the fan on either side by prolonging the shaft and supporting the motor independently. Unless otherwise specified, the motors are [series-wound for continuous current. All sizes are of the enclosed or steel-clad type, and have circular bodies with four poles. Each journal and end plate is cast in one piece, being so designed that the motors may be ventilated or entirely enclosed, in which latter case they are made dust, steam, water, and gas tight. The armatures are of the slotted-drum type, and carbon brushes are used,



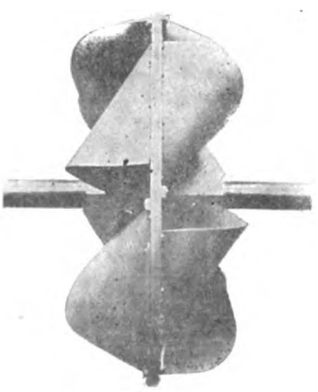
Sun Fan Enclosed Watertight Motor, showing Door over brushes, etc., Open for access.

carried in locking brush-holders of rigid design, the pressure being applied directly radial to the commutator by bent flat springs, giving an even tension throughout the life of the brush. The brush density is kept well below 40 amperes per square inch, and this, together with the large surface and liberal margin allowed for overload, ensures cool and sparkless running. As



Sun Fan Starting and Regulating Resistance.

regards the provision made for starting and controlling the motors, the firm's standard design of starting and regulating resistance is shown in one of the illustrations herewith. These resistances are made to reduce the top speeds by one-half when at the lowest stop, without unduly heating. The double-effect "Sun" fan, shown in another of the illustrations herewith, is recommended as being particularly suitable for high pressure, or



Double-Effect Sun Fan.

where a reversible fan is needed. Its efficiency is claimed to be very high, especially at moderate speeds, and equal in either direction. Full particulars are given in the catalogue under notice as to speeds, dimensions and power, prices, weights, etc., much care having evidently been taken with its compilation. Belt-driven fans are dealt with in a separate catalogue, a copy of which we have also received.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

513. Describe some reliable form of electric helm indicator, and explain the method of fitting the same on board ship.—J. S. B.

514. Some sawmills (river power) are having their electric light installation extended. At present one dynamo (compound), driven from the main shafting, is used. As the speed varies about 10 per cent. indifferent results have been obtained. Could a constant voltage be obtained by using a battery of accumulators in conjunction with the same or larger shunt-wound dynamo?—L. D. W.

ANSWERS.

Question No. 507.—By using a three-wire system of supply it is generally stated that a saving of about 20 per cent. of the copper required in the mains is effected. Does this saving more than cover the increased cost of the balancers, etc., required, and the extra complication involved in the working?

Best Answer to No. 507 (*awarded* 10*s.*).—The principal advantage of a three-wire system over the two-wire is the saving in copper in the mains.

In the two-wire system, suppose current from A to B (Fig. 1) to be 100 amperes, and current density in feeder

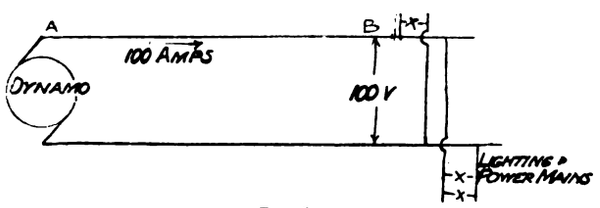

FIG. 1.

500 amperes per square inch, then section of feeder $= \frac{100}{500} = \cdot 2$ square inch. The resistance from tables will be ·22 ohm per mile. Hence, if A B be one mile, then drop of volts in feeders = 2 × 100 × ·22 = 44 volts, ∴ volts at dynamo terminals = 100 + 44 = 144 volts, if volts at B be 100. Then feeder efficiency $= \frac{100}{144} = 70$ per cent. Now, suppose we raise the pressure to 200 volts; then, with lamps taking the same power as before, the current will be 50 amperes, and the lost volts in feeders = 22 volts. Then feeder efficiency $= \frac{200}{222} = 91$ per cent. Hence the same feeders absorb 9 per cent. of power instead of 30 per cent., as in the first case. It is from this point of view that a high pressure of supply is desirable.

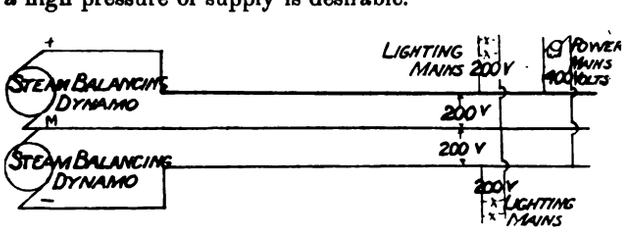

FIG. 2.

In the three-wire system, if the load on both sides be equal, the middle feeder will carry no current. If the two sides have not equal load, then the middle wire carries the difference between the currents in the two outers; it is usual to make the middle wire half the area of outer. Taking feeders one mile long as before, with 20 volts drop at full load as before, each dynamo must give 210 volts. The current in the two outers will be 25 amperes (instead of 50 with the two-wire), and the resistance therefore double. For the same drop the section of each outer is ∴ $\frac{1}{2}$, and of the middle $\frac{1}{4}$; ∴ weight of copper is $(\frac{1}{2} + \frac{1}{2} + \frac{1}{4}) = \frac{5}{4}$), as against (1 + 1) = 2 (with the two-wire system), ∴ in the three-wire system for the same the length and drop in volts is to the two-wire system as 5 : 8.

As regards the cost of laying the cables, a three-core can be laid for the same money as a two-core—*i.e.*, about £10 per 1,000 yards (·75 square inch copper). A general practice on the three-wire system is to have two steam balancing dynamos, each of about 45 kw. capacity, one on either circuit, with the larger machines feeding direct on to the outers. On very light loads one steam balancer can be run alone, along with a motor-generator. On large networks motor-generators are connected to various parts, especially if the load is out of balance at the part of the network. These balancers are not expensive—say, 20 kw. motor-generator costs about £250, and switchgear £50—total, £300. This total, being only a "first cost," can be spread over a few years if necessary. As regards the extra complications on the three-wire system, the extra number of pilot wires, etc., are liable to short-circuit, but with well-designed pilot boards with suitable fuses in circuit these should give very little trouble. In the three-wire system there is less risk of a total breakdown than in the two-wire system, and better regulation can be obtained, and I think that in a well-designed station of the three-wire system the saving of copper in the mains covers the cost of balancers and the extra complications involved in the working.—L. B. H.

Answer to No. 507 (*awarded* 7*s.* 6*d.*).—The advantages of the three-wire over the two-wire system do not lie merely in the saving in copper. Probably even greater advantages are: (1) regulation; (2) interchangeability of plant to supply either lighting or tramways.

1. *Regulation.*—Motors of fairly large size can easily be connected to a three-wire system, whereas in a two-wire system the fluctuation would be so great that a steady voltage could not be kept. For example, suppose a 25-h.p. motor was connected to a two-wire at 250 volts, and a three-wire at 2 × 250 volts respectively. In the first case the motor would take 100 amperes, and in the second (the motor would be connected across the outers at 500 volts) and would take 50 amperes a side, causing only half the fluctuation on the lights. If the motors are used for cranes and similar fluctuating loads, this is of enormous importance from the regulation point of view, quite apart from saving in copper.

2. *Interchangeability of Plant.*—As the standard pressure for tramway work is 500 volts, and it is of the greatest importance to have all the generators in combined lighting and tramway stations capable of serving either purpose, the three-wire system is the only way of making the generators serve either lighting or tramways.

The above-mentioned advantages should be quite sufficient to vary the balance in favour of the three-wire system even if there was no saving in copper. It will be found that those who advocate the two-wire systems are those who have to do with a 2 × 100 volts three-wire system; in this case it might be advisable to change over to a two-wire system at 200 volts. This was done at Liverpool some years ago, the supply being at 2 × 110 volts, three-wire, and was changed to 230 volts, two-wire, and later, when new plant was installed, to 2 × 230 volts, three-wire, the same machines working on either lighting or the trams.

As to saving in copper, an actual example may be of interest. In the town where the writer is employed the system is 2 × 220 volts, three-wire. The distributors are ·1, ·075, ·1 square inch; this is a saving of 31 per cent. in copper over the two-wire at 220 volts for the same kilowatt carrying capacity. There are five feeders (with an average length of 1,200 yards), two of ·3 square inch and three of ·2 square inch, feeding the outers only. There is only one middle-wire feeder, ·15 square inch, and the middle wire of the distributor which passes the works is brought in. The total length of middle-wire feeder is 1,200 yards. There is a saving of something like 43 per cent. in copper in this

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case. There is absolutely no difficulty in at all times balancing the system locally and as a whole. A booster would have to be employed in a two-wire system to charge the battery, and the only modification necessary in a three-wire system is to divide the booster into two and the motor into two, and you have the combined booster-balancer. The extra cost of this and the switchboard is very small, and the reliability of the three-wire system should be at least equal to the two-wire. The fact of its universal adoption of late proves the great superiority of the three-wire of the two-wire system.—C. L. E. S.

Answer to No. 507 (*awarded* 5*s.*).—It is readily acknowledged by engineers that there is a great saving of copper in the three-wire system. This system has, as is stated, disadvantages in the matter of balancers, switchboard connections, and the arrangement of mains being less simple. These would, however, be enough to affect the adoption of the system if it were not for the great saving in mains which it can show. This system can be safely said to show 40 to 50 per cent. difference in copper, but the difference in copper does not mean the difference in the entire cost of the system, as the percentage has to be taken for insulation and laying of mains, which total works out at about 10 per cent. As is generally the case with a three-wire installation, the mains can be worked at a higher current density, because the voltage drop in long feeders for a two-wire system necessitates a very much greater section than would be required if only the density limit were considered: therefore the greater the extent of the area served, the greater the advantages of the three-wire system over the two-wire. By comparing two 0·2 square inch conductors with two of 0·1 square inch and one of 0·06 square inch—that is to say, the relative weight of copper in the two cases would be in proportion of 4 to 2·6, or a saving of about 40 per cent. in favour of the three-wire system. Assuming the same percentage drop in potential in both systems, the percentage should be much higher than this This, however, should be enough to show your readers that the advantages are in favour of the three-wire system.—S. F. RICKETTS.

Answer to No. 507 (*awarded* 5*s.*).—If "J. C. R." had stated in his question the length and size of the cables, then it could be determined whether or not a saving of 20 per cent. of the total cost of copper would pay for the extra machines essential to the three-wire system. In its present state the question seems hardly complete, as he does not give sufficient data on which to base our calculations. It is obvious that the amount saved would depend upon the magnitude of the system. For instance, in a small town where the cables are laid, or are going to be laid, on the ordinary two-wire arrangement, it is doubtful if a change over was made to the three-wire system whether the saving would be sufficient to procure the necessary machines and switches, etc. For suppose the total cost of copper required for the mains in a two-wire system be £x, then saving effected by employing the three-wire system, according to "J. C. R.'s" estimate, would be $\frac{£x \times 20}{100} = \frac{£x}{5}$.

Now, it can be seen that the value of $\frac{£x}{5}$ depends directly upon the amount of £x. It is necessary, therefore, to determine the total cost of copper required before deciding which system to employ. Of course, in an extensive system the adoption of the three-wire system would undoubtedly result in a saving of more than sufficient for the purchase of the extra plant.

As to the actual percentage saved, the writer considers that 20 per cent. is too small. Take, for instance, a parallel circuit in which the current required for each main is, say, one square inch, making a total for the two mains $1 + 1 = 2$ square inches. Now, for the three-wire system only half the current will be required, consequently only half the amount of copper will be needed in each main—*i.e.*, $\frac{1}{2}$ square inch—making a total for the two mains $\frac{1}{2} + \frac{1}{2} = 1$ square inch. The third wire is usually made half the section of the outer wires, since it only carries the extra current which one side of the system requires over the other side when unequally loaded, and in this case would have a cross-sectional area of $\frac{1}{4}$ square inch. Adding up then, the total cross-sectional area of the three wires is $\frac{1}{2} + \frac{1}{2} + \frac{1}{4} = 1\frac{1}{4}$ square inch, instead of two square inches with a parallel circuit. This, it can be seen, works out to a saving of over 35 per cent. of copper. Nor is this value at all too high, for if "J. C. R." will turn to p. 477 in Biggs's treatise on "Electricity and Magnetism" (published at the office of this paper), he will note that it is possible, taking all things into consideration, to effect a saving of over 60 per cent. of the copper required for the ordinary two-wire system by adopting the three-wire system.—W. F. SAUNDERS.

Question No. 508.—An armature is former-wound, having the coils so arranged that by having a loop from the centre of the coil it can be connected up to either 400 or 200 volts. The two halves of the coil in this instance are connected in parallel for 200 volts. When the armature was being tested, it heated considerably without apparent cause. Would this undue temperature rise be attributable to any induction between the two halves of each, seeing that the outer half encircles the inner half?

Best Answer to No. 508 (*awarded* 10*s.*).—It is highly probable that the explanation suggested is the correct one, especially if the armature be a smooth-cored one. It has often been noticed that in the case of smooth-cored double-wound armatures—*i.e.*, armatures having two commutators with the winding connected to one commutator arranged outside that connected to the other—the voltage per turn of the outer winding is as much as 2 or 3 per cent. greater than that of the inner winding, due to the extra flux passing from pole to pole through the thickness of the winding without passing into the iron core at all. The same sort of thing, though to a less extent, may occur in the case of slotted armatures, especially if the density in the teeth be high.

Suppose that in this particular armature the normal full load ohmic drop, assuming a perfectly symmetrical winding, be 2 per cent. of the output voltage, and suppose that the difference between the induced voltages in the outer and inner windings be also 2 per cent., then, if C be the total output current of the machine and R the resistance of the armature from the + to the − brushes, the current, instead of dividing equally between the two windings and causing a drop of C × R volts, will divide in such a way as to make (induced voltage − drop) the same for both windings. That is to say, the difference in drop between the two windings must be equal and opposite to the difference in their induced voltage (which difference is assumed equal to the normal drop, C × R). This will be the case when the current in the outer winding is $\frac{3}{4}$ C, and that in the inner winding $\frac{1}{4}$ C; for the difference in drop is then $(\frac{3}{4}\ C - \frac{1}{4}\ C) \times 2\ R = C \times R$. This distribution of the current will cause the total ohmic loss in the armature to be $(\frac{3}{4}\ C)^2 \times 2\ R + (\frac{1}{4}\ C)^2 \times 2\ R = 1{\cdot}25\ C^2\ R$, instead of $C^2\ R$, which would be the value with symmetrical distribution. The increase in loss would be even greater than this 25 per cent. if the ratio of the voltage difference between the two windings to the normal voltage drop were greater than that assumed, and so would probably account for all the overheating noticed.

The difficulty could be overcome by winding the armature with two parallel wires, each of half the sectional area of the present wire, and with sufficient turns of this double wire to give the 200 volts The two parallel wires should be treated as one whilst winding the coils on the former, so that both wires become equally distributed over the winding depth. No voltage difference could then be set up between the two parallel wires.—Q.

Answer to No. 508 (*awarded* 5*s.*).—Without seeing the actual machine, it is very difficult in cases of this description to indicate the fault that is causing the whole of the bother. From the wording of the question, I presume 200 volts *was* obtained from the machine, and that the heating was not due to any of the usual causes, but showed itself to a greater extent than it should have done on light load. The question does not state whether the heating is of a local or general character. Fig. 1 diagrammatically shows the two halves of a coil, A, A_1; a, b, c, d are the ends coming out at the commutator end; B, B_1 are two commutator bars. For 400 volts, a is joined to B, b to c, and d to B_1. For 200 volts, a is still retained on B and

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d on B_1, but *b* is joined to B_1 and *c* to B. Among the loose ends coming from an armature, it might be quite possible that in changing over from 400 volts to 200 volts in any one case, a connection such as *c* may be joined to B_1 and *b* as before. This would short-circuit coil A_1, make A take all the current, unbalance the armature, and thereby giving rise to general heating. It is hardly likely that the two halves would be joined so as to make the E.M.F.'s of each half act in the same direction instead of in opposition, thus creating a large current, and in general producing the same effect as above. Each half coil may not give the same E.M.F. as its assistant half. This would produce a heating effect. As regards the question of induction, when the merits of the case are considered, it is easily seen that if the strength of the induced currents are large enough, heating will result Take the case of any coil. The under half is more hemmed in by wires than the outside half.

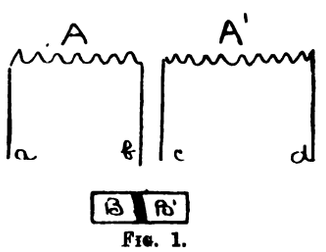

FIG. 1.

Hence the effect of induction is to produce a greater inverse current in the bottom layer than in the top. Of course, this sets up local currents, and therefore heating. As I have said before, it is extremely difficult to assign any specific reason for the case under question, as each particular case has its own remedy.—T. T.

Answer to No. 508 (*awarded* 5*s.*).—I do not think that the heating of the armature mentioned in the question can be due in any way to the effect of induction currents set up by having one-half of each coil encircling the other A current is only set up in a neighbouring conductor when the current in the first is varying, and as this only occurs when the coil passes a brush, the periodicity of reversal would be so very low that the E.M.F. set up could scarcely give rise to any appreciable loss. The armature is apparently "double-wound," which does not, as a rule, work so satisfactorily as a single-wound armature, but as regards the induction currents mentioned above, the two are on a par. In a single-wound armature we still have the coil undergoing commutation encircling several neighbouring coils. What the loss is very likely due to is that, owing to one pole being slightly stronger than another, large circulating currents are set up, and these overheat the armature conductors. The greater the number of poles, the greater the likelihood of this being the case. Every large multipolar armature should before finally being set to work be carefully balanced up. The machine should be run on open circuit, and the voltage between brushes carefully taken. The air-gaps should then be adjusted until the maximum difference between brushes of like sign is not more than 1 per cent. of the nominal voltage of the machine. If, in addition to this, balancing rings are fitted, we shall cut down the circulating currents to a very small amount, and any heating due to this cause may be neglected.

Another and very frequent cause of heating is due to bad insulation between the armature core plates This gives rise, of course, to large eddy currents and consequent heating. Usually a good coat of varnish on each side of the plate is sufficient, but it should be supplemented by paper discs placed about every inch axially along the core. If we are running a Hopkinson test with two machines, this can be easily tested for as follows. Run the set at full speed, (*a*) with generator unexcited, (*b*) with generator excited, but with no current in the armature, and find out the difference in the energy consumed. This represents approximately the open circuit iron loss of the machine. If this figure is unduly large, it is probably due to the above cause. Another cause of heating is bad soldered joints in the armature winding causing excessive drop. This is more likely to be the case here, as, owing to each coil being in halves, the number of soldered joints is likely to be large. This can probably be checked well by taking the resistance of the armature and comparing it with the calculated resistance for a continuous copper winding. The additional resistance due to the joints should not be more than 10 to 15 per cent. Many firms now are doing away with soldered joints altogether at the pulley or coupling end of the armature. Sometimes the heating may be remedied by improving the ventilation through the armature; a few fan blades judiciously placed in the armature spider often reduce the temperature considerably.

It has been said that "double windings" do not, as a rule, work so well as "single windings." This is especially so as regards commutation. If commutation is badly performed or sparking takes place, it also heats the armature, and some little of the heating may be due to this. Whatever be the cause of the heating, I do not think it is due to induction currents, as suggested in the question, but will probably be found, on investigation, to be due to one of the causes stated above.—T. SQUARE.

BIRKENHEAD ELECTRICITY ACCOUNTS.

The accounts of the electric supply department for the year ending March, 1902, show that the total expenditure on capital account amounts to £81,262. An abstract of the revenue account is given herewith:

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£1,000	4	8			
Oil, waste, water, and stores	266	0	6			
Wages at generating station	393	10	2			
				1,659	15	4
Repairs, etc., engines, boilers, machinery, and batteries				397	14	11
Distribution.						
Repairs, etc., of mains, etc.	13	9	7			
Transformers, meters, switches, etc.	15	16	0			
Public lamps	146	17	1			
Wages, linesmen, fitters, joiners, etc.	109	3	6			
				285	6	2
Rates, taxes, and insurance				189	10	0
Management Expenses						
Salaries—engineer's department	535	4	9			
Printing, stationery, and advertising	48	2	1			
General establishment charges	152	14	11			
Bank interest	189	12	10			
				925	14	7
Interest and sinking fund				3,503	9	6
Income beyond expenditure				225	10	5
				£7,187	0	11

Cr.	£	s.	d.
Sale of current	6,761	9	4
Rental of meters	386	1	8
Charges for work done	39	9	11
	£7,187	0	11

LEGAL INTELLIGENCE.

BATTERSEA SMOKE NUISANCE.

A very curious prosecution, arising out of the fact that the Battersea Borough Council is the local authority as well as the owner of the electric lighting works, came before the magistrate at the South-Western Police Court on Wednesday. The offence charged against the Council was that of allowing black smoke to issue from the chimney of the municipal electrical generating station. Much amusement was caused in court by Mr. W. P. Cauldwell, the borough solicitor, announcing that he appeared for both parties.

The **Magistrate**: What have you to say in defence?

Mr. Cauldwell: We admit the offence, and plead that as this is a first offence, only a prohibition order is necessary.

The **Magistrate**: There will be a prohibition order. The only objection I can see to the proceeding is that either the prosecution or the defence must be conducted with less vigour than is usual.

MONARCH MOTOR COMPANY.

Mr. Justice Swinfen Eady, in the Vacation Court on Wednesday, had before him a petition by Mr. S. C. Smee, judgment creditor, for the winding up of the Monarch Motor Company, Limited.

Mr. Kenyon Parker said that since the petition had been presented the petitioner had been approached by a shareholder, who, believing that the company possessed very valuable patents, and desiring that it should continue, had offered to take a transfer of the debt and pay

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the cost of this petition. He asked, therefore, that the petition should be dismissed.

His Lordship accordingly dismissed the petition.

CROYDON TRAMWAYS.

At the Croydon Borough Bench on Saturday, Frederick Truett, driver in the employ of the British Electric Traction Company, was summoned by the police for driving a car at a speed of over nine miles an hour.

The British Electric Traction Company were not represented; defendant pleaded not guilty.

Inspector Williams said on the morning of Sunday, Aug. 17, he saw defendant driving a tramcar in the Brighton-road. Witness timed him with a stop watch between Junction-road and the Swan and Sugar Loaf, and found that he covered the distance—a little over a quarter of a mile—in exactly one minute, the speed thus being about 15 miles an hour.

In reply to the Clerk, **Defendant** said they had no means to guide them as to the speed they were going. There was no indicator on the car, and they had to use their own judgment.

Inspector Williams was instructed to give notice to the British Electric Traction Company to be present in court next Saturday, and the case was adjourned for a week.

Henry Dennis, another electric car driver, was summoned for a similar offence committed on the same day.

The hearing of this case was also adjourned till next Saturday.

HUDDERSFIELD TRAMWAYS.

Validity of By-Laws.

Several persons were summoned at Huddersfield last week under the Corporation tramway by-laws, one defendant being charged with interfering with the comfort of passengers.

On the case being called, the **Magistrates' Clerk** said his opinion was that the Corporation by-laws were not valid. They were made in 1870, at a time when the Corporation did not contemplate working the tramways. The by-laws referred to the carriages of the "lessees." There was no reference in them to the Corporation. He thought the by-laws were inoperative, and suggested that an adjournment should be made for the attendance of the town clerk in order that the legal aspects of the case might be argued.

The cases against all the defendants were adjourned for a week, the chief constable agreeing, in the event of the by-laws being held in the meantime to be inoperative, to warn the defendants not to attend.

COMPANIES' MEETINGS AND REPORTS.

MERSEY RAILWAY.

The half-yearly ordinary general meeting of this Company was held in London on Friday.

Mr. James Falconer presided, and, in moving the adoption of the report, commented upon its apparently unfavourable character. The reason for the falling off in the receipts was due to the competition of the Birkenhead electric tramways, which for the first time had its full effect upon them this past half-year. Everywhere, he thought, where electric and steam traction came into competition, it had been found that the steam locomotive went to the wall and the electric tramway obtained the traffic. It had been proved very markedly in London, and also in Liverpool, where the Cheshire and the Liverpool and Lancashire Railways had suffered seriously from the competition of the electric tramways. It had been the same in Glasgow, and it was that fact which determined the Board to abandon steam locomotives and adopt electric traction. By the contract which they had with the British Westinghouse Company they believed they would be able to provide for the public the best service which science and money could possibly give. Not only would it be the safest, the most expeditious, the most comfortable, but in every way the most convenient and most frequent services would be provided. And if that were so, they might rely upon it that the public would appreciate it. Then they would see that the result of the tramway competition, which so long as they moved by steam was against them, would be a powerful factor in their favour, because it was vital to them that the traffic which was carried from one side of the Mersey to the other should have an efficient means of distributing itself from the two great centres of Liverpool and Birkenhead. As regarded the construction of the works, he was glad to be able to report that it was being proceeded with energetically by the British Westinghouse Company. There was every reason to believe that when next they met in that room to consider their half-yearly report the railway would be being worked by electric traction. Everything for their further success depended upon the completeness with which the work was carried out. To hasten it for the sake of starting a week or two earlier would be a mistake He concluded by moving the adoption of the report.

Mr. S. G. Sheppard seconded the motion, which was carried unanimously.

TYNESIDE TRAMWAYS.

The third general meeting of the shareholders in this Company was held at Newcastle on Saturday, Mr. W. A. Watson-Armstrong presiding.

The **Chairman**, in moving the adoption of the report, said that as regards the capital of the Company, although the public had so far only subscribed some £87,600 of the required amount, the directors, who could see their way to obtain the money necessary to complete the line, had so far made no effort to dispose of further shares. For, being satisfied as to the immediate success of the venture, they felt it only fair to those shareholders who had from the first shown confidence in them to give them the opportunity of securing further benefit from the Company before offering fresh shares to the general public. They propose, therefore, shortly to give the present shareholders the chance of increasing their holdings. He then referred to the success that attended the parliamentary proceedings of the Company during the past session, by which extensions of a particularly profitable character had been sanctioned. The threatened opposition from the Newcastle Corporation, which would have had a very detrimental effect upon the original main line of the trams, had been completely avoided. He trusted now that all question of hostility between this Company and the Corporation would cease. The Company in a few weeks' time would, he trusted, enter upon its career as a dividend-earning concern, and, satisfactory as this would be to those who had anxiously followed its fortunes from the commencement, it would play an even more useful and beneficent part in the lives of the large industrial population of Tyneside. Since the printed report was sent to the shareholders the official inspection of the permanent way of the cars had been carried out by Colonel von Donop. This took place on Friday, and passed off very satisfactorily. The electrical inspector of the Board of Trade was to visit Wallsend on the following Wednesday, Sept. 3, in connection with the overhead line, and immediately this was approved they could start a passenger service between Wallsend and Shields and between High-street and Neptune-road, Wallsend. The work on the tramroad was making good progress, and should be completed within a fortnight from date. The directors were advised by the Board of Trade inspector that he could not return to Newcastle until the end of September, so that the Gosforth line could not be opened before that date.

The report was adopted and the retiring directors (Mr. G. E. Henderson and Dr. Merz) re-elected.

A vote of thanks to the chairman closed the meeting.

CAVEHILL AND WHITEWELL TRAMWAYS.

A special meeting of the proprietors of this Company was held in Belfast on Tuesday for the purpose of empowering the directors to issue the new capital required for the electrical equipment of the line. The following resolutions were adopted: "That the directors be, and they are hereby, authorised and empowered, from time to time as shall be required for the purposes of the Company, to issue, at such times and under such conditions as to payment as they may deem expedient, the following share capital in the Company, to wit: 12,000 ordinary shares of £1 each authorised by the Cavehill and Whitewell Tramway (Amendment) Order, 1898, and 33,000 ordinary shares of £1 each authorised by the Cavehill and Whitewell Tramways Act, 1902"; and "That the shareholders present at the special meeting held on Sept. 2 urge upon the British Electric Traction Company the importance of commencing the work of reconstruction and conversion to electric traction of the Company's tramways at the earliest possible moment, and of pressing on the work rapidly and vigorously so that the cars may be worked electrically not later than Easter, 1903."

The proceedings concluded.

SENSITISED PAPER MANUFACTURING.

A compulsory winding-up order having recently been made against this Company, the usual meetings of creditors and shareholders were held on Monday at the Board of Trade Offices, Carey-street, W.C., Mr. H. M. Wincarls, assistant official receiver, presiding. The chairman reported that the Company was registered on June 19, 1900, for the purpose of acquiring from the Electrical Inkless Printing Syndicate, Limited, the exclusive licence for England and Wales to use an invention for the manufacture of a special paper for printing purposes called sensitised paper, on which printing could be done without ink upon the application of an electric current. The nominal capital of the Company was £100,000 in £1 shares, but only seven shares had been actually allotted. The Company was to acquire the licence mentioned for £8,000 in cash and £60,000 in fully-paid shares of the Company. The Company, however, never commenced business, and the purchase agreement was never carried out. No steps were taken to obtain working capital, and, beyond the purchase of machinery nothing was done towards the manufacture of paper. The statement of affairs showed unsecured liabilities £916, the only asset consisting of unpaid calls, the value of which was uncertain. No quorum was present at either of the meetings, which were accordingly adjourned for a week, the chairman intimating that if no resolution were passed on the next occasion the matter would remain in the hands of the official receiver as liquidator.

APPOINTMENTS VACANT.

Chief Engineer, Metropolitan Electric Supply Company, Limited. See advertisement.

Assistant Mains Engineer, Bristol City Council Electricity Department, £2. 10s. per week. See advertisement.

Engineer, for alternating-current station in West of London, experienced in the running of alternating plant, 35s., increasing to 40s. See advertisement.

Electrical Assistant for a large factory in the South of England. See advertisement.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bristol.—The Electrical Committee invite tenders for two 750-kw. single-phase steam alternators. Tenders by Sept. 16. See advertisement.

Celanova (Spain).—The Municipal Authorities invite tenders for installation and working of electric lighting for 20 years. Tenders by Sept. 23.

Nisch (Servia).—The Municipal Authorities invite tenders for the electric lighting of the town. The central station, cables, etc., are estimated to cost 600,000 dinars.

Madrid.—The Public Works Department require tenders for an electric tramway from Vigo to Bayona. The deposit required is 19,993 pesetas. Tenders by Sept. 29.

Malagon, Spain (Province Ciudad Real).—The Municipal Authorities invite tenders for installation and working of electric lighting for 20 years. Tenders by Sept. 19.

Christiania.—The Norwegian Government Railways require tenders for 27,400 kilos galvanised iron telegraph wires, 3,600 copper wire, 5,900 porcelain insulators and holders by Sept. 13.

Dundee.—The Gas Commissioners invite tenders for the supply of carbons for public lamps, delivered at the Electrical Power Station, Dundee. Tenders by Sept. 24. See advertisement.

Tientsin (China).—Mr. A. W. Harvey Pellingham, secretary of the British Colony at Tientsin, China, invite tenders for installation and working of electricity works. Tenders by Nov. 30.

Burton-upon-Trent.—The Corporation invite tenders for the supply and laying of electric mains, conduits, junction boxes, etc., in connection with the tramways. Tenders by Sept. 30. See advertisement.

Kirkcaldy.—The Corporation invite tenders for the supply and delivery of electricity meters. Specification, etc., can be obtained from Mr. W. L. MacIndoe, town clerk, Town Clerk's Office, Kirkcaldy. Tenders by Sept. 8.

Paris.—The Colonial Office require tenders for galvanised iron telegraph wire as follows: Tonkin, 100,000 kg. of 5mm.; 2,000 kg. of 2mm.; for Cochin-China, 50,000 kg. of 5mm.; 1,000 kg. of 2mm., by Sept. 9. 4, rue de Jean.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at the Electricity Works, Swindon, Wilts, of one complete lighting switchboard, with all instruments and accessories. Tenders by Sept. 19. See advertisement.

Bedford.—The Corporation invite tenders for the supply and delivery of two boiler feed-pumps. Specifications, etc., can be obtained from Mr. R. W. L. Phillips, borough electrical engineer, Cauldwell-road, Bedford. Tenders by Sept. 15.

Dundee.—The Gas Commissioners invite tenders for the supply and erection, at the Electrical Power Station, Dundee, of water-tube boilers, with mechanical stokers and superheaters, and induced-draught apparatus. Tenders by Sept. 24. See advertisement.

Bristol.—The Board of Guardians invite tenders for supply of boilers and electric wiring and fittings, etc., for their infirmary proposed to be erected for the accommodation of about 875 sick patients at Stapleton. Tenders by Sept. 10. See advertisement.

Orense.—The Municipal Authorities invite tenders for the installation and working for 20 years of electric lighting the above. One hundred 16-c.p. lamps will be paid for at the rate of 3,500 pesetas per annum. Tenders to the above authorities, province Celanova, by Sept. 23.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories Tenders by Sept. 15. See advertisement.

Cabeza del Buey (Spain).—The Municipal Authorities invite tenders for installation and working, for not more than 25 years, of electric lighting; about 3,000 c.p. are now required, for which a maximum of 3·33 pesetas per annum will be paid. Tenders by Sept. 19 to the above authorities, province of Badajoz.

Southampton.—The Corporation invite tenders for the construction of tramways in Onslow-road, Bevoir-valley, and Portswood-road, having a total length of about 2,058 yards of single track. Specification, etc., may be obtained and plans inspected at the Borough Engineer's Office, Southampton. Tenders by 2 p.m. on 17th inst.

Styal (Cheshire).—The Chorlton Board of Guardians invite tenders for the electric wiring of the new cottage homes at Styal, Handforth, Cheshire. Specifications, etc., may be obtained on application to Mr. G. R. Peers, A.M.I.E.E., consulting engineer, 16, John Dalton-street, Manchester. Tenders by 12 noon on 11th inst.

Bury (Lancs.).—The Tramways Committee invite tenders for the work required in the construction of the permanent way in several parts of the borough—viz.: Fairfield section, Bolton-road section, Heywood-street section, and Knowsley-street section. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by 24th inst.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

Pietermaritzburg.—Tenders are invited for the supply and delivery, free on rail, Pietermaritzburg, Natal, South Africa, of six miles of Vignoles rails, 704 pairs of fishplates (complete with bolts and nuts), 21,120 dog spikes, 1,408 crab bolts, nuts, and fang clips, and 1,760 copper bonds. Specifications, etc., may be obtained from the office of the Borough Engineer, Pietermaritzburg, or from the Corporation's London agents, Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, London, W. Tenders by Sept. 15.

Pietermaritzburg.—Tenders are invited for the supply and delivery, free on rail, Pietermaritzburg, Natal, South Africa, of eight miles of girder rails, 938 pairs of fishplates (complete with bolts and nuts), 938 sole-plates (complete with bolts, nuts, and clamps), and 2,345 copper bonds. Specifications, etc., may be obtained from the office of the Borough Engineer, Pietermaritzburg, or from the Corporation's London agents, Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, London, W. Tenders by Sept. 15.

Amsterdam.—The Board of Trade have received through the Foreign Office copy of a dispatch from H.M. Consul at Amsterdam reporting that on Sept. 8, at 12 noon, the Municipal Council of Amsterdam will receive tenders for the delivery and laying of the entire network of cables for the municipal electric works, consisting of about 150 km. high-tension, 70 km. low-tension, and 25 km. telegraph and telephone cable, with the necessary accessories. Particulars may be obtained from the Municipal Printing Office at a cost of 2·50fr. (4s. 2d). Information will be supplied at the office of the Director of Electrical Works, O. Z. Achterburgwal 213, Amsterdam.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of land-owners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

King's Norton, Birmingham.—The Urban District Council are prepared to lease their powers obtained under their electric lighting order in 1898. The area of supply comprises the whole of the civil parishes of King's Norton and Northfield, in the county of Worcester. The streets scheduled for supply within period limited by the order are all within the wards of Moseley and King's Heath, which together contain a population of 20,400. Prints of the order may be obtained from the Government printers, Messrs. Eyre and Spottiswoode. The engineer is Mr. A. W. Cross, A.M.I.C.E., 23, Valentine-road, King's Heath, Birmingham, to whom enquiries for further particulars should be addressed. Preliminary offers must be addressed to Mr. Edwin Docker, clerk to the Council, 10, Newhall-street, Birmingham, and reach his office by Sept. 18.

Reading.—The Corporation invite tenders for work in connection with the tramways—viz.: (Section A) comprising the supply, delivery, drawing-in and connecting up of all feeder cables, rail return cables, test wires, etc., with joint-boxes and jointing, and the carrying out of tests; (B) comprising the supply, delivery, erection, and connecting up of all poles, brackets, wires, cables, insulators, switch-boxes, and other fittings, and the carrying out of tests. Specifications, etc., may be obtained at the office of the engineers, Messrs. J. Bowen and I. E. Winslow, Town Hall, Reading; for Sections A and B, £5. 5s.; for Section A only, £3. 3s.; for Section B only, £5. 5s. These deposits will be returned after the Corporation shall have come to a decision upon the tenders received, provided that a bona fide tender has been sent in on the form bound up with the specifications, etc., from which it must not be detached. For the convenience of tenderers a duplicate copy of the bill or bills of quantities and schedules will be supplied on payment of £1. 1s. (not returnable). A copy of the specification and drawings may be seen at, but not obtained from, the office of Mr. I. E. Winslow, 35, Parliament-street, Westminster, S.W. Tenders by 12 noon on Sept. 18.

RESULTS OF TENDERS.

Epsom.—The Council have accepted the tender of Belliss and Morcom for one 200-h.p. engine coupled to Dick-Kerr generator.

Maidstone.—The tender of Messrs. Rowland Carr and Co., London, has been accepted for the supply of 1½ miles of cast-iron troughing.

Warrington.—The Corporation have accepted the tender of the St. Helens Cable Company, Warrington, at £276. 4s. 6d., for tramway cables.

Farnworth.—The Council have accepted the tender of Belliss and Morcom for one 400-h.p. engine coupled direct to British Westinghouse dynamo.

Stretford.—The Council have accepted the tender of Belliss and Morcom for four 145-h.p. engines coupled direct to British Westinghouse generators.

Dover.—The Electricity Committee have accepted the tender of the British Insulated Wire Company for the Admiralty Pier cable, which will supply power to the electric cranes.

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Accrington.—The Town Council have accepted the tender of the Albion Clay Company for the supply of 640 yards of 2½in. conduits.

Bloemfontein (Orange River Colony).—The Council have accepted the tender of Belliss and Morcom for two 300-h.p. triple-expansion engines for coupling to Crompton dynamos.

Liege.—The City Authorities have decided to instal two 380-h.p. Willans engines for direct coupling to dynamos made by the Cie. Internationale d'Electricité, for supplying power to their trams.

Mile End.—The Board of Guardians have accepted the tender of Mr. Russell, of Mile End, for the supply of electric lighting fittings and lamps at the infirmary and workhouse on the condition that all the articles are of English manufacture.

Swindon.—The Corporation have accepted the tender of the Tudor Accumulator Company, 16, Victoria-street, Westminster, for supply, delivery, and erection at the electricity works, Swindon, Wilts, of 252 accumulator cells and accessories, at £1,102.

Worthing.—The Town Council have accepted the tender of Messrs. Blackwell and Company, Limited, for the supply and erection, etc., of steam and exhaust drain and other pipes, condensing plant, etc., required in connection with the first extension of the works, at £438.

Wolverhampton.—The Guardians have accepted the tender of G. H. Woods and Co., Blackburn, at £6,800, for supplying Belliss engines, E.C.C. dynamos, Callender mains, and Chloride Company's accumulators. The Electric Construction Company also tendered at £6,923.

Wrexham.—The Corporation have decided to instal a 600-h.p. Willans engine for driving a traction generator made by the Lancashire Dynamo and Motor Company at £3,974. The Lancashire Dynamo and Motor Company's tender has also been accepted for a switchboard at £484.

BUSINESS NOTES.

TRACTION.

Hawick.—It is proposed to establish electric tramways in this district.

Galston.—It is reported that the new tramway from here to Liverpool has so far proved very successful.

Korea.—We understand that it is intended to extend the electric tramways at Seoul to a length of 12 miles.

Blackpool.—The surveyor estimates the cost of relaying the tramways from Warley-road to Park Hotel at £1,600.

Southampton.—The Board of Trade inspection of the tramway extension to Bitterne Park took place last Saturday.

Paignton.—The promoters of the Torquay and Paignton light railway have abandoned their application to the Light Railway Commissioners.

Stanmore.—It is believed that the official enquiry into the proposals of the Middlesex County Council for a light railway in the district will be held next month.

Liverpool.—A report on the working of the tramways during the past seven months has been prepared, and will shortly be considered by the Town Council.

Rotherham.—The architect has reported to the Electric Light and Tramways Committee that the contractor is making satisfactory progress with the tramcar sheds.

Manchester.—In the General Purposes Bill to be promoted by the Corporation next session, powers will be sought to construct one or two additional lines of tramway.

Ipswich.—The electric tramway system which is being laid down by the Corporation is now nearly completed; Oct. 1 is named as a likely date for the opening of the lines.

South Norfolk.—The Board of Trade have confirmed the South Norfolk Light Railway (Extension of Time) Order, 1902, amending the South Norfolk Light Railway Order, 1898.

St. Helens.—The South Lancashire Tramways Company are negotiating with the Town Council for permission to make a physical junction with the St. Helens lines at Haydock.

Halifax.—The Tramways Committee have decided to recommend the Town Council to extend the tramways from Stump Cross to Hipperholme, and from Salterhebble to Greetland.

Crewe.—The Town Council on Wednesday decided to appoint an electrical expert to advise them with regard to the protection of their rights under any scheme of light railways that may be granted for the borough.

Worthing.—Messrs. Burstall and Monkhouse have been commissioned to prepare the necessary plans, etc., in connection with the proposed application for an order authorising the Corporation to construct tramways in the town.

Southport.—The sanction of the Board of Trade to the plans for the projected section of the Corporation tramways along St. James's-street, Duke-street, and Cemetery-road, to join the present line at Ash-street, is now only awaited to begin work.

Kingston.—Much progress continues to be made with the laying of the electric tramway, which can now be seen from the corner of the Stanley-road and Broad-street. A start has now been made with the piece of line from Ferry-road to Kingston-road.

Pontefract.—At the last meeting of the Rural District Council a communication was received concerning the suggested adoption of a wider gauge for the projected tramways—4ft. 8½in. instead of 3ft. 6in. It was decided to ask the Board of Trade to guard the Council's interests in the matter.

Kingstown.—A deputation has been appointed by the Urban District Council to wait on the tramway company with reference to the tram poles on the Royal Marine-road with a view of having them removed or lighted at the expense of the company.

Wrexham.—The date of the commencement of supply of current to the tramways has now been agreed upon—*i.e.*, not later than Feb. 1 next. The Corporation are borrowing a sum of £11,000 to meet the expense of installing the additional plant required.

Lancaster.—The first of the electric cars built by the Lancaster Wagon Company for the new system of local tramways is now completed, and will shortly be delivered to the Corporation. It will then pass into the hands of the Westinghouse Company, to be fitted up with the electrical apparatus.

West Hartlepool.—Colonel von Donop has inspected portions of the tramways, with respect to which complaint has been made by the Corporation to the Board of Trade, particularly the sections in Cleveland-road and Church-street. The inspector will present his report to the Board of Trade in due course.

South Hams.—It is understood that the South Hams light railway scheme, which has been delayed by the unsatisfactory state of the money market, is to be brought forward again in November, with important amendments, and arrangements are in progress for taking it before the Light Railway Commissioners.

Wallsend.—The Board of Trade inspection of the overhead equipment of the electric tramways which have been laid down by the Tyneside Tramways Company took place on Wednesday. Immediately the necessary permission is received the company intend to start a passenger service on this part of their system.

Bradford.—As an electric car was passing down Harris-street one evening last week, the trolley pole became entangled with the overhead wire, and caused the wire to be pulled down. The trolley pole and stand were also displaced and fell over the side of the car into the roadway. Fortunately no one sustained any injury.

Shepherd's Bush.—A correspondent of the *Globe* calls attention to the disgraceful struggle for places on the tramcars at Shepherd's Bush on Sunday afternoons. Of the fact there can be no doubt, as anyone may satisfy himself by ocular demonstration; and the correspondent's suggested adoption of the queue system as a remedy for it, is at least worth trying.

Sowerby Bridge.—The electric tramway which the Halifax Corporation are extending from King Cross to Sowerby Bridge through Pye Nest Park is expected to be completed in the course of a fortnight or three weeks. Rails have been laid the whole of the distance, but some paving still requires to be done, and the overhead equipment is not yet complete.

Barcelona.—The British Consul-General at Barcelona in his last report says: "Foreigners of all nations are flocking here on business connected with electric tramways, electric lighting, mines, factories, and every branch of industry and commerce, and everyone visiting this city remarks that no one seeing Barcelona could ever consider Spain wanting in wealth."

Belgium.—A Brussels correspondent says that on Wednesday morning M. C. Ramaeckers, secretary to the Belgian Ministry of Railways, presided over a meeting of the Council of Railways to discuss the advisability of running an electric railway from Brussels to Antwerp. It is understood that it is possible that the plan will be executed by the beginning of next year.

Tramways and Light Railways Association.—We have received from the above association their membership list up to June 30 last, which now contains some 300 names. The monthly circular of the association includes a short obituary notice of the late Mr. E. J. Trewhill, manager of the Sunderland Corporation tramways, who was elected to the council of the association last January.

Spen Valley.—The Board of Trade have, after modification, confirmed an order made by the Light Railway Commissioners and entitled the Spen Valley and Morley Light Railways (Extensions) Order, 1902, authorising the construction of light railways in the borough of Morley and the urban districts of Birkenshaw, Drighlington, and Gomersal, in the West Riding of the county of York.

Manchester and Salford.—At Wednesday's meeting of the Manchester Town Council a discussion arose on the question of a through tramway service between Manchester and Salford, in the course of which it was stated that the committee were not without hope that without referring to the Board of Trade they would be able to arrive at an arrangement for the working of the through service.

Geneva.—A dispatch from Geneva, dated Aug. 31, states that the manager of the electric tramways there dismissed 42 men from the workshops the previous day, and offered them posts as conductors. The offer was refused, and all the employés went on strike. No trams are running, though the town is crowded with tourists, and in spite of extra carriages, the demand for vehicular accommodation cannot be met.

Ossett.—A public meeting of ratepayers was held on Wednesday week to protest against the action of the Mayor in refusing to call a ratepayers' meeting to consider the tramways question. A resolution was adopted regretting the refusal of the Mayor to convene a public meeting to consider the advisability or otherwise of applying for the necessary powers to construct a light railway from the Market-place to the borough boundary.

Accident in America.—A message from Pittsfield (Mass.), dated Sept. 3, states that President Roosevelt and a party of friends were driving in a drag from there to Lennox on that day when the vehicle was struck by an electric car. The horses of the drag were killed, several of the party were injured, and one killed. Mr. Roosevelt escaped with a few bruises. The driver of the electric car and the conductor have been arrested.

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Flamborough.—Application is about to be made to the Board of Trade for an extension of time for constructing the works authorised by the Flamborough and Bridlington light railway order of 1897. It may be mentioned that the company had a six months' extension granted them in March last, when it was understood no further extension would be granted.

Glasgow.—A collision between two electric cars is reported from this place. They were proceeding in the same direction when the car in front came unexpectedly to a standstill, and was run into with considerable force by the car which came behind. The result of the collision was that the car in front jumped the rails, and the passengers got a severe shock. It was, however, brought to a stand by the trolley pole slipping from the overhead wire.

Wakefield.—After modification, the Board of Trade have confirmed the Wakefield and District Light Railways (Extensions) Order, 1902, authorising the construction of light railways in the city of Wakefield, the borough of Ossett, and in the townships of Horbury, Lofthouse-with-Carlton, Thorpe, Rothwell, Sandal Magna, Oulton-with-Woodlesford, and in the parishes of Rothwell, East Ardsley, and Outwood, in the West Riding of the county of York.

Ilkeston.—At Wednesday's meeting of the Town Council a letter was read from Sir B. Cunard, Bart., stating that the promoters of a Light Railway Bill were prepared to take over the Ilkeston tramways, pay to the Ilkeston Corporation 6 per cent. per annum, and observe such stipulation as might be embodied in a written agreement. The offer was not accepted, it being stated that the Corporation were paying 7½ to 8¼ per cent. on capital involved by the undertaking.

Horndean Light Railway.—The promoters of the Cosham and Horndean light railway scheme are pushing forward the work of construction. A very considerable portion of the work has been accomplished; that from Cosham to the top of Portsdown Hill is all but complete, the fixing of the overhead wires to the supports alone remaining to be done. It is stated, however, that the promoters intend to apply for an extension of time for the completion of the work until 1903.

Dundee.—No public reference has been made lately to the proposed tramway from Dundee to Broughty Ferry and Monifieth, and it would seem as if the scheme had been abandoned. The necessity for better communication between these places has all along been admitted, and the community has been led to believe that the public bodies interested were taking the necessary steps to realise the long-cherished scheme. Much dissatisfaction is felt locally at the delay in making a start with the construction of the tramways.

South Lancashire.—The contractors for the South Lancashire tramways have now commenced laying the lines over Leigh Bridge, the short length being the last section required to complete the route through from Leigh borough boundary at Pennington to Bolton *viâ* Atherton, Halton, and Bandhill. The tramways are already opened from Bolton to Four Lane Ends, and it is expected that the Leigh and Atherton portions will be completed this month. Leigh Bridge has been widened and otherwise improved.

Perth.—The Corporation have decided to take over the tramways from the company. At a special meeting of the Council on Monday a resolution was adopted requiring the tramway company to sell so much of the undertaking as is within the burgh at a price to be fixed upon by arbitration. Negotiations between the parties have been going on for some time, but without any agreement being come to as to price. The Corporation consider £20,000 to be a fair figure for the undertaking, while the company are asking £25,000.

Barrow.—Plans and specifications for the proposed electric tramways are now being drawn up by the British Electric Traction Company's engineer, and in a very short time they will be ready to submit to the Council for approval or otherwise. It is proposed to carry out the powers the Corporation have already acquired for the construction of a new tramline from Michaelson-road to the Ferry, and to abandon the tram route from Ramsden-square to the steelworks. The company state that they will require electric power for the tramway service next August.

King's Norton.—An extraordinary meeting of the District Council has been held, at which the members discussed in private the report of the Tramway Committee recommending the Council to lease to the City of Birmingham Tramways Company the proposed line from the city boundary in Pershore-road to the Cotteridge, and also the junction with the Bristol-road route along Pebble Mill-road to Pershore-road. After more than an hour's deliberation the Council authorised their seal to be affixed to the agreements, subject to certain matters of detail now outstanding.

Birmingham.—It is announced that a conference of the representatives of the various suburban authorities with regard to the tram question will take place in Birmingham during the course of this month. The districts invited to send representatives are: Aston, Handsworth, King's Norton, Erdington, and Smethwick. The decision of the conference will be awaited with great interest, especially in Birmingham, where it is recognised that their determination will have a considerable influence upon the development of the tramway question in the city.

Burnley.—It was decided by the Town Council on Wednesday to proceed next year with the making of three branch lines of tramway in Accrington-road, Manchester-road, and Todmorden-road, at an estimated cost of £24,348. Considerable discussion arose on a proposal of the Electricity Committee to spend £4,500 on extending their plant to meet the prospective increase in the demand from the trams. Eventually the matter was referred back to the committee, considerable difference of opinion being expressed as to the necessity for extending the plant.

Belfast.—The refusal of the tramways company to accept the offer of the Corporation to purchase their undertaking for £380,000, was the subject of a long discussion at Monday's meeting of the Borough Council. The terms submitted to the company, it was generally agreed, were exceedingly generous, and much regret was expressed at the attitude taken up by the company. The Lord Mayor declared that he had done with the matter so long as he sat in the mayoral chair. The offer was the last and final one, and he was sure the company would never get as good terms

Kirkcaldy.—The work of laying the permanent way of the tramways is now almost completed, and the cables for the electric lighting and traction have been laid throughout the burgh, with the exception of a few yards in the Path, which is expected to be completed this week. The streets, which have been more or less blocked throughout the town for the last six months, are now open for traffic. There still remains a considerable amount of work to be done at the generating station before the scheme can come into operation, but the work there is being pushed steadily forward.

Additional Traffic Returns.—Anglo-Argentine, £245 increase; Barcelona Ensanche y Gracia, £71 decrease; Barcelona, £168 increase; Brisbane, £592 increase (month of June £10,187, increase £1,813); Buenos Ayres and Belgrano Electric (month of June, receipts £12,229, increase £470), £182 increase; Calcutta, £246 increase; Cape Town (month of June), receipts £14,148, expenditure £6,689; Isle of Thanet Electric, £377 increase; Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £259 increase; Port Elizabeth (month of June), receipts £3,849, expenditure £1,891.

Waterloo and Baker-street Railway.—Satisfactory progress is reported in the construction of the new tube that is to connect Waterloo Station and Baker-street. Land for the South London station has been acquired by the company, who have purchased the site of the School for the Indigent Blind at St. George's-circus for this purpose. At present a distance of one mile and a half of single tunnel remains to be made, so that three-fourths of the subway between the points mentioned are now finished. Lift shafts are already completed at St. George's-circus, Piccadilly-circus, and Baker-street.

Shipley.—A deputation of tradesmen has attended a meeting of the Highways Committee with a request that the construction of the tramway from the boundary of the district at Thackley and Nab Wood end shall be pushed forward without delay. The committee have expressed themselves in entire sympathy with the object of the deputation, and promised that there shall be no unnecessary delay in carrying out the works. Plans submitted by the Bradford Corporation for the construction of a tramway car shed in Bingley-road, Shipley, between Albert-road and Hirst-lane, have been approved, subject to certain conditions.

Leeds.—The Sub-Traffic Committee of the Corporation recommend the construction of a tramway from the end of Oldfield-lane into Lower Wortley. The extension will cover a distance of about three-quarters of a mile. The Council have under consideration a suggestion for revising the system of workmen's fares on their cars, with a view to obviate the anomaly by which a workman in the early morning can ride five miles from Stanningley to Boar-lane for 1d., but may have to pay 2d. to ride a fourth of the distance if his journey take him through both Boar-lane and Briggate. The manager (Mr. Hamilton) is to report on the subject.

Cardiff.—A collision between two electric cars on the Cathays route of the tramways happened in Woodville-road on Tuesday evening, resulting in serious damage to one of the cars, though no person was injured. The cars were both going towards town on a double-line passing-place, and a dash appears to have been made to reach the single line first. Before the cars could be stopped the one dashed longitudinally against the side of the other, smashing in the woodwork and the windows, so that it had to be taken off the line and will need considerable repair. It is understood that the alleged offending driver was suspended from duty.

Eccles.—Revised plans have been submitted by a syndicate to the Town Council and the Davyhulme Parochial Committee during the past week for the construction of electric tramways from Barton Bridge to Glossop. The Eccles Town Council, who have leased their lines to the Salford Corporation, have resolved to ask the latter whether they are prepared to connect the existing tramways in the borough at Patricroft Bridge, now in course of reconstruction, with the proposed lines of the Manchester Southern Electric Tramway Company at Barton Bridge. The Davyhulme Parochial Committee have decided to give general support to the scheme

Brierley Hill.—There was a lengthy discussion on the matter of the electric tramway system in the town at Monday's meeting of the Urban District Council, arising out of a report of the Tramway Committee. To this committee a letter had been sent by the manager of the Dudley, Stourbridge, and District Electric Traction Company, enclosing plans of proposed improvements to the tramway passing places in the district, and asking the Council's permission to put in additional loops. This was agreed to, and the suggestion carried that the company be asked to have wood blocks from Level-street to Chapel-street, Brierley Hill, and to construct a double line.

Worcester.—Fresh plans for the conversion of the tramways in the city to electric traction are being prepared by the tramways company in consequence of the rejection of the original ones by the Council. This will necessarily delay the work of reconstruction for some time, and under the circumstances the company have asked the Corporation for an extension of time for the commencement of the supply of electricity from the municipal power station, which was fixed for Dec. 1 next. The new station is nearly completed, and the Council will be quite ready to give the necessary supply by the date mentioned. They have therefore decided not to grant the company the extension asked for.

Gomersal.—At the meeting of the District Council on Wednesday, a discussion took place with reference to the proposed positions of the feeder pillars on the electric tramway, to which some of the members

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objected in the interests of local vehicular traffic. It was eventually agreed to defer the question, in the hope that an amicable arrangement may be made before the work is actually commenced. The award of Mr. Stephen Sellon with reference to the portion of the Dewsbury, Batley, and Birstall Tramways Company's undertaking which is to be taken by the Council on behalf of the electric traction company was submitted. The amount to be paid by the Council on behalf of the company is £877.

Croydon.—An electric water-cart for watering the lines is the latest addition to the up-to-date plant of the municipal tramway system here. In shape it is very similar to an ordinary water-cart, the one great difference being that the holder is cylindrical, and of a capacity to hold 1,300 gallons of water, enough to distribute over seven miles of track. Two pumps, working from the armature shaft, force the water to the tubes, but the latter are so arranged that a current of air blows all loose dust away from the metals first, the hard dirt being removed by means of four steel brushes fixed to the front of the cart. The water-cart is driven by electricity gathered from the overhead line, as in the case of the tramcars.

Brighton.—The Royal assent has now been given to the Bill for the extension of the electric tramways from the Royal Pavilion to the front near the Palace Pier. As regards the section along a portion of the London road, it is to be settled this week by the Town Council whether it shall be done immediately or postponed until December so that both sections may be completed under one contract. The tramway returns again show that considerably more than a quarter of a million passengers now use the service weekly. The question of tramways in Dyke-road is receiving the attention of the Tramways Committee. It is believed from the representations that have been made to the Council in the matter that the extension would prove generally popular.

Brighouse.—A deputation from the Brighouse Corporation has waited upon the Tramways Committee at Huddersfield with reference to the proposed extension of the tramway system to Brighouse. It is understood that the Huddersfield authorities expressed their willingness to come to an arrangement to hand over their powers to the British Electric Traction Company, providing suitable arrangements could be made with the Brighouse and Mirfield Councils for this to be done. In the case of Brighouse, it is proposed to extend the traction company's system from Hartshead Moor (in the Spen Valley scheme), through Clifton, Brighouse, and Rastrick, to Firby, and then join with the Huddersfield system. It is expected that negotiations will be entered upon shortly.

Mirfield.—Strenuous efforts are now being adopted by the District Council to secure the extension of the electric tramway system to their district. The Huddersfield Corporation are vested with powers for giving Mirfield the benefit of electric traction; but up to the present they have not exercised these powers to the full extent, the tramway now terminating at Bradley. The British Electric Traction Company having completed the laying of their lines to the end of the Ravensthorpe boundary, the position of Mirfield has become one of acute interest; and the local authority are, therefore, keenly desirous of having the tramway extended from Bradley to the Ravensthorpe boundary, so as to form a through connection between the important centres of Dewsbury, Batley, and Huddersfield.

South London Tramways.—The work of reconstructing the tramways between Tooting and Westminster for electric traction is proceeding apace. Messrs. J. G. White and Co. hope in the course of this week to have both lines from Tooting to the Plough, Clapham, practically completed, and the lines from Tooting to Waterloo, Blackfriars, and Westminster bridges are to be finished, if possible, by Dec. 1, but the work may not be done before Jan. 1. The same company have the contract for the line from Vauxhall to Camberwell Green, which is to be completed by March 1 next. Specifications have been issued for tenders for the Greenwich section, which is understood to be the next portion of the work to be undertaken. After this the Camberwell and Peckham route will probably be dealt with, and, last of all, the Brixton cable line to Streatham.

Swansea.—On Wednesday last week a large deputation from the Swansea Corporation paid a visit to Wolverhampton for the purpose of inspecting the working of the Kingsland mechanical surface-contact system and the Lorain magnetic system. Some time ago the Swansea Corporation determined if, possible, to have no more trolley system in the town if it could possibly be avoided, and they have been carefully considering the merits of the various conduit and surface-contact systems for the purpose of the extension lines they are about to put down The committee paid two visits to the Tramways Exhibition in London last month, and were impressed with the Kingsland system which was shown there. As the result, they passed a resolution in favour of adopting this system. The extension lines on which the system will be adopted will comprise about 3½ miles of double track.

Tramways v. Railways.—There is no doubt but that the linking up of the various systems of electric tramways in South Lancashire, particularly around Liverpool, is having a disastrous effect on the railway companies' returns in the districts affected. A Liverpool message says that the increasing abstraction of railway passenger traffic by the electric trams is exercising the Liverpool railways, the North-Western, Lancashire and Yorkshire, and Cheshire Lines, they having equally suffered from this cause. The Cheshire Lines have issued a reduced scale of weekly and monthly contract fares to compete with the Garston and south end of Liverpool trams and other companies. Even the Overhead Railway is considering measures necessary to combat this very serious loss. St. Helens, also Garston and Bootle (both centres of dock traffic) are all connected with Liverpool by electric trams at half the fares charged by the railways.

Calverley.—At the last meeting of the District Council the question was raised of the proposed extension of the Bradford tramways to **Greengates.** It was pointed out that Bradford only proposed to bring the tramways to the Roebuck Hotel, Greengates, and it was suggested that the Calverley Council should try to influence Bradford to extend their scheme as far as the Bradford boundary at the Carr, which adjoins Calverley. If this were done, it would be a great boon to the people of Calverley, and would be considerably nearer than any other railway station for Calverley people. It was pointed out that Leeds proposed bringing their tramways to Rodley, and the Chairman said that in future, when the thing became matured, he would be in favour of the Calverley Council themselves constructing the intervening line to join up to the respective Bradford and Leeds lines. It was agreed that private representations should be made to the Bradford representatives, pointing out the advisability of extending the scheme to the Bradford boundary.

Birkenhead.—The first annual report for the year ended March 31 last has just been issued by the tramways manager, Mr. A. R. Fearnley. During that period the total receipts amounted to £31,593. 11s. 10d., and the expenditure, including interest on loans and sinking fund, was £28,079. 7s. 5d., leaving a net profit of £3,514. 4s. 5d. The receipts per car mile amounted to 10·54d., and 8·98 passengers were carried per mile, the average fare per passenger being 1·16d. The total length of route is 13·52 miles, and the maximum gradient 1 in 13½ over a distance of 360 yards. There were 6,456,361 passengers carried, and the cars ran 718,726 miles, consuming 982,737 units of electricity. There were 69 cars in use, the single-deck cars carrying 31 passengers, the single-truck double-deck cars 55, and the bogie double-deck cars 75. The average distance of the 1d. fare was 1·43 miles, 1½d. fare 1·83 miles, and 2d. fare 2·63 miles, whilst the 3d. fare covers 5·38 miles, and consists of the Oxton and Claughton circle. The cost per unit for electricity was 1·05d., and the consumption per car mile 1·36 units.

Oldham.—Major Druitt, R.E., has now made his formal examination of three sections of the Corporation electric tramways which have been completed and are now ready for working. These are the Rochdale-road section, the Shaw-road section, and the line from Junction, Shaw-road, along Egerton street and Rock-street to the Market-place. The Rochdale-road length completes the line which crosses the town from boundary to boundary, from Bardsley on the one side to Royton on the other, and makes communication with the electric cars to Ashton, Guide Bridge, Denton, and Hyde, and the steam cars to Rochdale and Bury. This section is 1,624 yards long, and for the greater part of the distance is laid with double track. The Shaw-road line runs from Cross-street to Higginshaw, a distance of 826 yards. The Egerton-street line branches from the Shaw-road line, and is 1,009 yards in length. There are yet to be completed tramways in Ripponden-road (leading to Watersheddings football ground), Featherstall-road, and Chadderton-road, which will complete 21 miles of electric lines within the borough.

London, Deptford, and Greenwich Tramways.—Presiding over the half-yearly general meeting of this company on Thursday last week, Mr. George Ennis said that no doubt the shareholders would be anxious to learn whether anything further had transpired in reference to the negotiations for the sale of the undertaking to the London County Council. The only thing which he had to report was that on July 30 the Board of Trade gave their assent to the application of the County Council for leave to serve notice to purchase the remaining sections of the company's line. The directors had not received the formal notice so far, but probably it would be served on them when the County Council resumed their sittings. He had reason to believe that some effective proposition would be made to the company at an early date for the immediate surrender and purchase of the undertaking. It was considered inadvisable to delay the annual meeting, because the whole thing was still, to some extent, "in the clouds." It was thought better to get the ordinary business settled, and, if the occasion should arise for doing so, a further meeting would be called to discuss the matter. The Board, he added, regretted that no distribution to the shareholders was possible.

Military Motors.—The report has now been issued of the trials of self-propelled lorries for military purposes which were held last December at Aldershot. It may be recalled that the committee awarded the first prize of £500 to the Thornycroft Steam Wagon Company, Limited; the second of £250 to Edwin Foden, Sons, and Co., Limited, Elworth Works, Sandbach; and the third of £100 to the Straker Steam Vehicle Company, Limited, London and Bristol. The first and second prize-winning lorries are to be both purchased for army use. The committee in their report say the trials have shown that these steam lorries are good and serviceable machines suitable for present supply, and likely to be of great advantage to the transport service in countries where fuel and water in sufficient quantity is available. The committee, however, desire to call attention to the great possibilities for military purposes of the internal-combustion lorry burning heavy oil, as shown by the small combustion fuel and practical independence of water of the one which was tried, belonging to George F. Milnes and Co., Limited. The committee strongly recommend that steps to develop such lorries be proceeded with. Compared with horse draught, these trials have shown that self-propelled lorries can transport five tons of stores at about six miles an hour over very considerable distances on hilly average English roads under winter conditions.

Dewsbury.—Much progress has been made with the laying of the new tramlines in the Dewsbury, Thornhill, and surrounding districts. There remains only a very small portion of the route in the borough which has not yet been dealt with, so far as the lines are concerned. Some friction has, however, arisen between the Town Council and the British Electric Traction Company in respect to the new line which is being constructed between Dewsbury and Ravensthorpe. For several weeks complaints have been made to the Dewsbury Corporation of a dangerous corner near the Anchor Inn, Watergate, and on investigation it was reported to the Council that the lines in that particular part of the borough were not being laid in accordance with the original plans

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submitted by the company, and the town clerk wrote the company to that effect. The company, on the other hand, contend that the danger at the point referred to will necessarily be reduced by reason of only a single line being laid down there, and that the work is being carried out in accordance with the regulations of the Board of Trade. They also suggest that if the Corporation will purchase more land and give them £100 towards expenses, they will be prepared to fall in with the wishes of the Corporation. At a special meeting of the General Purposes Committee, sitting as the Town Council, the members declined to accept the offer made, and to at once write the Board of Trade calling their attention to the dangerous corner referred to.

Newcastle.—In his report on the accounts of the Corporation for the financial year ended March 25 last, Mr. Bowden, professional auditor, deals with the electric tramway department, principally with regard to capital expenditure. A portion of the system, he says, was opened for traffic on Dec. 16 last, so that the result of little more than three months' running of a section of the system is included in the annual accounts, and it is, therefore, hardly possible, with sufficient accuracy, to give a statement of profit and loss for the period. The revenue from the cars between Dec. 16, 1901 and March 25, 1902, amounted to £21,347. 4s. 1d. The expenditure amounted to £13,462. 17s. 11d., leaving a balance of £7,884. 6s. 2d., available for the payment of interest and redemption, which amounted to £9,802. 18s. 5d. for that period. A portion of the latter might, however, the professional auditor remarks, be fairly charged to capital in respect of that part of the system remaining unfinished. So short a time having elapsed since the opening of the system, the question of depreciation and preliminary expenses had not, Mr. Bowen understood, been under consideration, but the subject would require the careful consideration of the Council during the current year. Colonel von Donop has visited Newcastle, and made a tour of several of the tramway routes in the city. The chief section inspected was that which has been recently opened—from Barras Bridge to Spital Tongues. In a report on the proposed extensions of the city tramways, the Tramways Committee remark that it is important that the construction of the tramways be commenced at once, and proceeded with as rapidly as possible in order that they may be completed within the times limited by the Act. They recommend the Council to authorise them to carry out the work, and to purchase certain land for the erection of new car-sheds at the west end.

Berlin.—Some very interesting and instructive particulars of the tramway service in Berlin are given by Mr. Dietrich, the municipal engineer, in one of the Berlin daily papers. Statistics are given for last year, from which it appears that during the year 1901 nearly 82,000,000 km. were covered by the tramcars, and 330,000,000 fares were taken. The increase in passenger traffic over the total for 1900 was about 18 per cent. The average number of journeys made per head by the population (2,550,000) of Berlin and the suburbs in the year 1901 was 129. The corresponding totals in other towns of Germany were: Hamburg, population 1,000,000, journeys per head 109; Munich, population 550,000, journeys 95; Leipzig, population 500,000, journeys, 127; Dresden, population 500,000, journeys 148; Frankfort-on-Main and suburbs, population 390,000, journeys 110. But it must be taken into consideration that in the last-mentioned towns there are no special means of transit other than the tramways, whereas in Berlin there are the Metropolitan and Circular Railways, the Wannsee Line, numerous omnibuses and cabs, and of late the Electric Overhead Railway as well. For purposes of comparison, Mr. Dietrich reckons the total passengers in Berlin by all public vehicles as 540,000,000 fares in 1901, which gives an average of 212 journeys in the year per head of the population. Of this total traffic, more than three-fifths is on the tramlines. Since 1900 especially, as a result of the introduction of the uniform 10-pfennig traffic, there has been a rapid rise in the number of passengers. The passenger traffic of Berlin and the suburbs has increased forty-two-fold since the year 1870; or including cab and railway traffic, forty-five-fold. During the same period the use made of the means of traffic per head of the population shows an increase of more than fifteen-fold, whilst the number of residents in Berlin and the suburbs has grown 180 per cent. The total length of the Berlin tramway lines is 864·9 km.

Croydon Tramways Lease.—The *London Gazette* for the 29th ult. contains an important announcement with regard to the lease of the Croydon Corporation tramways to the British Electric Traction Company. It is to the effect that, subject to the approval of the Board of Trade, the Corporation intend to lease to this company the whole of the lines which were completed at the end of last year under the Corporation Act of 1900 for the term of 18 years and seven calendar months from June 1 last. The terms of the lease are set out in detail. In the first place, the lessees covenant to pay the Corporation the clear yearly rent of 6½ per cent. on the capital outlay, and also £100 per mile per annum as from June 1 last for the maintenance of the roads along which the tramways are laid. The company further bind themselves to pay an annual sum equal to 6½ per cent. upon all moneys expended by the Corporation with the consent of the lessees in the construction, or improvement, or renewal, or alteration of any of the works connected with the tramways during the currency of the lease. The lessees further undertake to indemnify the Corporation against all claims, to keep the tramways in proper repair, not to assign or underlet without license from the Corporation, but may transfer to their nominees, subject to those nominees being approved by the Corporation; and to purchase from the Corporation all electrical energy required for the purposes of the tramways. The intended lease also containing the following covenant: power to the Corporation to determine the lease at any date at which the term created by the lease, dated Jan. 23, 1900, of the other tramways by the Corporation to the lessees is determinable. There is also a proviso that the lessees may determine by notice either lease in the event of the Corporation determining one only. In the previous lease, which was for 21 years, the rent payable by the company was fixed at 6 per cent., whereas in the new agreement an annual payment of 6½ per cent. is to be made. Again, whereas it was originally provided that the company should pay 2½d. per unit for their electrical energy under the new lease, they will pay only 2d. per unit.

Torquay.—Following the lead of Wolverhampton and Swansea, this place has decided upon the adoption of a surface-contact system of tramways known as the "Dolter." In a report presented at the last meeting of the Town Council by the deputation which had inspected the various systems of electric traction in England, it was stated that they were of opinion that the conduit system, in consequence of its expense, was not such as they could recommend to be adopted in such a town as Torquay. The overhead trolley system had found most favour in Great Britain, probably because the chief portions of the work were above ground, and could be easily got at and repaired. No doubt where the work was done efficiently to begin with, and all the necessary precautions of guard wires below telephone wires were taken, it was comparatively free from serious accidents. The erection of posts were unsightly, and in some parts the overhead wirework looked like a huge spider's web. To a large extent the objection to the conduit system applied equally to the Kingsland, although in a lesser degree. Should a track be laid along the Torbay-road, they feared the slot would at times be filled with sand and sea-water, and seriously affect the working. The cost of the Kingsland system was given as £6,500 to £7,500 per mile of single track. The deputation, having very carefully considered all the bearings of the question, were of opinion that the surface-contact system with a 3ft. 6in. track was decidedly superior to the overhead for a town like Torquay. They had not been unmindful of the fact that a combination of the surface-contact and overhead systems was possible and was in operation. At the same time such a combination restricted the use of double-decked cars, the alterations from one to the other being easily made where single-decked cars are used, whilst in the double-decked the changing would not be unattended with risk, with the introduction of some complicated appliances on the top of the car. For these and other reasons the deputation recommended the surface-contact system for general adoption in the borough, and of the systems now in actual practical operation the "Lorain" and "Dolter" were those most suitable, in their opinion, for Torquay. Of these two they were further of opinion that the "Dolter" was the more preferable. This report was adopted by the Town Council, as well as a recommendation from the committee advising the Council to arrange for the erection of a new power-house, shaft, and other works for the electric lighting and tram stations at an approximate cost of £17,593.

LIGHTING AND GENERAL.

Morebattle.—Preparations are in progress for the installation of the electric light at Corbet Tower.

Coalville.—The Urban District Council have elected a committee to consider the Electric Power Bill.

Reigate.—The Town Council will apply for sanction to borrow £3,500 for electric supply extensions.

Torquay.—During the past month new electric lights of the equivalent of 381 8-c.p. lamps were connected.

Keighley.—Application is to be made for sanction to borrow the sum of £6,000 required for electricity extensions.

Rotherham.—The Town Council are considering a proposal to join the Sheffield Corporation's municipal telephone scheme.

Madrid.—Messrs. Siemens and Halske have transformed their Spanish and Portuguese agency into a Spanish company.

Heckmondwike.—The District Council have received sanction to the borrowing of £6,500 for additional electricity purposes.

Darlington.—The consideration of the advisability of having the electric light installed at the workhouse has been adjourned.

Dunkirk Lighthouse.—A new electric revolving light has been installed, the flashes of which are visible at a distance of 40 miles.

Rotherham.—The Town Council have deferred giving consent to the application of the Sheffield Corporation for a telephone license.

Pontypool.—The local electric light company are about to reduce the price of electric light for the Mart Hall from 6d. to 3½d. per unit.

Long Eaton.—The Council have confirmed an arrangement with the West End Mills Company for a supply of electric light to the lace factories.

Cromer.—An enquiry has been held into the application of the District Council for sanction to borrow £25,000 for electric lighting purposes.

Dungannon.—Mr. E. G. Cruise, electrical engineer, has prepared plans and specification in connection with the proposed electric lighting of the town.

Newark.—The amended draft agreement with the Derby and Notts Electric Power Company will come before the Sanitary Authority in September.

Bridlington.—The Town Council are applying for sanction to a loan of £25,000 for the purpose of carrying out their electric lighting order of 1900.

Wells.—Further correspondence with regard to lighting the city with electricity is before the Town Council, but discussion thereon has been deferred at present.

Monmouth.—The Town Council have agreed to extend the electric mains in Cinderhill-street, and to wire the borough court and jury room for electric lighting.

Fraserburgh.—At the last meeting of the Town Council the clerk submitted an exhaustive report on the offer recently received to light the town with electricity.

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Bexhill.—It having been decided that the addition to the electric light station is to be of a permanent nature, the surveyor will now prepare the requisite plans.

Felixstowe.—The District Council have appointed a committee to negotiate with the local electric lighting company with a view to purchasing their undertaking.

Llanelly.—The British Insulated Wire Company have notified the Council that they are about to proceed with the electric lighting and traction for Llanelly and district.

Brighton.—The oft-referred-to report of the Telephones Committee, recommending generally the installation of a telephone exchange as soon as possible, has been adopted.

Kildare.—Mr. P. C. Cowan has held an enquiry into the application of the Nass Rural District Council (No. 1) for sanction to borrow £3,000 for an electric supply scheme.

Birkdale and Southport—The District Council have received several letters re the proposed Southport municipal telephone area. Meanwhile the scheme seems to be hanging fire.

Personal.—We understand that Mr. Reginald R. Todd has resigned his position as chief engineer of the Metropolitan Electric Supply Company, and will terminate his engagement next spring.

Manchester.—A recommendation relating to the provision for experimental purposes of arc lamps in Portland-street, Oxford-street, and Cheetham Hill-road will be brought forward at the next meeting of the Council.

Ilkeston.—The Town Council have notified the electric power company that the Corporation would expect the work undertaken by the company to be completed by Nov. 1, when the company must be ready to supply current.

New Premises.—Messrs. James Willats and Son, 19, Gray's-inn-road, Holborn, are opening new showrooms at 29, Gillingham-street, Belgravia, S.W., for electrical and gas light fittings, heating apparatus and sanitary appliances, wallpapers, friezes, etc.

York.—The Electric Lighting Committee have been authorised to put in foundations for new boilers and extensions of machinery at the works to meet the increased demand upon the works. The accounts to March 31 show a revenue of £2,752, and an actual profit.

Worcester.—The General Purposes Committee in their last report recommended the City Council to employ Mr. A. R. Bennett, of Glasgow, to advise the committee as to the desirability of establishing a municipal telephone exchange and the initial and annual cost.

Crewe.—The number of units sold during the last quarter were: for lighting purposes, 39,182; for motors, etc., 41,713; for tramway purposes, 223,146—a total of 304,041, which was an increase of 32,947 units as compared with the corresponding quarter of last year.

Shipley.—The purchase of a Lancashire boiler, mechanical stoker, and other plant for the electricity works at Dockfield has been authorised, subject to the approval of the Local Government Board. The additions are needed to meet the increased demand for electric current.

Kingseat Asylum.—A sub-committee of the Works Committee of the Aberdeen City District Lunacy Board have received tenders for the electrical lighting of the new lunatic asylum at Kingseat, and agreed to remit the matter of lighting to Mr. A. Marshall Mackenzie, architect, for a further report.

Annual Outing.—On Saturday last a large number of the staff and employés of the Sir Hiram Maxim Electrical and Engineering Company proceeded by special train to Margate, where they were welcomed by Sir Hiram and Lady Maxim, who afterwards entertained them to dinner at the Arcadian Hotel.

Holyhead.—The probable cost of the Urban District Council's electric lighting scheme is estimated by Mr. Price White, the engineer, at £16,000, with £750 for emergencies. The Council have resolved to purchase the existing steam mills at a cost of £3,000, subject to the approval of the Local Government Board, as a site.

Bromley.—Application will be made for the insertion of a clause in the Bills of the electric light companies applying for powers to supply electricity in various parts of the Council's district for the protection of the roads, and also for the insertion of an optional clause for the purchase of the undertakings in 7, 14, or 21 years

New Book.—Messrs. Whittaker and Co. will publish shortly a work on "Galvanic Batteries" by that well-known writer on electrical subjects, Mr. S. R. Bottone This book will treat fully upon the theory, construction, and use of electric batteries, comprising primary, single and double fluid cells, secondary and gas batteries, and will contain numerous illustrations.

Diving Bells.—A diving bell and barge, built for the Admiralty for the purpose of laying naval moorings at Gibraltar, has been completed at Wivenhoe. The bell weighs 50 tons, and can be lowered to a depth of 42ft. Telephonic communication is maintained between it and the barge, and the latter is fitted with chambers for compressed air. The bell is lighted by electricity.

Catalogues.—We have received from Messrs. Flather and Co., Limited, Park Electrical Works, Marshall-street, two new price-lists of their multipolar continuous-current dynamos for voltages from 110 to 660 volts, and of enclosed continuous-current motors for all voltages from 110 to 530 volts, and for which they claim an efficiency ranging from 70 per cent. in the small to 91 per cent. in the largest sizes.

South Shields.—The Electrical Committee's last report stated that for the three months ending June 30 the number of consumers was 784, as compared with 710 at the corresponding period of 1901 The value of the current sold during the quarter was £2,224. 5s. 9d., the average price per unit being 4 74d.; meter rents, £91. 8s.; and public lighting, £693. 15s. 3d.—a total of £3,009. 9s., as compared with £2,586. 18s. 2d. for the quarter ending June 30 last year.

New Companies.—The Northampton Street Tramways Company has been reincorporated as a limited liability company (capital, £45,000). The Worcester Electric Traction Company, Limited, with a capital of £120,000, has been registered to carry on in the United Kingdom or elsewhere the business of electrical engineers, electricians, etc. The Slough and District Electric Lighting Company has been formed to take over the electrical lighting order for Slough and Datchet (capital, £50,000).

Dover.—The electric cranes for the quick handling of mails and baggage are expected to be at work on the Admiralty Pier within the next two months The notice to lay a cable from the electricity station to the pier for the electric cranes has been approved, subject to various details being arranged for. The cable will be capable of supplying other customers on the line of route who want to have the continuous current for power, as it is being laid with a capacity three times that required for the pier cranes.

Hartlepool.—The Electricity Supply Committee reported at Wednesday's meeting of the Town Council that, having considered the terms offered by the Hartlepools Electric Tramway Company for electric lighting, the committee did not consider the terms offered such as should induce them to alter the previous report. The report was adopted. Communications in respect to the supply of electric current in bulk are before the Council in committee. The Finance Committee reported that, having considered the application of the West Hartlepool Corporation for permission to include Hartlepool in the area to be included in their municipal telephone license, the committee recommended that in the first instance the license should be limited to the area of West Hartlepool borough. The report was adopted.

Wireless Telegraph Tariff.—It is announced from Rome that Mr. Marconi has arranged a tariff with the Italian Minister of Posts and Telegraphs for wireless telegrams between that country and England and America. The charge for such messages to England is said to be fixed at 12 centimes (about 1¼d.) per word, and to America at 60 centimes (about 6d.) per word. It will thus be seen that the approximate charge for a message between England and America is 4¾d. per word as against 1¼d. between Italy and this country. This agrees very well with the arrangement Mr. Marconi was reported in February last to have made with the Dominion Government of Canada for the transmission of wireless messages between that country and England at 5d. per word. While we think Mr Marconi at this stage of his experiments is somewhat premature in fixing his tariffs for the exchange of commercial messages between the countries named, there can be no doubt that they are remarkably low, and if it were possible for the public to take advantage of them at the present time, the cable companies directly affected would be very hard hit.

Stock Exchange.—The Stock Exchange Committee have appointed Sept. 10 as a special settling day for Willans and Robinson's £105,000 4 per cent. first mortgage debenture stock, and provisional scrip certificates for a further issue of £135,000 4 per cent. first mortgage debenture stock; and Sept. 17 for Cape Town Consolidated Tramways and Land Company's 400,000 shares of £1 each, fully paid, Nos. 1 to 400,000. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the County of London and Brush Provincial Electric Lighting Company's further issue of 10.000 6 per cent. cumulative preference shares of £10 each. The committee has ordered the undermentioned securities to be quoted in the official list: National Telephone Company's £1,000,000 preferred stock, in lieu of the 200,000 preferred shares of £5 each, Nos. 590,001 to 790,000, now quoted; and Willans and Robinson's £105,000 4 per cent. first mortgage debenture stock, in lieu of the 4¼ per cent. first mortgage debenture stock now quoted, and provisional scrip certificates for a further issue of £135,000 4 per cent. first mortgage debenture stock.

Accidents.—An enquiry has been held into the death of an arc lamp trimmer of the Yarmouth Corporation, who had ascended a lamp standard without first cutting off the current by turning the switch at the base. As soon as he reached the lamp frame he received a current with a force of 700 volts and fell, sustaining injuries which caused death within two hours. According to the evidence of the electrical staff, express instructions were given for lamp trimmers to first satisfy themselves that the current was off before ascending a lamp standard, and this was the first case in eight years in which this order had been disobeyed. A verdict of accidental death was returned. An enquiry was also held at Walsall touching the death of a labourer in the employ of Mr. T. Tildesley, of Willenhall, who died on Friday morning from the effects of a fall from a girder Dr P. A. Shore, who had made a *post-mortem* examination of the body, attributed death to a fracture of the base of the skull. The doctor also found two burns upon the left leg of the deceased, and he formed the opinion that it had come into contact with a "live" electric wire, and the shock had caused the deceased to fall. Mr. H. Wyllie, the electrical engineer under the Walsall Corporation, said he could not understand how the deceased could come into contact with the bars charged with electricity. There were "dead" bars in front, which the deceased would naturally take hold of in climbing. He believed the live bars were altogether inaccessible to the deceased, being over 15ft. from the ground. He did not think there could be any leakage from the bars charged with electricity. The jury returned a verdict of accidental death. A serious fire broke out on Wednesday at the works of the Underground Electric Railway Company, Chelsea, for whom Messrs. W. Perry and Co., of Tredegar Works, Bow, are the contractors. The premises involved consisted of a building of two floors, used as offices and stores, the latter containing a large quantity of inflammable material.

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Dundee.—A great improvement has been effected by the recent large addition to the number of lamps along the whole length of the Downfield main road, extending from the electric car terminus at Fairmuir northwards to Gorrie Brae, a distance of nearly 1½ miles. This will have the effect of equalising the lighting at both sides of the road, the lamps hitherto being fixed only along the one side.

Shardlow.—At the next meeting of the Rural District Council a communication from the Stapleford Rural District Council will be discussed relative to the proposals of the Derbyshire and Notts Electric Power Company. It is suggested that each rural district affected by the provisions of the proposed scheme should appoint three members to serve on a commission to deal with the question, so far as it affected the Councils.

Ballymoney.—The Rural District Council have passed the following resolution: "That we have noticed repeatedly the efforts made by the County Council of Antrim to obtain redress from the heavy burden of taxation caused by the Bann navigation, which in our opinion is worse than useless, and would again urge them to unite with the Londonderry County Council in their effort not only to remove the obstruction, but to seek powers to utilise the water power for electric purposes if practicable."

Airdrie.—The streets of Airdrie were lighted by electricity for the first time on Sept. 1. The ceremony of turning on the light was performed by Bailie Ewart, convener of the Lighting Committee, at the distributing station in Craig-street. The current is generated at the Scottish House-to-House Electricity Company's works in Coatbridge, which burgh is also partially lighted by electricity. In Airdrie the electric installation at present consists of 10 arc and over 116 8-c.p. incandescent lamps

Korea.—In August last year Seoul was ablaze with the light from 2,000 incandescent lamps, ranging in candle-power from 16 to 150. Twenty arc lights also flashed up on the grounds and neighbourhood. It was a gala night for the people, and, crowded in the power-house and about the adjoining grounds, 10,000 Koreans watched with amazement the wonderful transformation scene, for the foreigners had changed night into day, and what they might do next was a matter of interesting speculation for the natives.

Gorton.—A proposal to provide an electric light installation for the district, to work in conjunction with a refuse destructor, has been referred to a joint committee consisting of members of the Electricity, Health, and Destructor Committees of the District Council, with a view to formulating a scheme for carrying out the work of electric lighting, and in order to ascertain the best terms on which the Manchester Corporation would accept a lease and pay all the expenses of the Council in obtaining the electric lighting order.

Ebonite.—We are informed that Dr. Heinrich Traun, trading as the Harburg India Rubber Comb Company (Harburger Gummi-Kamm Company), Hamburg and Harburg o./E., has taken his sons, Mr. Heinrich Otto Traun and Dr. Friedrich Adolph Traun, into partnership. The business will be carried on exactly as before, but under the changed style of the Vulcanite Works, Dr. Heinr. Traun and Sons, formerly Harburg India Rubber Comb Company Mr. F. Winter, 8, Redcross-street, remains the company's agent in London.

Belfast.—The following motion is before the Council in committee: "The Postmaster-General having intimated that unless the Corporation establish a *bonâ fide* system of telephones in competition with that of the National Telephone Company within a reasonable period the license may be withdrawn, that it be an instruction to the Law and Improvement Committees to prepare and present a report to the Council, without further delay, as to the establishment of a municipal system of telephones, and, if necessary, to employ expert assistance in the matter."

Norwich.—The Corporation have consented, in accordance with Clause 5 of the agreement between the Norwich Electricity Company, Limited, and the Corporation to the company expending a sum of £7,363 in the undermentioned works—namely, machinery and boilers purchased in 1901 (balance paid this year), £1,157; water-tank, etc, £300; new mains, services, meters, and wiring for new consumers, £5,000; extension to engine-room, £800; shaping machinery, £106—and the Finance Committee are to make all necessary financial arrangements required.

Burnley.—The accounts of the electricity works for the last year show an income of over £600 for sale of current more than last year. The total expenditure was £7,507. 6s. 2d., and as the income was £7,628. 10s. 8d., there was a profit to put to the reserve fund of £121. 4s. 6d. However, the same fund was depleted to the extent of £148. 9s. 6d. for expenditure on change of pressure. The generation of electricity cost £1,691. 14s. 2d., repairs and maintenance £387. 11s., distribution £152. 18s. 5d., management expenses £783. 18s. 3d. The capital sunk in these works is £71,461. 14s.

Earsdon.—The question of public and private lighting in the villages embraced within the Earsdon urban district was discussed at some length at the last meeting of the District Council. A letter was read from the Seaton Delaval District Co-operative Society, stating that the society noted that permission to run wires for private lighting along poles to be used for public lighting had been refused by the Roads and Bridges Committee of the County Council. This decision, however, did not alter the intention of the society to lay down plant and supply electric current for public lighting purposes.

Wallasey.—Application is to be made by the Gas and Electricity Committee for power to borrow the sum of £52,350 for providing for the requirements of electricity works up to the year 1910. This includes £1,140 for 5,200 square yards of land in Seaview-road, Liscard; engine-house, £4,500; boiler-house, £4,000; offices, £500; chimney, etc., £2,000; five boilers and seatings, £3,750; economiser, £1,000; two condensers, £1,500; three 500-kw. direct-current generators, £18,000; fuel stores and elevators, £3,000; transformers, switchgear, and sub stations, £3,500; and seven miles of cable, £5,600.

London Gazette.—The following amended notice has been issued in substitution of that published in the previous issue of the *Gazette*: A receiving order has been made out in the estate of W. Morton (electrical engineer) and W. T. Sampson (mechanical engineer), trading as Morton and Sampson, Trinity-buildings, Corporation-street, Warrington, Lancs., on debtors' petition. The first meeting in the estate of the above will be held to-day, at 2 30 p m, at Official Receiver's Offices, Byrom-street, Manchester, and the public examination on Oct. 3, at 11 a.m., at Court House, Palmyra-square, Warrington

Explosion.—A Reuter's telegram from Cherbourg says: "The accident on board the submarine boat 'Le Francis' occurred in the following manner: A quartermaster, while descending into the vessel, inadvertently turned the handle of the electric accumulators. An explosion at once followed, by which one sailor was badly burned about the face and hands. It appears that on Saturday, after the accumulators had been charged, the vessel was not ventilated as it should have been, the result being that the gases generated by the process were ignited by electric contact on the handle of the accumulators being turned."

Barnstaple.—According to the *North Devon Journal*, Mr. W. H. Trentham is satisfied that the installation throughout the compulsory area will be completed before Christmas, so that the electric light will be available for the Christmas display in the business establishments. The Town Council have decided that electric light shall be installed at the municipal offices and all public buildings in the occupation of the Corporation. The demand for the light among the townspeople greatly exceeds the original anticipation. An objection has been raised in certain quarters to the Town Council undertaking the work of wiring in the case of general customers, and, according to the same source, the threatened opposition to such a reasonable and obviously desirable procedure is keenly resented by the townspeople. In the course it is pursuing the Council has the cordial support of the burgesses generally.

Accrington.—Certain portions of Blackburn-road and Abbey-street are to be lighted by means of arc lights, and an additional feeder main laid in Abbey-street. The engineer in his last report states that the plant generally is in good order. The conversion of street-lighting from gas to electricity is now practically complete to the extent sanctioned, with the exception of lamp globes, which are not yet delivered. The units delivered for week ended Aug. 9, 1902, numbered 1,682; for corresponding period last year, 1,067; being an increase of 615, or 57 per cent The electrical engineer has prepared estimates for taking the electric mains from the main cable in the town hall to the assembly room for cinematograph purposes and also for raising the electrolier in order that it might get out of the line between the cinematograph and the stage screen. Messrs. Simpson and Sons, Hapton, and Messrs R. P Gerland and Co. have been asked to submit tenders for the work.

Kirkby Stephen.—The installation of electrical power for the lighting of the station and sidings of the North-Eastern Railway Company at Kirkby Stephen is now completed, the new power, which is derived from a waterfall on the River Eden, being introduced for the first time on Friday. To provide against a temporary failure in the water supply, however, the North-Eastern Railway Company have, according to the *Birmingham Daily Post*, arranged for an electric motor, which is replacing the present steam-engine for driving the machinery in the workshops, to be driven as a dynamo from the old steam plant, thus keeping the accumulators charged. All the station buildings, locomotive workshops and sheds, signal cabins, and posts are supplied with the electric light, whilst the cattle mounts and turntables are to be similarly illuminated, but by means of arc lamps on iron poles. In course of time, it is stated, the electrical plant will, in conjunction with pneumatic power, be utilised for working the railway signals and points in the Kirkby Stephen marshalling yard. The contractors for the work are Messrs. Gilkes and Co., engineers, of Kendal.

H.M.S. "Assistance."—This ship was formerly a tramp steamer, and has now, at a cost of over a quarter of a million, been transformed into a ship-repairing vessel. All the decks are arranged as factories. There is on the lower deck a cupola for melting pig iron and other raw materials for the making of three-ton castings, with all the moulders' appliances to be found in any foundry. There is a furnace to take steel plates up to a very large size for shaping them to any angle; a steam-hammer has been fitted, with very considerable ingenuity, so as to distribute the shock resulting from the working of the tool. A complete system of pneumatic tools with electric-driven air-compressor, has been installed, and, in addition, there are several large shops full of machine tools, driven from shafting running across the ship at various points, and rotated by electric motors. Some idea of the size of the tools fitted on board may be gathered from the fact that the lathe has a 90in. headstock, and that the beds are 10ft long, while the capstan lathes vary up to 15in. headstock. The hatches are about 25ft. square, so that big jobs may be lifted from or lowered to the various machine shops between decks.

Worthing.—The Electric Lighting Committee have placed on record its cordial appreciation of the work of the resident electrical engineer, the borough surveyor, and their staffs generally in connection with the illumination and decoration of the town hall on Coronation Day, and of the very successful results attained thereby. The resident engineer in his last report states that the machinery at the station continues to run satisfactorily, and that the insulation of the dynamos and motors have been tested by the inspector of the insurance company. Mr. Fernie has resigned his post as assistant engineer, he having

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received an appointment under the Edinburgh Corporation. Mr. Broadhurst, of Bushey, near Watford, has been appointed on trial for a period of two months to the vacant post. The resident engineer is about to report as to the capital and annual cost of lighting Tennyson-road by means of electricity. With a view to obviate the subsequent lifting of the paving to the footway on the north side of Manor-road, between Heene-road and Shakespeare-road, it has been agreed that as new paving is about to be laid in that road the necessary quantity of conduit casings should be obtained at an estimated cost of £30, and put down in the footway on the north side of the road.

Aberdeen.—The Electric Lighting Committee have resolved to recommend the Council to leave the electric charges for services as at present, with the exception of those for lighting, which should be 6d. for the first hour's service and 2½d. instead of 3d., as at present, for all subsequent service, which practically means a reduction of ½d. for the maximum demand. Mr. J. A. Bell, the electrical engineer, in his last report on electric lighting states that the tramway department has become a large consumer; that 172 additional consumers have been coupled up during the year, 45 of which are private residences in the west end. These additions make the total number of consumers coupled 950. Ninety new motors of an aggregate horse-power of 353 have been connected during the 12 months, 65 of these being hired from the Corporation. This brings the total number of motors on their mains to 216, representing 838 h.p. Electrical heating has increased by the equivalent of 621 33-watt lamps; 46 private arc lamps have been added during the year, making the total coupled to date 235. Public arc lamps, including harbour, now stand at 235. The total number of consumers on the mains for lighting, heating, cooking, motors, etc. (not including traction), on July 31, expressed in 33-watt lamps, was 101,473.

Watford.—The Urban District Council have informed the isolation hospital authorities that they would bear the expense of laying the main in that district providing the hospital authorities would pay the remaining cost. The subject of the electrical engineer undertaking professional work has again been discussed, and it has been decided that each application for professional services made to Mr. Colebrook should be brought before the committee and dealt with by the committee on its merits, previous notice to be first given to the committee when such cases arise. The erection of a sub-station at Chalk Hill is to be proceeded with. The committee also recommended that the Highway Committee be requested to grant permission for the paving to be taken up for the purpose of continuing the pipe containing the cable from the boundary in the direction of Bushey. The committee recommended that policies be entered into for the following amounts, as suggested by the electrical engineer: fire—£7,000, to cover plant and buildings, with Messrs. Hinton, Hill, and Coles; accident—£500 each on Nos. 1 and 2 boilers, £800 on No. 3 boiler, £300 on economiser, with the National Boiler Insurance Company. The Council intend to apply for a provisional order to include Aldenham and part of Radlett parishes, together with parts of Bushey rural and Watford rural.

Glasgow.—The Electricity Committee's report with regard to the Kinning Park electric lighting order states as follows: "In accordance with the resolution passed by the Corporation on June 19, 1901, and at the request and with the consent of the Town Council of the burgh of Kinning Park, an application was made to the Board of Trade in the present session of Parliament to authorise the Corporation to supply electrical energy within that burgh. The application so made has been granted by the Board of Trade under the title of the Glasgow (Kinning Park) Electric Lighting Order, 1902, and the Act confirming the order has now received the Royal assent. By the order it is, *inter alia*, provided that the maximum prices which may be charged by the Corporation, as mentioned in Section 32 of the schedule to the Electric Lighting (Clauses) Act, 1899, are to be those stated in the third schedule to the order, but that the prices actually charged by the Corporation to ordinary consumers within the area of supply under the order shall not exceed those for the time being charged by them in like circumstances to ordinary consumers within the city of Glasgow. By the Act confirming the order it is, *inter alia*, provided (1) that, notwithstanding anything contained in the Electric Lighting Acts, 1882 and 1888, or the order, the Corporation shall not be bound to fill up or publish a separate annual statement of accounts of their electricity undertaking in the burgh of Kinning Park, authorised by the order, but the expenditure on the revenue from that undertaking shall, without being separately shown, be included in the accounts of the electricity undertaking of the Corporation authorised by the Glasgow Corporation Electric Lighting Order, 1890; and (2) that the local authority of the burgh of Kinning Park shall not be entitled (unless specially authorised by Parliament) to require the Corporation to sell to them the undertaking authorised by the Glasgow (Kinning Park) Electric Lighting Order, 1902."

Otis and Waygood Amalgamation.—A consolidation has just been effected between the Otis Elevator Company and Messrs. R. Waygood and Co., Limited, with the effect of placing Messrs. Waygood and Co., Limited, in possession of the present and future patents, designs, experience, and goodwill of the vast American lift manufacturing "combine," the Otis Elevator Company, of U.S.A. Secure thus, as regards the British Empire, from the threatening competition of the American company, and possessed of its designs and experience, in addition to the home manufacturing facilities already possessed by Waygood and Co., it seems that the British manufacturer, in this field, at any rate, starts out well equipped for the struggle. The joint business will in future be carried on under the title of "Waygood and Otis, Limited." The name of Waygood has been associated with the highest quality of hydraulic lift and hoist work for the last half century, while to the Otis Company attaches the credit of having introduced and popularised the electric lift in Great Britain. The major portion of lift business in this country has been carried out by these two firms, and many installations in the Royal palaces, Government offices, public institutions, and leading hotels have been almost entirely entrusted to one or other of them. The following may be mentioned as a few of the lift installations recently carried out by one or other of these companies: Buckingham Palace; Bank of England; Colonial and India Offices; Royal stands, Ascot; Speaker's residence, House of Commons; Institution of Mechanical Engineers; Surveyors' Institute; Central London Railway; Salisbury House; Army and Navy Stores; Messrs. Debenham and Freebody; Maple and Co.; I. and R. Morley; Spiers and Pond; Peter Robinson; Wm. Whiteley, etc.; and the following hotels: Brown's, Buckingham Palace, Carlton, Cecil, Claridge's, Coburg, Great Central, Russell, and Savoy, London; Majestic, Harrogate; Empire, Bath; North British Railway Waverley Hotel, Edinburgh; the Gordon and Frederick Hotels, etc. In the field of crane and hoist work installations have been carried out for the following: Bellamy's Wharf; Fresh Wharf; Gun and Shot Wharf; Hay's Wharf; Kennett's Wharf; Mark Brown's Wharf; Lancashire and Yorkshire Railway; London, Brighton, and South Coast Railway; London and North-Western Railway; London and South-Western Railway; South-Eastern and Chatham Railway, etc. Waygood and Otis, Limited, will continue the manufacture of lifts and hoisting machinery in London, as heretofore carried on by Waygood and Co. at their works in Southwark. Mr. H. C. Walker, chairman and managing director of R. Waygood and Co., will be chairman, and together with Mr. R. Percy Sellon, M.I.E.E., managing director of the Otis Elevator Company, Limited, will act as joint managing director of Waygood and Otis, Limited.

PROVISIONAL PATENTS, 1902.

AUG. 25.

18609. Improved trolley head for overhead electric traction. A. Lester Taylor, 36, Dale-street, Liverpool.

18637. A new or improved electric post, being a method of and means for the collection, transmission, and delivery of letters, parcels, and the like. Robert Taeggi-Piscicelli, 33, Chancery-lane, London. (Complete specification.)

18651. Improvements in or relating to electric switches, plug sockets, and the like. Francis Gibson Baily, 111, Hatton-garden, London.

18655. Automatic switch for electric pumps. Richard Collings and Alfred Chalkley Griscom, 6, Breams-buildings, Chancery-lane, London. (Complete specification.)

18685. Improvements in electrical measuring devices. Arthur Thomas Cooper, de Montfort Island, Reading, Berks.

AUG. 26.

18696. The electro-chemico process of printing newspapers, posters, sheets, books, and the like without the use of ink. Alfred William Turner, 67A, Corporation street, Birmingham.

18708. Improvements in handles of brake levers for electric cars, motors, or road vehicles, or the like. William James Green, 67, North-road, St. Andrews, Bristol.

18727. Improvements in mechanism for cleaning grooved rails used as permanent way for light railways, electric tramways, and the like. George Grant, 114A, Chancery-lane, London.

18731. Improvements in electrical contacts. Frederick John Esmond, 149, Lewisham-road, Lewisham, London.

18744. Improvements in controller regulators. Reginald Haddan, 18, Buckingham-street, Strand, London. (The Electrical Device Company, United States.) (Complete specification.)

18747. Improvements in automatic telephone exchange mechanism. Reginald Haddan, 18, Buckingham-street, Strand, London. (The Strowger Automatic Telephone Exchange, United States.) (Complete specification.)

18766. Improvements in alternating-current electricity meters. Sebastian Ziani de Ferranti and William Hamilton, 18, Southampton-buildings, Chancery-lane, London.

18771. Improvements in controlling or limiting the play of electric collectors. Christopher Tatham, 55, Chancery-lane, London.

18777. Improvements in and relating to trolley holders for overhead conduit systems. Albert Thode, 45, Southampton-buildings, Chancery-lane, London.

18782. Improvements in or connected with lifeguards for electric cars and the like. Ambrose Mitchell Martin and James Tennant, 6, Lord-street, Liverpool.

18786. Improvements in electric arc lamps. Hugo Bremer, The Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London.

AUG. 27.

18793. Improved means for synchronising alternating electric current machines. Michael Birt Field, 121, West George-street, Glasgow.

18808. An improved electric belt for medical purposes. Ebenezer Smellie, 100, Wellington-street, Glasgow. (Complete specification.)

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18816. Improvements in commutators for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Hermann F. T. Erben, United States.)

18817. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William O. Mundy, United States.)

18818. Improvements in electric transformers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter S. Moody, United States.)

18819. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles C. Badeau, United States.)

18820. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry G. Reist, United States.)

18821. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.)

18824. Improved electric glow lamps. Stephen Horvath, 181, Carlingford-road, West Green, London.

18831. Improvements in safety fuses for electric conductors. John Robert Quain, 65, Chancery-lane, London.

18854. Improvements in trolley catchers for electric cars. Phelan McCullough, 6, Lord-street, Liverpool.

18858. Improvements in measurement of the energy of electric currents. William Stanley, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18859. Improvements in the generation and distribution of electrical energy. William Stanley and John Forrest Kelly, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUG. 28.

18865. An improved transparent cover for contact breaker of motors. William John Graham and Sidney Charles Graham, Parade Cycle Works, Enfield Town, London.

18870. Improvements in electric generators. Miles Walker, 7, Skerton-road, Old Trafford, Manchester

18872. Improvements in and relating to electrical switches. Harry William Cox, Brougham-chambers, Nottingham.

18886. An improved means for regulating the electric current employed in joining the carbon filaments of electric incandescent lamps, mine firers, or the like, to the connecting wires by means of electrolysis. Leopold Gans, 15, Took's-court, Cursitor-street, Chancery-lane, London.

18901. An improved portable electric hand fan. Eadley Stanley, 25, Gower-street, London.

18903. Improvements in or connected with electric tramway rails. Harry Sebastian Halford, 37, Nevern-square, Kensington, London.

18920. Improvements in the manufacture of insulated or covered wires and in machines therefor. Charles Martin, 139, Queen Victoria-street, London.

18922. Improvements in electric meters. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

18923. Improvements in direct-current electricity meters. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

18924. Improvements relating to variable-speed driving mechanism for electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

18925. Improvements in or relating to rheostats for starting electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

18926. Improvements in electrical transformers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

18931. Improvements in high-potential insulators. George Cecil Dymond, 6, Lord-street, Liverpool. (The Karlsbader Kaolin-Industrie-Gesellschaft, Austria. (Complete specification.)

18933. Improvements in safety appliances or trolley catchers for electric cars. George Comer Milnes, 6, Lord-street, Liverpool.

18958. Improvements in or pertaining to apparatus adapted for indicating, or for opening or closing a circuit of change of the direction of flow of electrical energy. Leonard Andrews 46, Lincoln's-inn-fields, London.

AUG. 29.

18966. Improvements in connection with swivelling trolley heads for electric locomotives, cars, or trucks. Thomas Ernest Raymond Phillips and Frederick Alexander Moore Allingham, Finsbury-pavement House, London.

19009. Improvements in electrically insulatory wall plates and the like. Joseph Tott, 27, Chancery-lane, London. (Robert Müller, Germany.)

18985. Electrical system and apparatus for automatically or otherwise controlling tramway and railway points, and also trolley wire points at junctions or branches. Harry Chapman, 34, Meersbrook-road, Heeley, Sheffield.

19013. Improvements in cut-outs or fuse boxes. Edwin Percival Allam, 11, Hatton-garden, London.

19032. Improved system of control for multiple-unit electric trains. Thorsten von Zweigbergk, 18, Southampton-buildings, Chancery-lane, London.

AUG. 30.

19048. Improvements in electric resistances. Hans von Kramer, 121, West George-street, Glasgow.

19079. An universal pivot joint for electrical light fittings purposes. Robert Walter Braham, 60, Red Lion-street, Clerkenwell, London.

19097. Improvements in apparatus for breaking electric arcs. Callender's Cable and Construction Company, Limited, and Harold Hastings, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 18.

1901.

16979. Electric switch. Davis and Palmer.

17215. Construction of insulators for supporting overhead trolley lines and the like. Quin and Simpson.

17256. Connecting of electrically-propelled cars. Siemens Bros. and Co., Limited, and Siemens.

17282. Incandescent electric lamps of the "Nernst" type. Drake and Ram and Nernst Electric Light, Limited.

17357. Trolley arms for electrical conductors. Hunter.

17363. Luminous press button for electric bells for indicating when the attendant is coming. Dauvey.

18314. Means for measuring the energy of three-phase alternating-current circuits. Conrad. (Date applied for under International Convention, Feb. 14, 1901.)

18840. Drying air by means of electricity. Coffin.

19088. Electric igniting devices for explosion motors. Mauguin.

19973. Brushes for dynamos and the like. Matthews and Davies.

20294. Track construction of conduit electric railways. Chapman.

20406. Trolley heads for electrically-propelled vehicles. Walsh and Leigh.

21433. Electric heating apparatus. Smith and Watts.

21565. Electrical switchgear. Ruthven-Murray and Ferranti, Limited.

22200. Electrical systems for operating signals, points, belts, and other railway and like apparatus. Boult. (Neelemans.)

22219. Electric telegraphy. Murray.

23131. Conduits for electric railways and tramways. Cornwallis-West.

1902.

12738. Means or apparatus for effecting an all-glass seal between the stem which carries the filament of an incandescent electric lamp and the enclosing bulb. Swan.

12739. Bases for incandescent electric lamps, and means or apparatus for manufacturing same. Swan.

14772. Liquid starting apparatus for electromotors. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktiengellschaft.)

14790. Armature winding for electric motors or dynamos. Johnson-Lundell Electric Traction Company, Limited. (Lundell.)

14883. Telephonic intercommunication systems. Aitken.

15037. Posts for supporting telegraph wires, cables, and the like. Griveaud.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-½
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Insulated Wire, Ord., 1-70,000	5 ..	7¼-7¾ xd
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	103-105
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1¼-1⅜
— Non. Cum., 6 per cent. Pref.	2 ..	1¾-2
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103 xd
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16¼
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2¼-3
—— 5 per cent. Debentures	100 ..	101-106 p.c.

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Name.	Amount paid.	Last price.
Edison and Swan United, "A" Shares, 1-99,261	3	¼-⅜
—— "A" Shares, 01-017,139	5	1½-2½
—— 5 per cent. Debentures	100	78-83
—— 4 per cent. Deb. Stock, Red.	100	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10½
—— 4 per cent. 1st Mort. Deb. Stock	100	100-103
W. T. Henley's Telegraph Works, Ordinary	5	16-17 xd
—— 4½ per cent. Preference	5	5½-5¾ xd
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	4¼-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13-14 xd
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12½-13½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12¼-13
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅛-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	103-106
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-400,000	1	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	96-99
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	10¾-11¼
—— " " " " " "	5	8¼-8¾
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	108-110
—— " " Prov. Crts.	50	81-83
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11½-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8½-9½
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	14s.	¾
—— £50,000 " "	1	1
—— £500,000 4½ per cent Debenture Stock	70 p.c.	70 p.c
Telephones.—		
National Telephone, Preferred	100	93-95
—— Preferred, 590,001-790,000	3½	—
—— Deferred Stock	100	55 57
—— 6 per cent. Cum. First Pref.	10	12-13
—— 6 per cent. Cum. Second Pref.	10	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	4⅞ 5⅛
—— 3½ per cent. Deb. Stock, Red.	100	96-99
—— 4 per cent. Deb. Stock, Red.	100	102-106
Oriental Telephone and Electric Company	1	15/16-1 1/16

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	103-106
Bournemouth and Poole, Ordinary	10	11½-12½
—— 4½ per cent. Cum. Pref.	10	9¼-10¼
—— Debenture Stock, Red.	100	101-104
Brompton and Kensington, Ordinary	5	10-10½
—— 7 per cent. Preference	5	10-10½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7-8
—— Nos. 20,001-30,000	5	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " " £10 Ord.	6	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-108
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5¼-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	106-107
Chelsea Electricity Supply	5	5¼-5¾
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	9-10
—— 6 per cent. Cumulative Pref.	10	12-13
—— 5 per cent. Debenture Stock	100	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	102-105
County of London and Brush Provincial, Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6¼-6¾
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4-4¼
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¾-6¼
—— 4½ per cent. First Deb Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10¼-11¼
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	3	1¾-2¼
—— 6 per cent. Pref.	5	4¾ 5¼ xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15-16
—— 4½ per cent. First Mortgage Debenture Stock	100	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9½
—— Preference	4	6¼-6¾
Notting Hill Electric Lighting	10	13¼-14½
Oriental, 1879	1	—
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	97-100
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¾-3
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8¼-9¼
—— 3½ per cent. Deb.	100	97-100
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	5¾-6¼
Electric Railways.—		
Central London, Ordinary	100	103-106
—— 4 per cent. Pref.	100	104-107
—— " " deferred	100	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	72-74
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " " '96	100	126-129
—— " " " " '01	100	121-125
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	80-83

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week ending	1902.	1901.	Increase or decrease. Week	Current year.	Miles of single track open. 1901.	1900.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug.	—	—	—	—	18	—	May 31	—	—	266,552	—	10·51	—	—
Birmingham Tramways	" 30	4,997	4,626	+ 371	+12,259	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	22½	—	—	—	—	1,140,000	—	—	—	—
Blackburn Corporation	" 29	872	794	+ 78	+ 3,431	24	—	—	26,064	—	738,557	—	11·86	—	—
Blackpool Corporation	" 23	2,068	1,768	+ 300	− 650	16½	—	Mar. 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	" 30	1,564	1,154	+ 410	− 854	16½		Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 31	1,662	1,447	+ 215	+ 4,492	52			77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	" 31	3,479	1,185	+2,294	+65,232	61	—	Mar. 31	79,213		1,530,531	—	11·00	1,159	7·57
Bristol Tramways Company	" 29	5,060	3,759	+1,510	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	" 30	232	206	+ 26	+ 409	—	—	" 31	8,675	2,010,373	325,044*b*	1·03	6·46	—	4·65
Central London Railway	" 30	5,632	5,412	+ 220	+ 5,135*b*	12	12	" 31	335,046	4,123,734	1,243,739*b*	1·95	64·6*a*	27,900	34·1*a*
City and South London Railway	" 31	2,537	1,932	+ 585	+ 3,117	12½	9½	" 31	62,691*a*	7,000,842*a*		2·15	—	5,010	—
Cork E. T. and L. Company	" 28	895	527	+ 368	+ 3,915	15	15·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—			" 31	11,845	2,905,323	270,523	0·978	10·50	2,630	—
Dover Corporation	" 30	319	307	+ 12	+ 115	4½		Dec. 31	5,553	362,484	101,464	3·68	13·20	769	8·08
Dublin & Lucan Electric Railway	" 31	163	153	+ 10	− 68*b*	7½	6½	" 31	246,255	45,813,734	6,670,000	1·29	8·89	—	5·71
Dublin U. T., electric cars	" 29	4,434	4,120	+ 314	− 429	46	46	May 15	26,053	6,303,412	446,350	0·98	14·0	1,180	—
Dublin S. District, Electric	" 29	1,678	1,520	+ 158				" 31	90,392	22,060,891	1,319,977	0·875	14·6	780	6·64
Dundee Tramways Company	—	—	—	—	—	22		" 31	54,959	13,173,024	1,063,764	1·00	12·4	1,960	9·67
Glasgow Corporation	" 30	12,505	13,089	− 1,429	—	105	87	Mar. 31	49,011	7,624,865	1,001,033	1·54	11·7	—	13·90
Halifax Corporation	—	—	—	—	—	27½	18½	" 31	72,331	17,264,013	1,647,026	1·00	10·54	—	4·72
Huddersfield Corporation	" 30	1,176	993	+ 183	—	—	—	Dec. 31	—	—	10,970,063	—	10·32	—	—
Hull Corporation, E. S.	" 30	1,776	1,651	+ 121	+ 1,591	—	—	" 31	82,918*c*	10,815,673*c*	1,022,832*c*	1·84	19·45	5,350	14·02
Liverpool Corporation	—	—	—	—	—	93	78	—	—	—	—	—	—	—	—
Liverpool Overhead Railway	" 31	1,650	1,670	− 120	− 1,066	15½	15½	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	" 30	2,253	1,162	+ 1,096		29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Sept. 1	4,204	—	—	—	46½	—	Mar. 31	191,837	49,176,631	3,791,993	0·93	11·82	4,150	—
Southampton Corporation	—	—	—	—	—	11	—	" 31	23,373	4,761,119	696,159	1·45	9·98	2,630	—
Sunderland Corporation	" 1	1,530	1,180	+ 350	—	17	—	" 31	57,397	13,569,868	1,170,207	1·01	11·76	3,380	6·31

(*a*) Train mile. (*b*) Half-year's figures. (*c*) Include rail and tram.

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NOTES.

Northampton Institute.—Work at the above institute will be resumed towards the end of this month, when the session 1902-3 will be opened. The evening courses and classes in all technological subjects will commence on Monday, the 22nd inst., and the day courses in engineering on Monday, the 29th inst. In the electrical engineering department instruction is given in electricity and optics on Mondays and Fridays, in heat on Wednesdays, and in laboratory work on one evening per week. The lecturers are Dr. R. M. Walmsley (the principal), Dr. C. V. Drysdale, and Mr. E. Kilburn Scott.

Influence of Voltage on the Formation of Ozone. When a small E.M.F. is applied to an ozoniser, no ozone is formed, but as the E.M.F. is increased, ozone begins to form at a certain point, and a further rise of E.M.F. causes a very rapid increase in the amount of ozone formed. When the E.M.F. is high, the power of the current to produce ozone is proportional to the square of the potential difference which exists between the armatures. As this law is not applicable until a certain E.M.F. is reached (which depends on the size of the apparatus), Mr. A. Chassy in a recent paper introduces the idea of a dielectric inertia to explain the irregularity.

International Fire Exhibition.—In order to assure the international character of the proposed International Fire Exhibition at Earl's Court next year, we are informed that the British Fire Prevention Committee has arranged with its foreign corresponding members for the formation of local committees in the countries principally interested in the question of fire protection. The following are among those countries which will co-operate in carrying out this scheme: Austria, Belgium, Denmark, France, Germany, Holland, Italy, Portugal, Russia, and the United States. The acting secretary is in attendance daily from 11 till 1 p.m. at the offices of the committee, 1, Waterloo-place, to which all enquiries should be directed.

Depolarisation of the Hydrogen Electrode.—The difference of potential between a platinised platinum electrode saturated with hydrogen and a normal solution of sulphuric acid (or potassium hydroxide) containing some 10 per cent. of alcohol is diminished considerably by the addition of a reducible substance to the solution. The magnitude of the diminution is regarded as a measure of the facility of reduction of the compound used. Experimenting on the subject recently, Mr. A. P. de Bottens found that the 53 compounds used gave the following diminution of potential difference in acid solution: nitroso compounds, 0·64 to 0·5 volt; mononitro compounds, 0·33 to 0·23 volt; nitrosoamines and *iso*diazo hydrates, 0·16 to 0·09 volt; diazonium compounds, 0·47 to 0·37 volt. Normal diazotates do not depolarise. Of the dinitro derivatives of benzene used, the ortho compound gave the largest depolarisation; other similar regularities were not observed.

Telephonic Communication with Belgium.—No definite date has yet been fixed for the opening of the new telephone between London and Brussels, but it is hoped that the direct communication will be available between these two places within a few weeks. The cable has already been successfully laid, and the lines connecting it with London have also been completed. It crosses the North Sea between St. Margaret's Bay, near Dover, and the little Belgian watering place of La Panne. We understand that the delay in throwing the line open for public use, is due to the fact that the agreement as to the working arrangements has not yet been concluded between the representatives of the two countries. It may be of interest to state that when the line is opened the public in London will be able to communicate with people in Brussels from their own houses, but this only applies to subscribers to the Post Office system. The charge for a three minutes' conversation will probably be 8s.—the same as for the Paris telephone.

Electric Railways in Italy. — It is officially announced that the new electric railway on the Ganz system was opened to traffic on the 4th inst., between Chiavenna, Colico, and Sondrio, in North Italy. The new line is about 50 miles, and for the first 20 miles runs along the east side of Lake Como to Colico. It then branches off in a right angular direction through the hills to Sondrio. The electrical energy for the line is derived from the Falls of Adda, which are situate about 10 miles from Sondrio and 20 from Colico. The power is transmitted at a voltage of 20,000, and reduced to 3,000 at sub-stations, at which potential it is supplied to the motors. From the same source power will also be obtained for the Lecco-Colico line when it is opened soon. This line is about 25 miles in length, and runs along the east side of Lake Como the whole way. With the line just opened it will form a direct connection between Chiavenna at the north and Lecco at the south of the lake, a distance of about 50 miles, allowing for deviations in the line of route.

Electric Railway Working in Germany.—The German State railway authorities announce the conclusion of the experiments which have been going on now for more than two years with an electric train on the Wannsee Railway, near Berlin. From what we can gather, it is not that the trials have proved unsatisfactory, but that the conditions under which the electric train was required to work were most unfavourable to its complete success. It had to contend with a service of steam trains on the same line, and it was therefore impossible to arrive at a fair comparison of the operating expenses. We understand, however, that another experiment is to be made next year by the removal of the steam trains on the section between Potsdam and Gross Lichterfeld, and the substitution of a regular service of trains driven by electricity. Each train will consist of three motorcars, and will have a total seating capacity for 206 passengers. It is reasonably expected that these trials will yield far more satisfactory results than those obtained from the tests just concluded.

Electrolysis of Aqueous Solutions.—In a paper on the electrolysis of solutions with platinised electrodes and the electrolytic formation of dithionates, Messrs. F. Foerster and A. Friessner give the following short review of the results of their experiments: When a solution of sulphuric acid or sodium hydroxide is electrolysed with platinised electrodes at a constant temperature and with the same strength of current, the difference of potential at the terminals and the anode potential gradually increases, whilst the difference (in volts) between the two remains constant. The cathode potential does not alter during the electrolysis, and the anode has the higher potential immediately the cathode becomes slightly polarised, showing that the phenomenon is due to small quantities of oxygen. This result is illustrated by the electrolysis of sodium sulphite. No oxygen escapes on the anode, and some SO_3 ions combine, forming S_2O_6 ions, whilst some combine with hydroxyl ions, forming SO_4 ions and water. Several experiments were tried, in the most successful of which 47 per cent. of the current was utilised in the formation of dithionate.

American Pacific Cable.—From our American contemporaries we learn that President Roosevelt has at last consented to authorise the Pacific Commercial Cable Com-

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pany to lay a cable across the Pacific to the Philippines. This decision of the elected head of affairs in the United States will have the effect of putting an end to the conflict which has raged for years among rival cable companies in America as to who should have the right of laying a cable to the Philippines. The proposed route is from San Francisco to Guam, and thence to Manila, and the esti mated time of laying the cable is about 14 months. At present all cable messages to the Philippines go over an English line from Hong Kong, the English company having a franchise monopoly granted by the Chinese Government. It is stated that under the favoured nation clause of the treaty between the United States and China the American Government have the right to claim a similar franchise for an American cable company, and advantage will likely be taken of this treaty relation. By getting a terminal in China the cable company, it is estimated, would obtain 700 miles of new lines. The proposed Pacific cable would then connect with the Atlantic cable lines in China, some of which are in the hands of American concerns.

Conductivity of Aqueous Solutions of Electrolytes. In some recent experiments to determine the conductivity of aqueous solutions of electrolytes, consisting of univalent ions, Messrs. F. Kohlrausch and H. von Steinwehr examined the following salts: cæsium chloride, thallous chloride, potassium iodide, potassium bromide, potassium thiocyanate, potassium fluoride, sodium fluoride, thallous fluoride, thallous nitrate, silver nitrate, and potassium chlorate. The behaviour of thallous chloride differs from that of the chlorides of the alkali metals; the equivalent conductivity increases more quickly with rising concentration above 0·001 N, and this is connected with the power of thallium of occurring in a polyvalent form. Thallous nitrate behaves quite normally, and at higher concentrations thallous fluoride is also quite normal. In dilute solution, however, thallous fluoride behaves anomalously, indicating that hydrolysis takes place. The conductivity of very dilute solutions of silver nitrate between platinised plates increases with time, but solutions which are more than 0·01 N do not show this change of conductivity with time.

The Telephone at Battersea.—In pursuing their commendable policy of extending their new telephone system into the areas under the jurisdiction of the metropolitan borough councils, the Post Office have many difficulties to contend with, in particular that of obtaining the consent of the local authorities to the laying of the pipes in certain streets. A case in point has arisen at Battersea, where the engineers of the Post Office and the Borough Council cannot agree as to the laying of a short piece of pipe which would establish a connection between the Post Office and National Telephone Company's exchanges, to the mutual benefit of the subscribers to both systems. The effect would undoubtedly be greatly to enhance the value of telephonic communication to the inhabitants of Battersea and London generally, yet from some cause at present unexplained the Council are withholding their permission for the laying of the cable which would enable this great improvement to be carried out. In the circumstances the Post Office have determined to apply to the local county court judge to settle the difference, but in the meantime the Borough Council have convened a conference of representatives of the Corporation of London and metropolitan borough councils for the 23rd inst., and on their deliberations will largely depend the future course of action of the Battersea Council in the matter.

The Smoke Nuisance.—The extent to which this evil has grown in and around London is at present occupying the serious attention of the Public Control Department of the London County Council, as is shown by the annual report of the chief officer just issued. To summarise the figures, it is shown that the action taken under the Public Health Act by the London County Council and by the metropolitan borough councils during the year ended March 31 last has resulted in 819 cases of nuisances being reported, of which 541 were regarded as serious. Legal proceedings were taken, however, only in 225 cases, the total amount of penalties imposed being £551. The Public Health Committee are now considering how they can increase their powers in this matter, and it is suggested that the special section of the Act should be so worded as to cover any serious emission of smoke from a chimney. Also, it is proposed to impose a direct penalty of not exceeding £10 for the first offence, to be increased for subsequent offences. It is thought that the adoption of heavier penalties will go a long way in helping the authorities to keep the smoke nuisance in London under better control. The report also shows that under the same Act procedings were taken in regard to 74 cases of smoke nuisance arising from railway locomotives, the worst offenders in this respect being the South-Eastern and Chatham Railway Company, who contributed just one-half of the cases.

Obituary.—By the death of Sir Frederick Abel, the distinguished chemist, at the ripe age of 75, a remarkable career in the service of science is brought to an end. The office he held for a longer period than any other was that of chemist to the War Office—a position which he filled for 34 years. His official duties in this capacity naturally led him to devote attention to the study of explosives for military purposes, and thus he became concerned in some of the most important developments that the latter part of last century witnessed in the manufacture and use of ammunition. It was Sir Frederick Abel who, in conjunction with Prof. Dewar, patented the substance which is now the standard powder of the British services, and which is known as cordite. He also in later years had a lot to do in the framing of regulations as to the use of petroleum and other mineral oils as a means of domestic illumination. Sir Frederick Abel received recognition of his scientific work from many quarters. Elected a Fellow of the Royal Society in 1860, he was awarded a Royal medal by that body in 1887. At various times he served as president of the British Association, the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, and the Institution of Electrical Engineers. Of the Iron and Steel Institute he was elected president in 1891, as a recognition of his scientific contributions to the chemistry of iron and steel, and he was awarded its Bessemer medal in 1897.

Electrical Equipment of the Mersey Railway.—Particulars are to hand of the generating plant which the Mersey Railway Company are putting down in connection with the electrification of their system. The main generators and engines, as our readers know, have been built by the Westinghouse Company at their East Pittsburg works, and they are now nearly all delivered in this country. The generators are of the railway type—1,200 kw., 650 volts, 90 revolutions per minute—and are to be direct connected to vertical cross-compound Westinghouse-Corliss engines of 1,500 h.p. each. The power-house lighting and the electric light of all stations and sidings will be supplied from a separate generating plant, comprising two compound-wound generators, each having a capacity of 200 kw. at 650 volts, direct connected to Westinghouse compound engines, and running at a speed of 250 revolutions per minute. The power generating plant

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will have an aggregate output of about 6,600 h.p. The Westinghouse electro-pneumatic system of train control is to be used, and the cars will be equipped with high-speed air brakes. Some 60 cars, each about 60ft. in length, will comprise the rolling-stock. Each train will consist of five cars, the first and last cars being each equipped with four 100-h.p. motors. The conductor rail of the third-rail system is to be laid alongside and just outside of the running track, a fourth rail being laid between the running rails for the return current. It is expeeted that the railway will be working electrically inside of six months from now.

Alternating-Constant-Current Circuits.—A patent has been granted in the States to Mr. W. S. Moody relating to alternating-constant-current arc light circuits, the invention consisting of a means for avoiding injurious effects arising from grounds on a circuit, including a Thomson constant-current transformer. This is accomplished by causing the current to pass first through one portion of the transformer or reactive winding, then through the lamp circuit, and finally through the other portion of the winding. To still further guard against bad effects from grounding, the neutral point of the supply circuit is permanently grounded, either at the generator or through the middle point of a transformer primary. The above-mentioned method of winding the constant-current transformer also admits of the attachment of a simple device for indicating when a ground comes on the circuit. Another patent, taken out by Mr. J. F. Kelly, describes an arrangement whereby an alternating-constant-current circuit may be maintained without the accompaniment of low power factor affecting the supply circuit, as when a reactive transformer is employed. The system consists of a synchronous motor driving an alternating-current generator, so designed as to maintain automati cally a constant current in a circuit of varying impedance, such as a series arc lamp circuit. Though the power factor of the lamp circuit will be low at light loads, the main supply circuit will not be affected, the motor operating just as it would with any corresponding load of a mechanical nature.

Sterilising Water by Ozone.—Mr. H. J. Van't Hoff recently presented to the German Bunsen Society an interesting paper on the Vosmaer-Lebret system of sterilising water on a large scale by means of ozone. The system has now been in use commercially at Schiedam for about six months for eleven hours a day without interruption. An alternator gives alternating current at 110 volts and 100 periods and a transformer raises the voltage to 10,000, at which tension the current is supplied to the ozone apparatus; one pole of the same is earthed. The ozone is formed by means of dark discharge, without any solid dielectrics. Through the ozoniser the dried air is driven at a speed of about 40 litres per minute; a concentration of 3·5 mgr. to 5 mgr. of ozone per litre is obtained. For sterilisation purposes a concentration of 3 mgr. to 3·5 mgr. has been found to be sufficient. The ozonised air is then pumped into the steriliser, which it enters at the bottom and leaves at the top. The coarse impurities of the water are filtered off by means of a quick filter, before the water is sterilised by the ozone. The author give some details of various tests. The sterilising result is said to be at least as good as with other ozonising systems, as a brief comparative table of such systems shows. The cost of ozonisation is said to be from $\frac{1}{3\frac{1}{2}}$d. to $\frac{1}{16}$d. per cubic metre. The cost of installation is not given, as it is said to depend upon the local conditions. Sterilisation by ozone is generally superior to central sand filtration. It is proposed to introduce ozonisation at the waterworks in Rotterdam.

Electroplated Lace.—In depositing metal electrolytically upon a non-conducting base, it is, of course, essential that a conductive surface be afforded, and this is usually accomplished by the chemical precipitation of a thin layer of silver or other metal, or by the mechanical application of graphite or metal powders, often with the aid of an adhesive binding medium. Such coatings, and especially the highly perfect ones, formed by the chemical precipitation of silver are of a high degree of tensity, and, therefore, of high electrical resistance, from which it follows that even with the low density currents used for electroplating the deposit cannot take place evenly over any extended surface. The important point, therefore, in securing a perfect cathode connection to work of this character is the number of the contacts. Mr. C. P. Townsend, in the *Electrical World* for the 1st ult, describes a simple arrangement for electroplating lace, consisting of an open-meshed basket of copper wire, upon which the lace, suitably prepared with a conductive coating, is stretched. The contrivance is the invention of Mr. J. A. Daly, of Washington. Fine copper wire is wound in coils around the basket and over the lace in such a manner as to secure the fabric, and to provide a number of contacts, which must be greater in proportion as the mesh of the lace is more open. Deposition is said to proceed evenly over the entire surface, and it is claimed that the simplicity of the manipulation effects a saving of 90 per cent. of the time usually required for wiring. The deposition should proceed under these conditions for a few moments only, the object being merely to stiffen the fabric by a preliminary deposit in order that it may be hung in the bath from the usual supports to receive the final and heavier coating.

Electrical Progress in Russia.—In Russia hitherto the transmission of electrical energy to considerable distances has not been seriously considered, nor has the development of water power been taken in hand with any degree of avidity. It is announced, however, that the Russian Government have lately granted a company a concession to supply electrical power to St. Petersburg from the Volhov Rapids, the scheme involving an estimated cost of nearly three millions sterling. The maximum transmission distance is 188 miles. The company, it is said, has undertaken to provide public lighting in the Russian capital gratuitously in return for the concession granted it. In other directions, also, Russia is showing signs of considerable progress in the use of electricity. For traction purposes electricity was first employed in Russia, at Kief, in 1893, and five years later 45 cities had constructed electric tramways, their total length exceeding 312 miles. There are several projects at present under consideration for the employment of electric traction on some of the great railways of Russia. Included in these is one which aims at the construction of an electric railway to connect neighbouring towns on the western frontier of Russia. In regard to electric lighting, it is only in the past few years that such cities as St. Petersburg and Moscow began to have their streets lighted by electricity. At the present time there are more than 50 towns which use electric light, and many other places are putting down electric lighting plants. In view of the good progress Russia is making in the application of electricity, it may reasonably be anticipated that the market for electrical machinery and appliances in that country will considerably increase in the next few years. Most of the electrical appliances for Russia are supplied by German firms, who at present are in possession of the field there.

An X-Ray Phenomenon.—*L'Industrie Electrique* recently described a very interesting phenomenon which was noticed by Mr. M. R. Blondlot while working with

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a sparking coil in the neighbourhood of an X-ray tube. The effect noted is of importance in that it differs from that discovered by Mr. Swyvgedauw in 1896, that X-rays increase the sparking distance of a coil for a given potential. The apparatus used in the experiment consisted of an induction coil connected to two copper bars, each about 15 cm. long, with points filed smooth and arranged so that the gap between them could be varied. Beside this, and parallel to it, was placed a Crookes tube operated by an induction coil. At each discharge of the tube, a small spark passed between two copper rods, which in this experiment were placed very close together. Placing a lead sheet between the tube and the spark-gap modified the character of the spark. It then assumed the aspect of a small reddish glow. By properly adjusting the distance between the sparking points, this discharge took place perfectly regularly. When the sheet of lead was removed, the spark assumed its first character, being white and bright. To show that this effect was not due to induced charges on the lead plate, a plate of aluminium was substituted for this, but it was not observed to have any effect upon the character of the spark. That the effect was not due to static charges, was proved by the fact that the Crookes tube was connected directly to the sparking apparatus. The effect in this case was the same as before. The explanation given for this phenomenon is that the effect of the X-rays is to reduce the resistance of the air-gap, so that a greater quantity of energy passes across the gap at discharge. To observe this phenomenon, the gap must be very small, otherwise the discharge would heat the air sufficiently to reduce the resistance of the gap, and in this way mask the effect of the X-rays.

Electric Tramways for Melbourne.—The engineer-in chief for railways in Australia, Mr. Rennick, has submitted to the Government a scheme for the construction of a system of electric tramways in Melbourne in substitution for the present partly cable and partly horse system. The proposal to introduce electric traction into Melbourne has long been on the *tapis*, and we have reason to believe that the suggested change would prove most popular. The existing lines consist of about 44 miles of cable and four miles of horse, and have been in operation now for close on 15 years. Under the scheme proposed by Mr. Rennick there will be just over 50 miles of line when the substitution of electric traction is completed, but it is conjectured that extensions of the system would from time to time be made, ultimately bringing the total mileage up to a considerably larger figure. On account of its comparative cheapness, Mr. Rennick recommends the Railways Department to adopt the overhead trolley system of working. The cost, including all equipments and substantial construction of track, is estimated at between £7,000 for the lightest traffic lines to £12,000 for the more heavy and important lines per mile of single line. In preparing his scheme of electric tramways, Mr. Rennick has at the same time had due regard to the effect they would have on the suburban lines of railways in Melbourne, and his conclusion is that the best method of working a system of electric suburban tramways would be to operate them in conjunction with the suburban railways, which, to keep up with the progress of the times, must be converted from steam to electric traction in the near future. He, therefore, recommends that any tramways constructed now should be dealt with as part of a general electric scheme for suburban railway and tramway working. From this aspect the location of a central power-house for the generation of electricity to supply the whole system is considered. A proposal has been made to build the station at a coal mine some 12 miles distant from the city, but the engineer refutes this on the ground of the extra expense entailed in transmitting energy over that distance. He, however, makes no definite recommendation, but advises that the question of electric power installation should be exhaustively investigated before the proposed tramways are put in hand. It is also suggested that the Government should obtain the best expert professional advice on the subject of converting the suburban railways from steam to electric traction.

Relaying Telephone Currents.—A patent recently granted to Mr. J. Lyons, of Washington, U.S.A., discloses a highly novel method of reinforcing telephone currents on long lines. Briefly stated, the inventor applies to these currents an effect discovered some time ago by the two French electricians, Hufin and Leblanc, which is that a faint alternating current can be reinforced by including in the circuit an alternator specially designed in relation to the frequency of the current to be reinforced. This reinforcing machine is ordinarily composed of a stationary iron field ring having inwardly projecting radial pole-pieces. The system is represented as operating as follows: Speech uttered against the microphone causes alternating electric currents to be generated in the secondary of the induction coil. One branch of the current passes through the field coils of the reinforcing machine by the conductors, and another branch passes to the line. Both current branches are exceedingly weak, and the branch passing to the line is too weak to cause an audible reproduction of sounds in the telephone receiver if the line exceeds a certain length; but if now the rotor of the reinforcing machine is rotated with such speed that its number of rotations per second exceeds the number of periods of the currents due to the sound of highest pitch that is uttered against the transmitter divided by half the number of poles of the field, then the initial and exceedingly weak alternating field excited by the telephone currents is reinforced, and these currents themselves are reinforced. This reinforcement of telephone currents may be carried practically to any desired extent, depending upon the size and speed given to the reinforcing generator and also depending upon the electromagnetic reactance of the reinforcer. This reactance should be made as small as practicable, and for this purpose the amount of iron entering into the construction of the machine should be made very small, and the iron, if employed at all, should be highly laminated, as is usual with machines of this character. It will be understood that the reinforcing machine may be in series in the line instead of in a branch derived therefrom. The inventor claims that with his improved system there is no practical limit to the length of the telephone line, since, whatever that length may be, its apparent resistance is so largely reduced by the reinforcing operation that speech can be transmitted over very long lines with the same loudness as is now attained upon comparatively short lines.

The Tube Railway Problem.—Notwithstanding all that has been written concerning tube railways in the past year or so, and the searching enquiries made into the various schemes proposed for the Metropolis by the Parliamentary Committee, the subject is far from being exhausted, as is shown by a very long article in the current number of the *Chamber of Commerce Journal* from the pen of Mr. R. E. Middleton. Contrary to the opinion generally held by those who have studied the question, the writer does not think that the tube railway of to-day will effectually meet the problem to be solved. Nothing, he points out, has been done to connect the terminal stations of the great railways which radiate out of London on all sides, and it is in this one important particular that, as at present designed, the tube railway fails in its purpose. Going further into the question, Mr. Middleton finds that

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in but few of the tunnels already designed or constructed is it possible for a carriage or truck of standard gauge to pass: they will not therefore serve as connecting links between the main lines of railways. They do not pass the several markets, and cannot be used for the distribution of foodstuffs or parcels, which is also prohibited by the system of continuous working, barely admitting of efficient repairing of the line. He does not, therefore, consider that the proposed underground railways will do much to relieve the general congestion of the streets, because they are at present all directed to the rapid transport of large numbers of passengers only, which will not materially relieve the congestion of the streets for any length of time. It would appear, therefore, that either the whole system of underground railways must be reconstructed, or an entirely new system must be provided for inter-communication between railways and for the carriage of goods. The problem to be solved is two-fold; the transport of workers from their houses to their places of business and back, and the removal of congested traffic from the streets. At the present, only the former of these has been in any way met. In conclusion, the writer makes a suggestion which may or may not meet with approval—for ourselves we think it is rather late in the day—*i.e.*, that to secure the best system of underground railways it is desirable that this momentous question should be referred to a committee composed of the engineers and general managers of all the metropolitan railways, assisted by experts whom the committee might employ and presided over by a statesman of the capacity of, say, Lord Balfour of Burleigh.

Magnetic Properties of Iron and Steel.—Mr. C. C. Trowbridge contributes a most useful article to the current number of the *Electrical World* on the subject of the magnetic properties of iron and steel at low temperature. In the first place, he clears up a common misconception as to the temperature of liquid air, which is usually accepted as – 185deg. C., as though it had a definite value. Owing to air being a mixture of the two gases, oxygen and hydrogen, each having a different boiling point, the temperature of liquid air may be anywhere between these two boiling points, according to the relative proportions of the two gases present, and to their previous history—that is to say, the temperature will be not above – 181·4deg. nor below – 194·4deg., and usually in the neighbourhood of – 185deg. The broad conclusion arrived at by the author as the result of the magnetic researches at the temperature of liquid air mentioned is that the magnetisation of steel is practically the same, whether effected at the temperature of air liquefied or at the temperature of the air we breathe. In other words, in the case of the samples tested the magnetisation was not very different whether communicated at 20deg. C. or at – 185deg. C. An interesting deduction is next made by the determination of the permeability of liquid air. It seems that although liquid air is regarded as a magnetic substance, yet its permeability is only about one-third of 1 per cent. in excess of the permeability of ordinary gaseous air. In spite of this relatively feeble permeability, as compared with iron, it seems that, volume for volume, the susceptibility of liquid oxygen is about 1,600 times greater than that of gaseous oxygen. According to this deduction, magnetic susceptibility increases markedly in oxygen with the density, or mode of aggregation. Another instructive fact elicited from the results is the following: When an iron or steel bar is powerfully magnetised at ordinary temperatures, it will lose magnetism if heated, and it will also lose magnetism if cooled. The loss accompanying initial heating is greater than the loss accompanying initial cooling; but what goes off within a small range of temperature in either case may be regarded as sub-permanent magnetism readily dislodged. After a few cycles have been passed through, however, and the magnet enters a fairly steady condition, then heating will always weaken the magnet, while cooling in liquid air will usually strengthen it. It is stated that the hysteresis loss in iron at high induction densities is the same at normal and at very low temperatures. This would tend to show that not only the area, but also the shape of the hysteresis loop is the same at these various temperatures.

Electrical Transmission in Canada. — Our New York contemporary, the *Electrical Review*, for the 30th ult. prints a long illustrated article, describing the most recent and largest case of electrical transmission that has yet been undertaken in Canada. Its purpose is to supply the town of Hamilton with electrical energy for working the street railway system as well as for lighting. The power-house is situated in the neighbourhood of the Niagara Falls, but in this case water is taken from the Welland Canal. It is conducted by way of a private canal about five miles along the Lake Erie plateau through three storage reservoirs, and ends near the brow of what is known as the Niagara escarpment at a point not far from the power-house. Between the canal and power-house extends a steel penstock approximately 1,000ft. long, through which water comes down under a head of 263ft. and enters four turbine wheels. Two of these are Riva Monneret turbines, rated at 3,000 h.p. each, and the other two are of the Stilwell-Bierce type, rated at 1,500 h.p. each. An alternator of 2,000 kw. capacity at 2,400 volts, three phase, is direct-connected to each of the two larger turbines, and a similar alternator of 1,000 kw. in like manner to each of the smaller wheels. Current from the generators passes directly to the switchboard, and thence to a bank of step-up transformers on the same floor, which raise the voltage from 2,400 volts to 22,500 volts, at which potential the energy is transmitted to Hamilton, a distance of between 36 and 37 miles. One transmission line takes the direct route to the sub-station in Hamilton, and has a length of 35 miles; the other mounts from the power-house to the Lake Erie plateau, which it follows most of its length of 37 miles to the same sub-station. On one line, consisting of three copper conductors, glass insulators are employed, and on the other porcelain insulators. The sub-station at Hamilton is a large building, containing, besides the necessary bank of step-down transformers, rotary converters, a booster for the street railway, a large storage battery and distribution boards for the lighting, stationary motor, and traction circuits. The transformers bring the voltage down from 22,500 three-phase to 2,400 two-phase for light and power work. A part of the transmitted energy is transformed at the sub-station by three rotary converters, which deliver direct current at 500 volts for the street railway system. In addition to operating the entire electrical supply and street railways of Hamilton, the company transmits energy to a further distance of some seven miles to Dundas and to a suburban railway at Burlington, about 11 miles further on. Fifty-four miles of single track are included in the entire street railway system. At present the maximum load on the combined lighting, stationary motor, and traction systems is about 4,800 kw., or somewhat less than the capacity of the water-power station. We understand from our contemporary that water power has been the all-important element in the development of the undertaking, as it has enabled the company to successfully meet competition by gas in the district it supplies.

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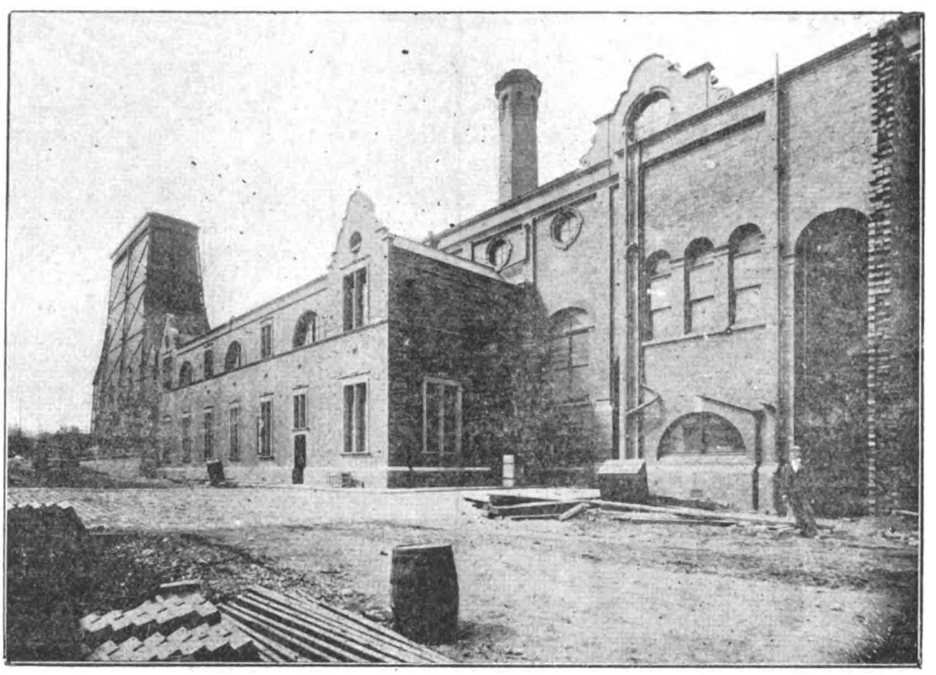
SUNDERLAND ELECTRICITY WORKS.

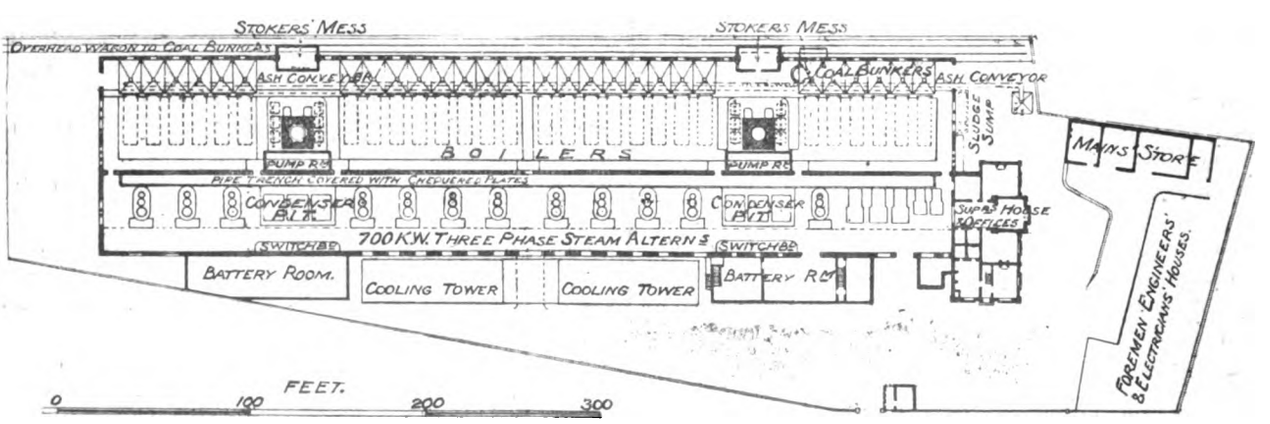
We are indebted to Mr. Snell, the able electrical engineer to the Sunderland Corporation, for most of the accompanying notes and illustrations descriptive of the extension work which has been carried out under his superintendence at Sunderland. We had the privilege some three or four weeks ago of viewing this station under the guidance of Mr. Snell and Mr. White, the station engineer, and can speak very highly of the care that has been taken to thoroughly think out every practical detail, and, so far as a cursory examination of the work was concerned, the whole of the apparatus installed seemed to be the very best of its kind. The plan of the station given herewith will show the general arrangements.



Exterior of Station, looking South, Sunderland.

Hylton-road Electricity Station.—The site of the pioneer Dunning-street station having been filled up, the Corporation of Sunderland acquired a new site of three acres in extent upon which a station for 20,000 h.p. will be ultimately erected. The site obtained is peculiarly suitable in the way of levels for the easy delivery of coal from the colliery, with which the Corporation has made an agreement for the supply of coal at advantageous terms. The ground also has the advantage of good foundations, consisting of stiff boulder clay overlying the magnesian limestone. A further advantage is an existing deep well, the shaft of which is 80ft. deep and 6ft. in diameter. A new 11½in. borehole has been sunk into the Permian sands to a depth of 120ft., and a good supply of fresh water is pumped by means of an Isler's deep-well pump, driven by a "Marshall" horizontal engine of 8 h.p. The pump is designed to deliver 5,000 gallons per hour into the overhead tanks and cooling pond. Room is also provided for a second borehole and pump. Messrs. C. Isler and Co., of Bear-lane, Southwark, London, S.E., were the contractors for all this pumping machinery.

Buildings.—The first instalment of buildings was let to Mr. J. W. White, contractor, of Sunderland, and consisted of an engine-room 169ft. by 43ft., and a boiler-house 169ft. by 63ft.; and also a battery-room annexed, 71ft. by 24ft. Also fitting shop, joiners' shop, spare gear-room, messroom, lavatories, etc. This portion of the building is designed to hold 5,000 h.p. The chimney is 120ft. high by 8ft. diameter, and is built square to the plinth and octagonally beyond. It is also lined with fire-brick to a height of 90ft. The chimney foundations were taken down to the limestone at a depth of 20ft. from the datum level. In the boiler-house will be noticed the pump-room at the back of the chimney, and symmetrical to the right and left batteries of boilers and opposite this (in the engine-room) is the condenser and hot-well pit. The flues are so arranged that the gases from each or both ranges of boilers may pass through either or both of the two economisers flanking the chimney or through the by-pass into the chimney. Provision has been made for coupling induced-draught fans at the base of the chimney between the economisers and the by-pass. An ash tunnel can be arranged when the number of boilers has increased so as to require the mechanical removal of the ashes. Overhead, self-trimming, steel-plate bunkers, fed from the coal viaduct on the west side of the building, are carried by a steel structure. The boiler blow-down pipes are taken to a sump outside the boiler-house, of ample capacity, in two compartments, so as to



Sectional Plan, Hylton-road Electricity Station, Sunderland.

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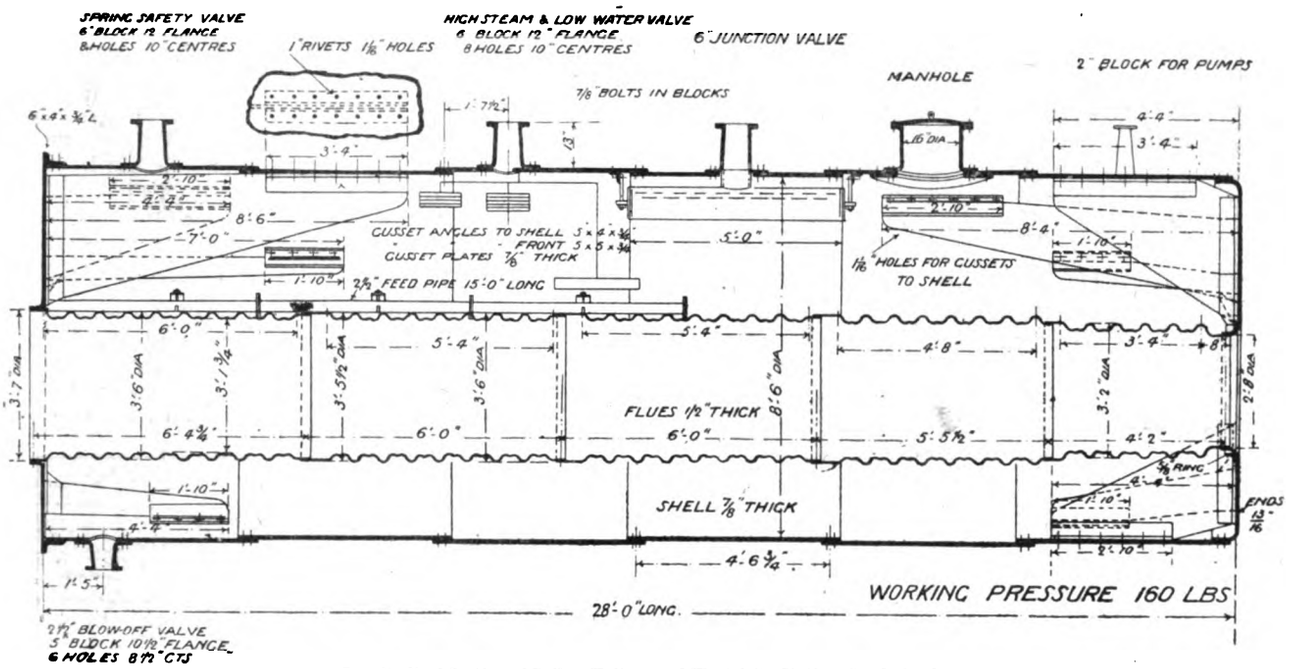
enable the water to be cooled before running off into the sewer. Lavatory, bathroom, and messroom for the stokers are also provided. In the engine-room there is an ample pipe race at the back of the engines, and a roomy cable race at the east side of the engines The engine-house is lined to the eaves with glazed brick, and ventilated by clerestory windows operated by patent window-openers. Both engine and boiler rooms are

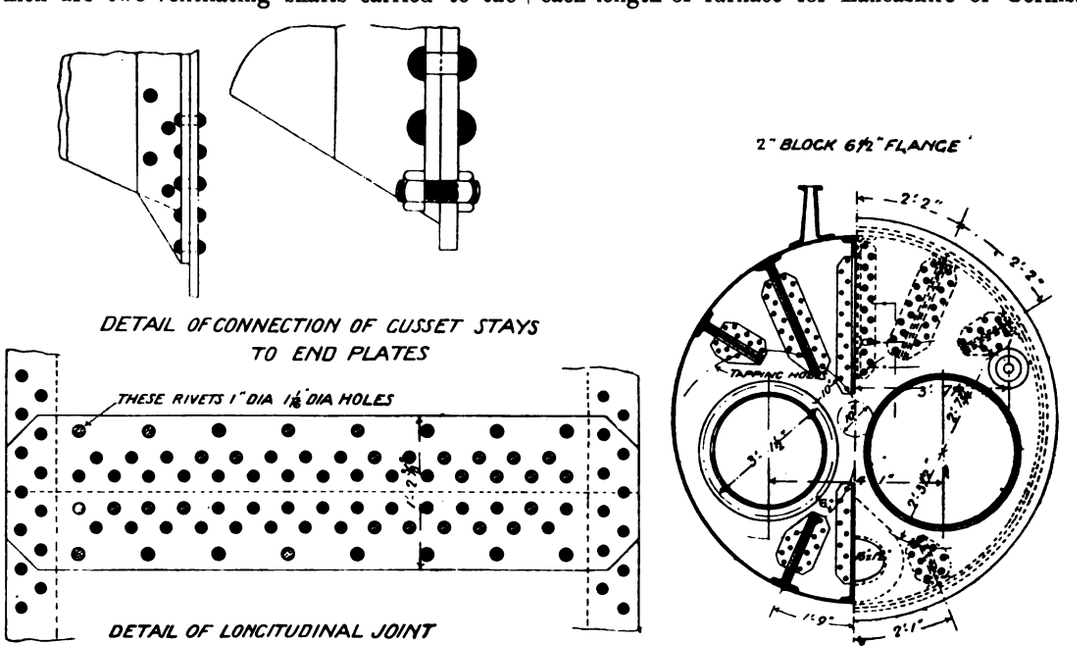
Boiler-House Equipment.—In the boiler-house provision has been made for eight Lancashire boilers, 28ft. by 8ft. 6in. diameter, of which five are at present installed. These boilers were constructed by Messrs. Clayton, Son, and Co., of Hunslet, Leeds, and work at a pressure of 160lb. They are fitted with Deighton's patent corrugated flues, for which the following advantage are claimed: very much the strongest furnace made to resist collapse; 18 per



Longitudinal Section of Boiler, Hylton-road Electricity Station, Sunderland.

glazed with Helliwell's patent glazing. The floor of the cable race, etc., is composed of "Fawcett's" (Messrs. Mark Fawcett and Co., 50, Queen Anne's-gate, S.W.) patent fireproof flooring, 6in. thick, on steel stanchions, and covered with "Edwards's" (of Ruabon, Wales) red Ruabon tiles, 1in. thick, set in cement. The battery-room is paved with blue Staffordshire stable bricks, and the floor above (through which are two ventilating shafts carried to the

cent. more heating surface than plain flues; as the furnace is so much stronger to resist collapse, the plates can be made much thinner, so that the heat can penetrate more quickly; there is just the requisite amount of elasticity, no need to use extra stays; these furnaces can be taken out of the shell without disturbing the front plates, a great advantage when renewing furnaces; there are only five plates in each length of furnace for Lancashire or Cornish boilers


DETAIL OF CONNECTION OF CUSSET STAYS TO END PLATES
THESE RIVETS 1" DIA 1⅛" DIA HOLES
DETAIL OF LONGITUDINAL JOINT
2" BLOCK 6½" FLANGE
TAPPING HOLES

Details of Boilers, Hylton-road Electricity Station, Sunderland.

roof) is constructed also of Fawcett's patent fireproof flooring. At the north gable the design has been arranged for the construction of a station superintendent engineer's house and committee-room. To the north of the main building has been constructed a mains store for the mains department, which will hold both heavy and light stores, and provides stabling for the arc lamp tower wagons. A lavatory with bathroom is built off the engine-room. At the entrance gate there is a lodge for the timekeeper.

30ft. long, against 16 plates in the ordinary plain furnace, thus reducing the number of riveted joints and possibility of leakages. The reason that corrugated flues have not been more commonly used with Lancashire boilers, is the prohibitive price which people have had to pay for them. Messrs. Deightons have fitted up complete new works for this particular class of work, and the cost is now largely reduced. This section of furnace greatly helps the circulation of the water in boiler. These boilers are fitted with "Triumph"

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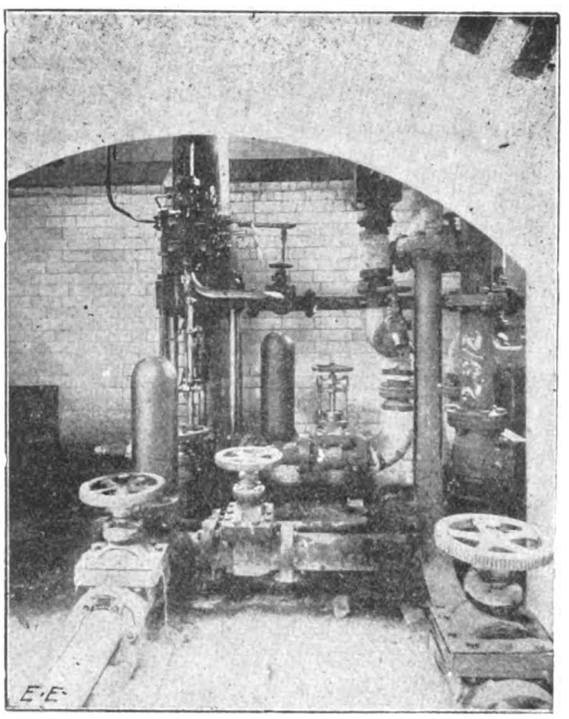
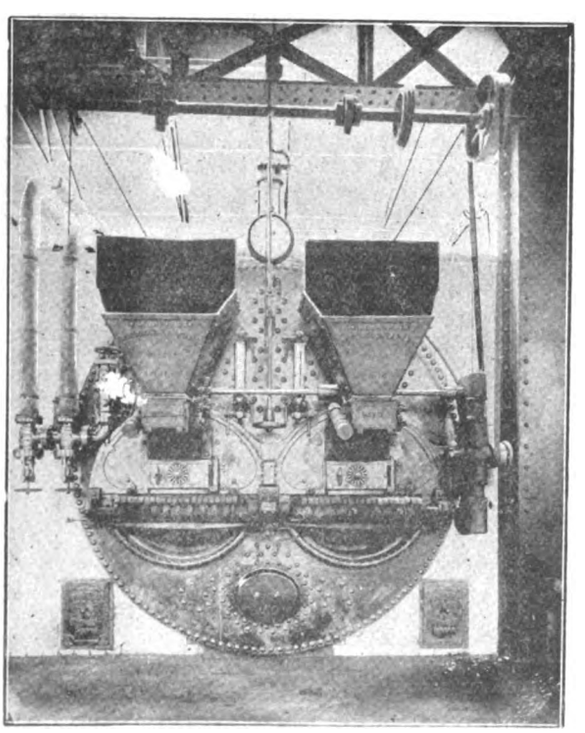
mechanical stokers and "Hopkinson's" fittings throughout, and are seated on "Poulton's" seating blocks. The boilers are covered in a somewhat unusual manner, the partition wall between each pair of boilers being carried up above the top of the boiler shell, and the top being covered flat with chequer plates laid on light tee frames, the standpipes



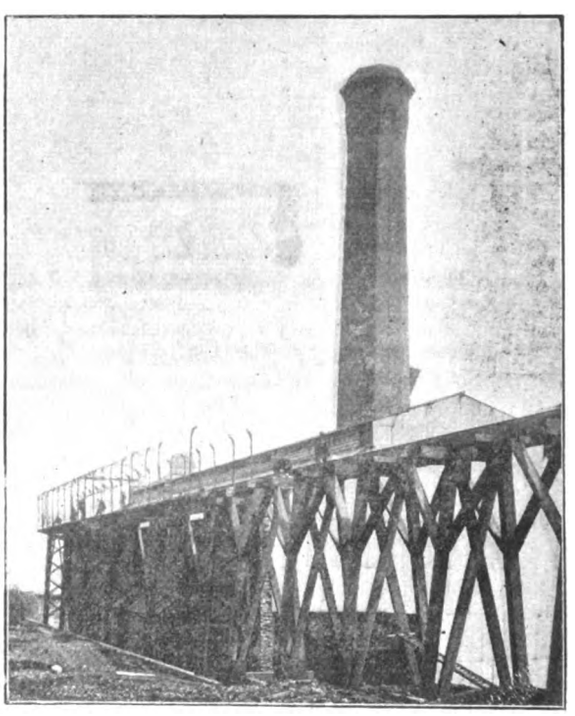
Interior of Pump Room, Sunderland.

on the boilers being made additionally long to permit of this covering. On the boiler shells are laid blue asbestos mats, and these, together with the air space between them and the chequer-plate tops, form an exceedingly efficient and neat boiler covering. There is space for two economisers, one of which, by Messrs. E. Green and Sons,



Front of a Boiler, Sunderland Electricity Works.

Wakefield and Manchester, consisting of 360 tubes, has already been fixed. The mechanical stokers and economiser scraper gear are driven by a 4-h.p. "Lundell" motor. Mention has been made of the steel-plate and wooden viaduct, etc., for leading the coal from the colliery to the stokehole. This gantry was constructed by Messrs. Clayton, Sons, and Co., Limited, Hunslet, Leeds, who also erected the steel plate bunkers. An electrical locomotive by the British Thomson-Houston Company is being supplied, and will be driven by a trolley wire fed from the tramways system for shunting the coal wagons. The feed pumps are by Messrs. Hall, of Peterborough, and each is capable of delivering 4,500 gallons of water per hour, against a pressure of 160lb. per square inch. Provision has been made for two more pumps, and the four will complete the No. 1 pump-room equipment. Above the pump-room are situated storage tanks, each capable of holding 8,000 gallons, on the top of which is a water-softener by Mather and Platt, Limited, of Manchester, which treats the water by the Archbutt-Deeley process. Under the race, between the flue and the main wall, is situated a first instalment of a Harris-Anderson purifier, supplied by the Harris Patent Feed-Water Filter Company, Limited, of 73, Queen Victoria-street, London, E.C. This is designed to deal with the condensed steam for 2,500 h p., and the apparatus removes from the condensed water the whole of the oil present in the finely divided or "emulsified" condition, which is incapable of removal by mere filtration. This result is accomplished by adding to the water minute quantities of two reagents, which by their interaction form a precipitate in which the oil particles become entangled, and can then be removed,



Exterior View, looking N.E., showing Coal Gantry, Sunderland.

together with the precipitate, by filtration through a suitable medium. A special feature of the invention is that the reagents are supplied to the apparatus in the solid form without weighing, and by a novel automatic arrangement are dissolved and supplied to the water as required, in proportion to the flow at any instant. The whole of the water is first led into the "distributor," the function of which is to divide off from the total water two small fractions to be made into solutions. The distributor consists essentially of a turbine, made frictionless by being water-borne, the rotating nozzles of which discharge into an annular trough, and thus distribute the whole water evenly over the surface of the trough. This trough is provided with two small compartments formed by radial partitions, each of which receives a definite fraction of the total water. From these compartments independent pipes lead these fractions to two solutioners, each of which is charged with one of the solid reagents (sulphate of alumina and carbonate of soda). The solutioners are deep, narrow vessels, divided vertically into four compartments, communicating below. The substance in a wire-gauze cage is placed in one compartment, in contact with the water which fills the whole apparatus, and thus free to dissolve. The fraction of water from the distributor is led into the

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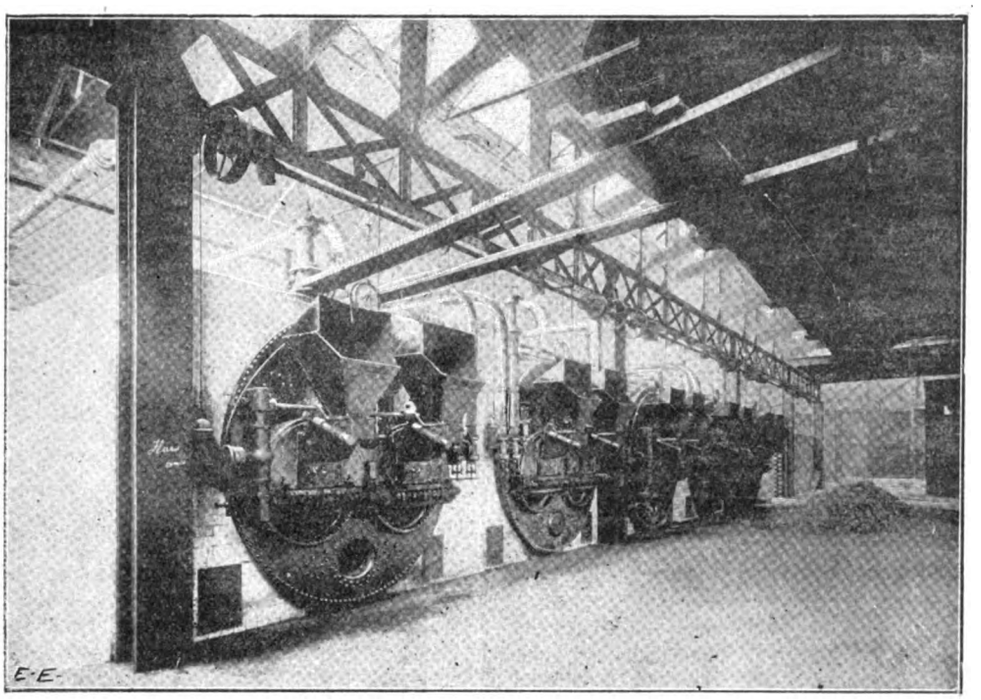
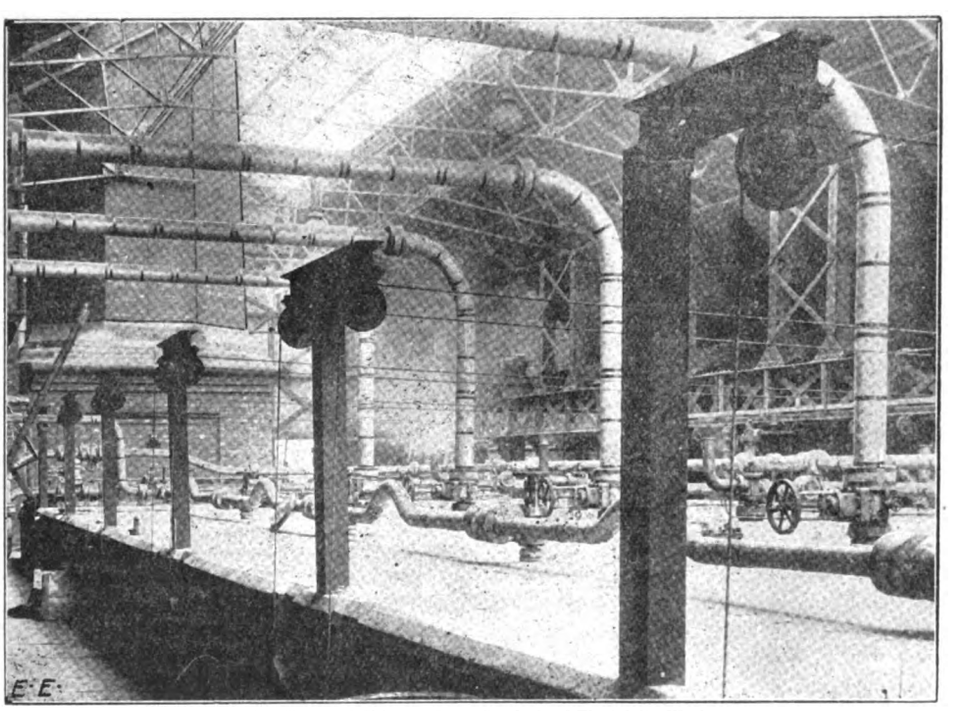
second compartment, passes down, and carries the solution into the fourth or outlet compartment and away by a spout. There is, therefore, a column of solution in the last compartment balanced by a column of water in the second compartment. The level of the water column must, of course, be higher than the level of the column of solution,



Stoking Arrangement and Front of Boilers, looking South, Sunderland Electricity Works.

and as soon as this difference of level attains a certain value, which is adjustable, water overflows from the second compartment to the third, passes down this latter, mixes with the outflowing solution, and keeps it at the exact strength corresponding to the difference of level of the water and solution columns. The strength of the solution thus made is not dependent either upon the amount of solid



Roller Tops and Chimney Base, Sunderland Electricity Works.

present (provided, of course, it is sufficient), not upon the amount of solution delivered, nor upon the temperature of the water, but only depends upon the setting of the apparatus. The only attention requisite is the recharging at intervals of the cages containing the substance Thus two definite fractions of the total water are automatically taken off and made into solutions of the two reagents of definite strength.

These solutions are then returned to the main body of the water and thoroughly mixed with it, when they react upon one another and form the precipitate which entangles the oil globules. The reaction takes place in the treatment vessel, which in the Sunderland plant is a narrow tank provided with divisions to prevent the water taking a short cut to the outlet. Attached to the side of the treatment vessel are the primary filters, compartments charged with a coarse filtering material, arranged in parallel. Here a large amount of the precipitate with the oil is detained. The primaries are cleaned from time to time by running a current of water through them in the reverse direction. From the primaries the water passes to the main filter, which consists of a number of superposed filtering cells of a special medium, arranged in parallel and affording a very large surface. Here the last traces of the precipitate are removed, and the water issues bright and entirely free from oil. The main filter is also cleaned by running a reverse stream of water through it, and by a special arrangement the cells are arranged in a number of sections which are

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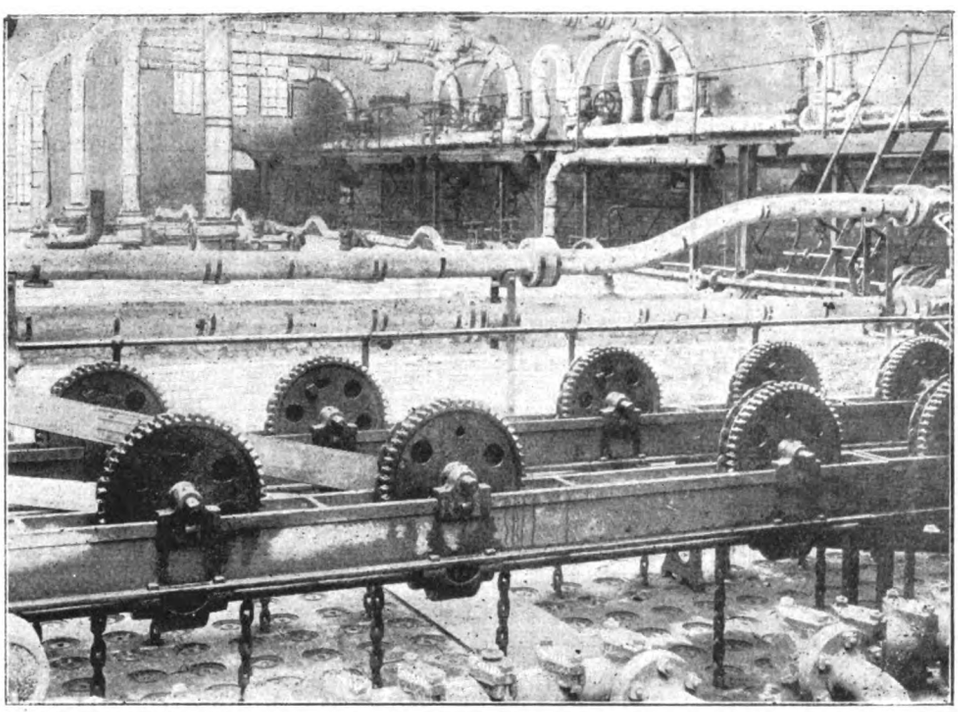
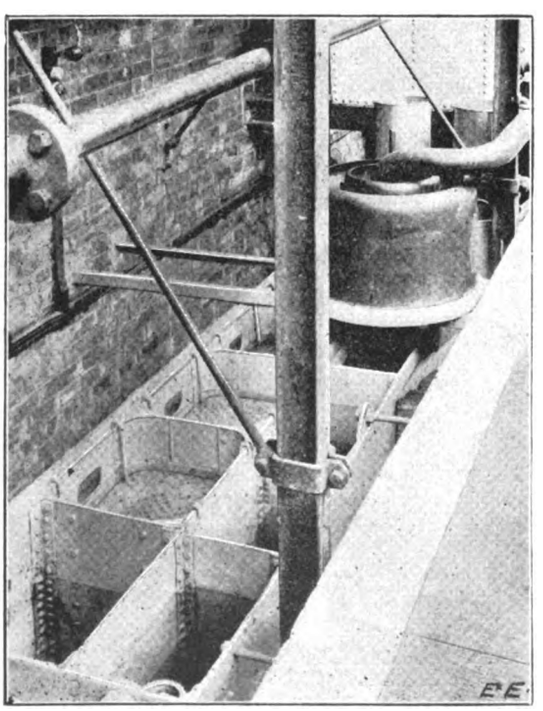
cleaned successively, the cleaning water being thus concentrated on a small part of the total surface at a time, a very thorough cleaning resulting. The cost of the reagents is less than ½d. per 1,000 gallons treated. The water, which leaves the condenser in a cloudy condition, after passing through the purifier is delivered to the reservoir perfectly clear and free from oil, warm and soft, without a trace of hardness having been added to it, and at the same time of a slightly alkaline character preservative of the boiler plates from corrosion without any scale-forming properties.

The stokehole is lit by incandescent and arc lamps. On a light steel platform is carried the pipe range, all of which is within the boiler-house, and is easy accessible, only the branch pipes for the engines being taken into the engine-room. The main steam-pipes are 6in. in diameter, and of welded steel; all bends are of solid-drawn copper with Holden and Brooke's steam-driers, complete with steam-traps, and Hopkinson's isolated valves on each boiler. The stop valves are full-way of Messrs. Hopkinson's well-known make.

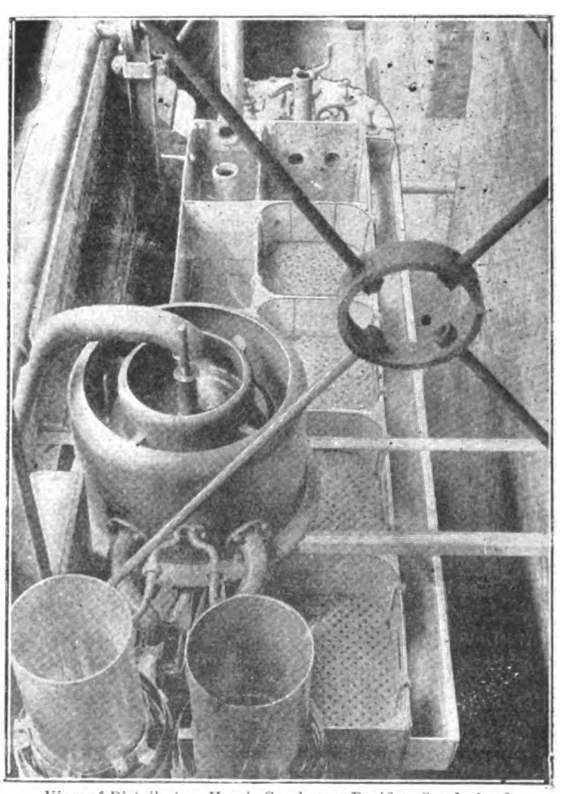
Engine-Room Equipment.—There are at present two 125-kw. Silvertown dynamos coupled direct to Belliss three-crank, triple-expansion, marine type, enclosed engines, running at 500 revolutions per minute; and three Silvertown four-pole dynamos, coupled direct to Belliss 500-h.p. triple-expansion engines, running at 360 revolutions per minute. The smaller dynamos are of the Silvertown four-pole K-260 type, each capable of giving a current of 570 amperes at from 220 to 260 volts when running at a speed of 500 revolutions per minute, and supplied with steam at 150lb. per square inch. Their armatures are of the slotted-core type, barrel wound, and parallel connected, the current being collected by four sets of carbon brushes. When tested at the engine-makers' works the following



Boiler Tops, showing Economisers, Sunderland Electricity Works.



General View of the Harris Condenser Purifier, Sunderland.



View of Distributor, Harris Condenser Purifier, Sunderland.

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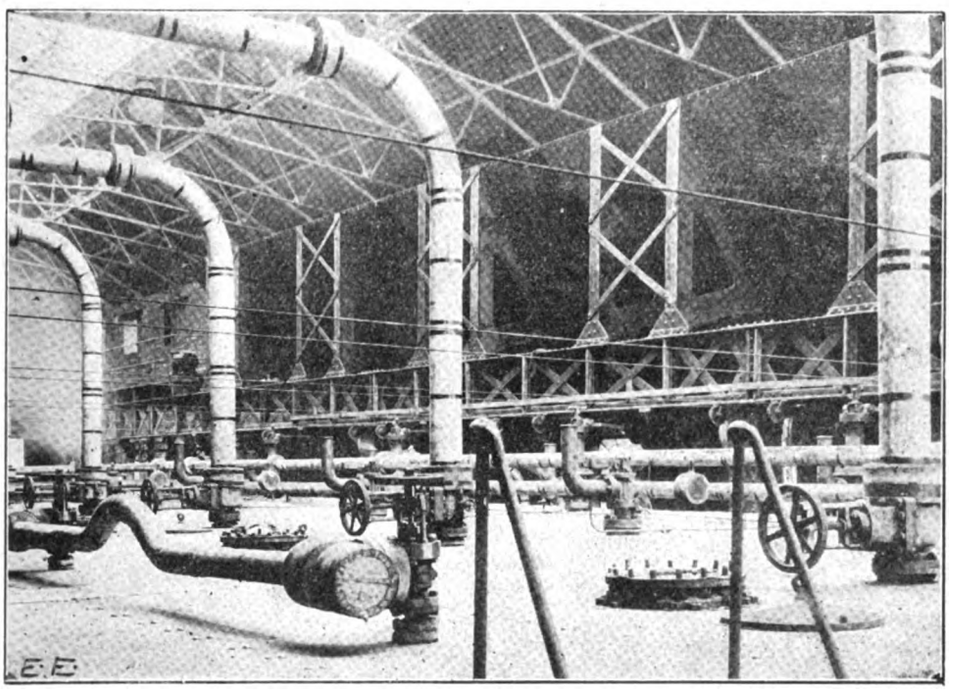
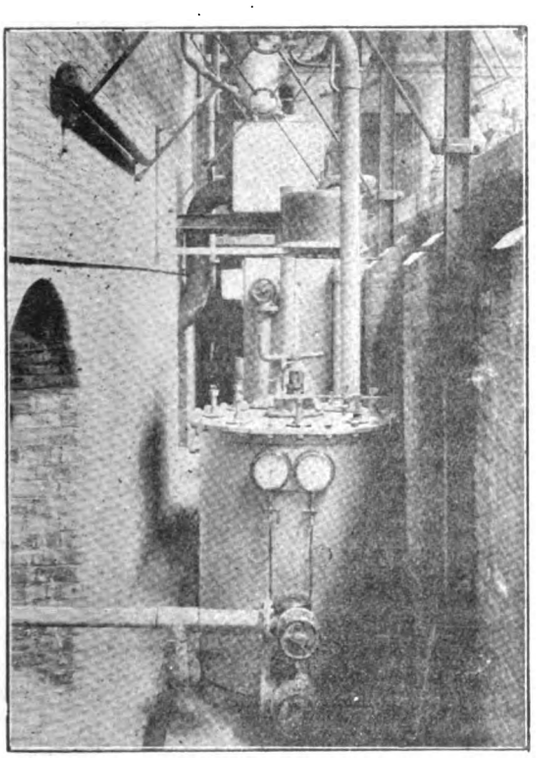
results were obtained from one of these sets—viz.: steam consumption of 26·7lb. per kilowatt per hour at full load with a steam pressure of 150lb. per square inch and a vacuum of 25·9in., and at half load a steam consumption of 30·25lb. per kilowatt per hour with the same steam pressure and a vacuum of 25·8in. The maximum temperature rise of any part of the machine after a 11 hours' run was 63deg. F.

The three larger dynamos are of the Silvertown six-pole K-900 type, each giving an output of 1,250 amperes at 220 to 260 volts when running at a speed of 360 revolutions per minute, and supplied with steam at 150lb. pressure per square inch. These machines also have slotted-core armatures, which are barrel wound and parallel connected, the current being collected by six sets of carbon brushes. A test of one of these sets at the engine-makers' works showed a steam consumption of 24·31lb. per kilowatt per hour with a steam pressure of 150lb. per square inch and a vacuum of 25in., and under similar conditions a steam consumption of 26·8lb. at half-load. The maximum rise of temperature of any part of the machine after 8½ hours' run at full load was 43deg. F. above that of the surrounding atmosphere. The machines are all of very substantial make.

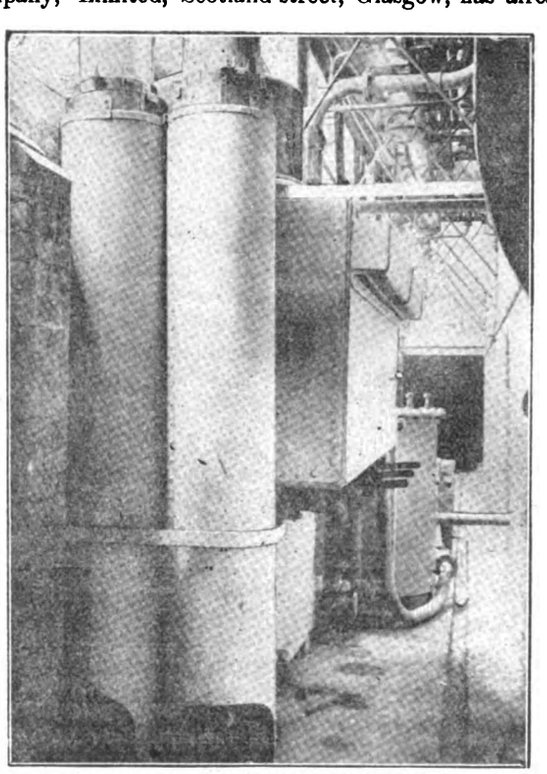
There is provision in the engine-room also for two 700-kw. steam sets, which will be shortly installed. It is intended to make the 700-kw. sets hereafter the standard unit for the station. Opposite the switchboard, and in line with the pump-room and chimney, is situated the condenser pit. Provision has been made for three surface condensrs, one of which, supplied by the Mirrlees, Watson, and Yaryan Company, Limited, Scotland-street, Glasgow, has already been fixed. Each set has to deal with the steam of 2,500 h.p. The condenser pumps are driven by a compound steam-engine. The air-pumps are of Edwards's type. The circulating water is taken from an outside cooling pond (which holds 50,000 gallons) and on which is mounted a Klein's natural-draught wooden cooling tower. This



Boiler Tops, showing Piping and Coal Bunker, Sunderland.



Filter, Harris-Anderson Purifier, Sunderland.



Solutioner, Harris-Anderson Purifier, Sunderland.

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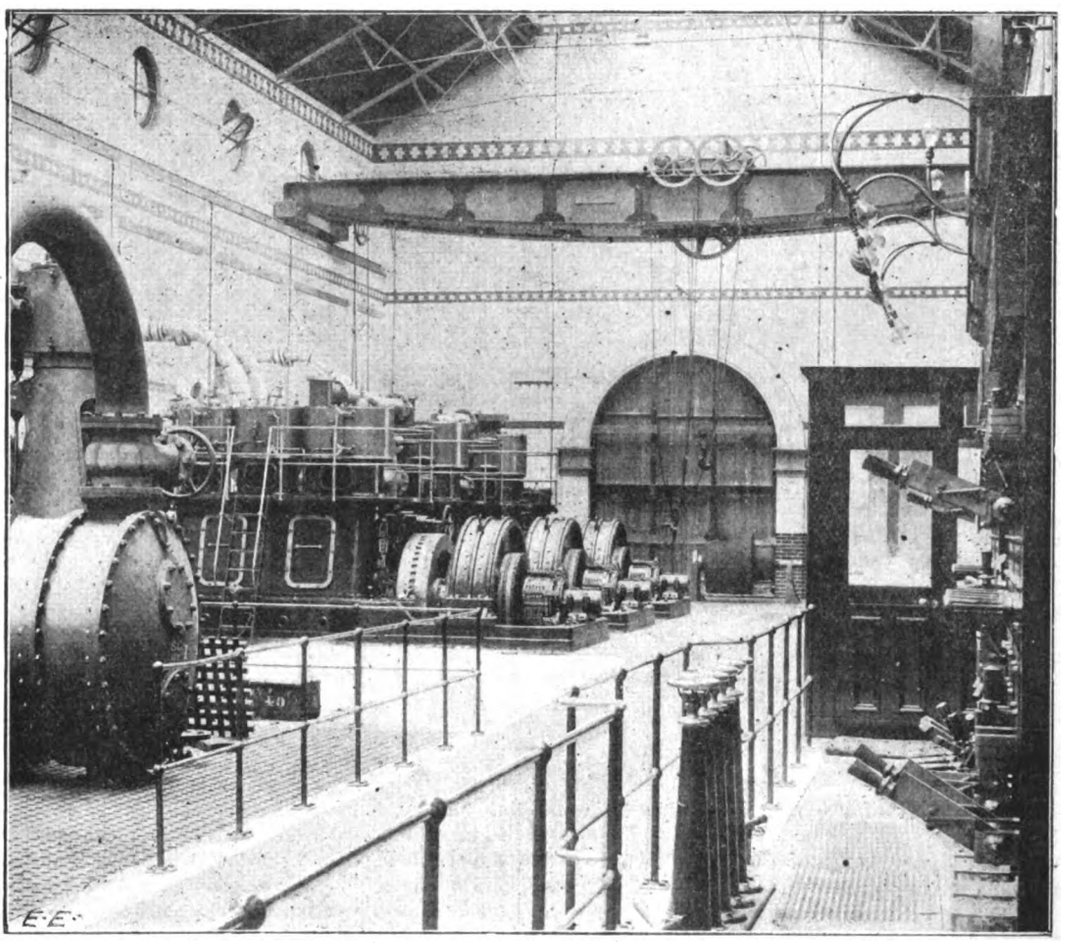
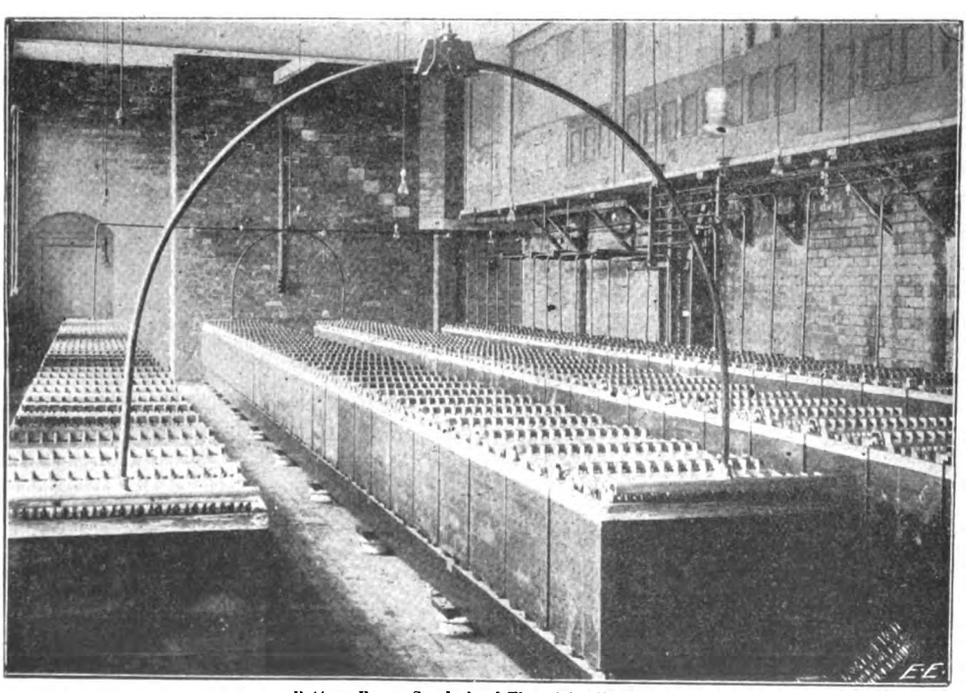
batch of two condensers will deal with the steam from one half of the ultimate station, the engines being arranged equally on each side of the pit, and exhausting right and left into the condensers.



Interior of Dynamo Room, looking North, Sunderland Electricity Works.

Switchboard.—The switchboard is mounted slightly above the floor level, on a wooden parquetry, and was supplied by Mr Bertram Thomas, of Cornbrook Telegraph Works, Manchester. The switchboard has the instruments mounted on enamelled slate panels, 2½in. thick, set in an iron frame, and finished off with wood moulding. There are three horizontal 'bus bars, and each machine has on the positive pole an automatic cut-out, ammeter, and vertical 'bus bar, and can be plugged on to either of the three bars mentioned above. On the negative pole there is a watt-meter, knife switch, and an overload fuse, and a vertical 'bus bar. Each feeder has on each pole an ammeter and long-break knife switch, and vertical 'bus bar, similar to the dynamo 'bus bars. Thus each feeder can be plugged on to either of the main 'bus bars. Magnetic blow-out fuses are fixed on a separate frame at the back of the switchboard. The negative panels are on the left-hand side and the positive on the right-hand side of the centre panel. On this centre



Battery Room, Sunderland Electricity Works.

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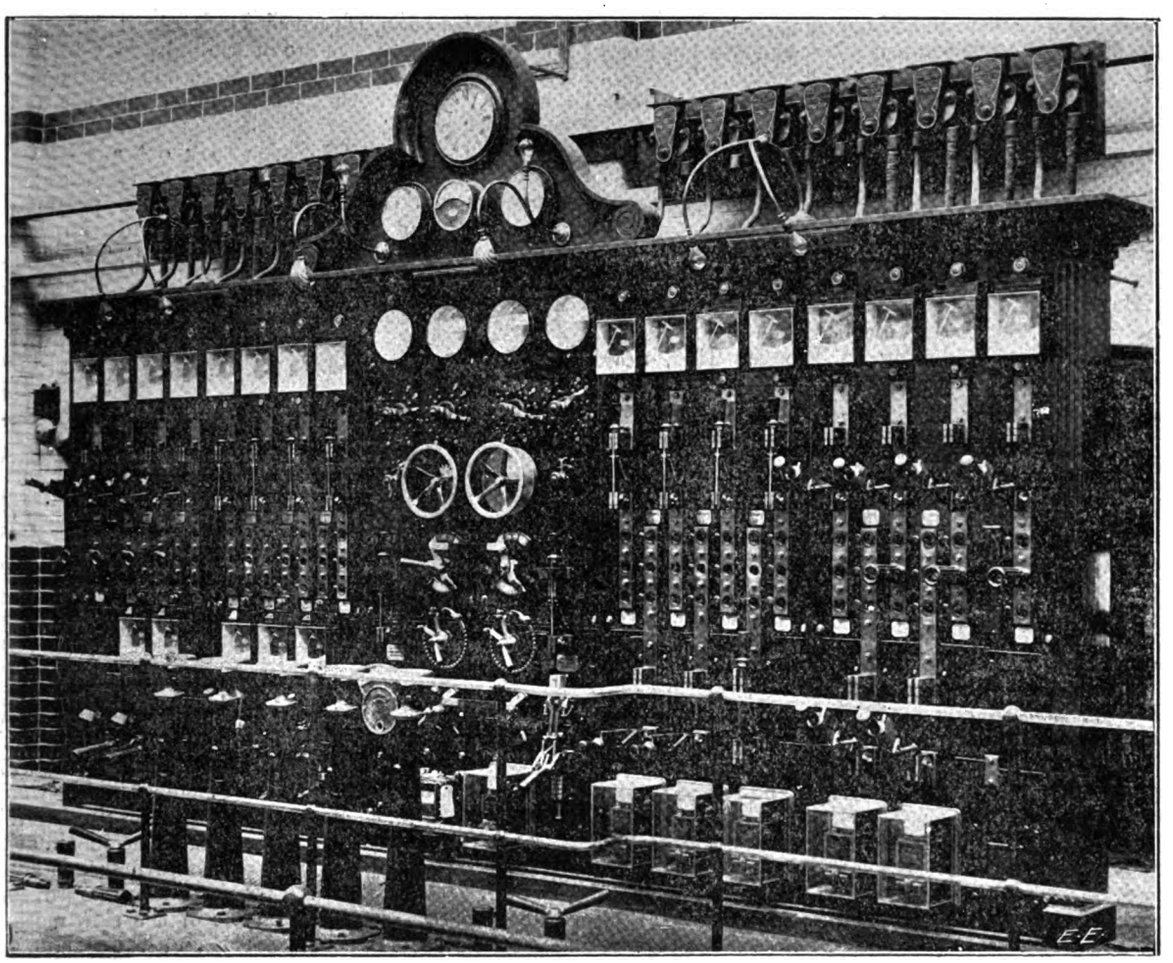
panel are mounted dynamo voltmeters, with multi-voltmeter switch, booster switch, and instruments for the battery-charging booster, and the battery emergency switches The dynamo rheostats are of the standard type, with revolving handles fixed immediately in front of this central panel, and well under control.

Accumulators. — In the battery-room there are 130 "Tudor" cells, each with a capacity of 1,680 ampere-hours. These can be charged or discharged by a hand-regulated motor-driven booster supplied by Messrs. Bruce Peebles and Co, of Edinburgh. This machine is capable of boosting from 0 to 80 volts, and has a carrying capacity of 400 amperes, being the maximum working load of the battery under normal conditions. In addition, there is a heavy battery switch, which can be worked in emergency and when the battery is under repair, and which is capable of taking the full emergency load of the battery—viz., 800 amperes—for one hour. For milking purposes there is a small motor-generator, also supplied by Messrs. Bruce Peebles and Co., located in a small brick compartment and within the battery-room, which connects with two pairs of trolley wires run above the central gangways between the rows of the cells, to which the milking leads can be connected.



Front View of Switchboard, Sunderland Electricity Works.

Above the battery-room is situated a machine shop, containing a 12in. lathe with bed sufficiently long enough to take the longest shaft, and the gap to take the largest cylinder. This is motor-driven, the motor being contained in a casing under the headstock; also a brassfinisher's lathe, shaping machine, radial drilling machine, and a tool grinder. These were supplied by Mr. Thos. Lunsden, of Gateshead-on-Tyne. Adjoining this is a fireproof room in the joiners' shop, which contains a band saw, circular saw, and grindstone. These were also supplied by Mr. T. Lunsden, and are driven by "Lundell" motors. There is also an engineers' messroom overlooking the engine-room, underneath which is situated a spare gear room, and on the walls of which will be hung the necessary spare gear.

A large development is taking place in the borough among the shipyards, which are gradually throwing out their obsolete plant and using electrical power. The demand is required at some distant points, and it has become necessary to make immediate arrangements for the installation of high-tension transmission plant. Sub-stations will be erected in the first instance at the South Docks and at Monkwearmouth, each sub station being about two miles from the central station. These sub-stations will contain three-phase motor-generators, the motors being run off a 5,500-volt circuit at 50 periods per second, and the generators being direct-current, 220-volt, delivering into the low-tension network. The cables will, of course, be three-core, drawn into Doulton's casings, laid in concrete. At the station it is proposed to remove Nos. 4 and 5 dynamos and couple them to motors at the sub-stations, and in their place to instal three-phase alternators, and to add two 75-kw. machines. These will generate at 5,500 volts, 50 periods per second, and will be "star" wound, with the centre point "earthed." It is intended eventually that the pioneer station shall be converted into a sub-station, the machines to be driven from the main station at Hylton-road.

The building designs were prepared by Mr. John W. Lincoln, the chief draughtsman (and now on the staff of the British Electric Traction Company, Limited), in conjunction with Mr. Snell, and the supervision of the building and installation by Messrs. R. J. F. Carter and Edward White, A.M.I.E.E., the clerk of works and station superintendent engineer respectively. The ground was first cut in March, 1901, and the supply was first given on Oct. 31, 1901, in time for last winter's load.

Daylight Development.—The last development in photographic inventions is a neat box about 14in. by 5in. by 6in., in which rolls of films can be developed in any room in daylight in the space of a few minutes. It is called the Kodak developing machine, and was shown last Monday upon the occasion of the opening of the magnificent rooms recently added to the premises of Kodak, Limited, 43, Clerkenwell-road, E.C.

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STAITE AND PETRIE'S ELECTRIC LIGHT—1846-1853.

BY J. J. FAHIE, M.I.E.E.

(Continued from page 340.)

On March 3, 1851, Staite laid before the committee a lengthy memoir from the commercial point of view, a copy of which occupies 13 pages of the preface to vol. 1 of his paper cuttings, followed by 21 pages of testimonials, etc., from public authorities, engineers, and others.

The labours of the committee appear to have been brought to a close early in May, 1851, but up to Dec. 31 following (the date at which Staite's collection of paper cuttings ceases) no report was issued. However, from a few cuttings added many years later by his son, the Rev. G. H. Staite, I find the substance of the report in an article from the *Manchester Courier* of Feb. 15, 1881, as follows: "The apparatus presented to the committee was by no means satisfactory. Battery power was used to produce the light, and the rapid consumption of the plates and acids at once settled the main question of cost. The light, too, flickered, varied in brilliancy, and was apt to go out, and was, therefore, uncertain in its action. The conclusion come to was that in the form presented to the committee the light could not be advantageously adopted in the town. Mr. Staite then asked that investigation should be made of other methods he had in hand, but this the committee declined to do, as in their opinion the light was not, by the means proposed, in a condition to be brought forward, since it could not be economically produced."

During the year 1851 many further exhibitions were held at Manchester, and at Rochdale, Edge Hill Tunnel, Miles Platting railway station, etc., and the Staite papers end with accounts of a display at Worsley Hall, near Manchester, the seat of the Earl of Ellesmere, on the occasion of the Queen's visit, Oct. 10, 1851. Glowing accounts of this event appeared in all the Manchester papers of the period.

Arrangements had been for some time in progress, under Mr. Staite's direction, for the exhibition of the light from three distinct points. One of these lamps "said to be of 5,000 (*sic.* Query, 1,000) wax candle-power—a power never before attained in any single apparatus," was erected in front of the hall, at the centre of an extensive flower terrace, and having between it and the hall a large fountain. The light was enclosed in a dioptric (Fresnel) lens of elegant design, with the object of collecting and projecting the rays in one broad sheet of radiance in a horizontal plane. Two other lamps "of equal power," one at each end of the terrace, were provided with reflectors, so as to throw the light across the terrace and on the whole façade of the hall.

"It is scarcely possible by any written description to convey an adequate idea of the splendid effects produced by this combination. The grounds around for a considerable distance were rendered as light as day, and even some miles off the effects were such as to strike the beholders with astonishment. The flower slopes and shrubs appeared lighted up as by a sunbeam. The *jets d'eaux* of the fountain as seen from the hall presented beautiful prismatic effects, and at times a permanent bow of prismatic light was seen spanning the drops as they diverged in their descent and were spread out by the wind in fan-like form. Her Majesty watched from the window these varying effects with evident pleasure, and when the full blaze of the side lights was directed for a moment or two into the drawing-room the Queen was positively startled with surprise." The practical results of these numerous and costly demonstrations are disappointing.

The Staite papers contain references to only two instances where the light was actually used. In his Ipswich lecture of Dec. 14, 1849, Staite says: "The Barge Steam Towing Company between London and Oxford make use of the light on their tug-boat 'Enterprise,' and are thereby enabled to continue their towing operations at night. The apparatus is fixed at the stern, enabling the helmsman to see the banks on either side with the greatest ease. The light is produced by a battery, perfluent and self-sustaining, in which solutions of neutral salts are used for exciting the zinc instead of acid. By this means the power is rendered equal, all local action is prevented, and the necessity for amalgamating the plates done away with." That the company were satisfied with its performance we learn from a letter from the secretary to Mr. Staite, dated Jan. 25, 1851, ordering a complete apparatus for their new boat. So, apparently, for over two years at least, the lamps were employed on board the vessels of this company.

Then as regards the second application, we learn from the *Manchester Courier* of Oct. 18, 1851, that Captain Laws, managing director of the Lancashire and Yorkshire Railway, "impressed with the importance of the electric light for railway purposes, determined that it should be fully and fairly submitted to a practical test on that line. With this view a complete set of apparatus has been for some time completed at the works of the company, and is ready to go up.

* * * * *

The light is expected to be in permanent operation next week."*

In 1852-53 the Liverpool Dock Board were in treaty with Mr. Staite for the use of the light in the docks, and to test its applicability it was shown on several consecutive evenings from a temporary erection on the pier and head of the Prince's Dock.

On March 14, 1853, Staite took out a sixth and last patent, No. 634, for "Improvements in Electric Light Apparatus and Galvanic Batteries." The preamble indicates a mode of supporting and of gently impelling the lower or positive electrode towards the negative by a float

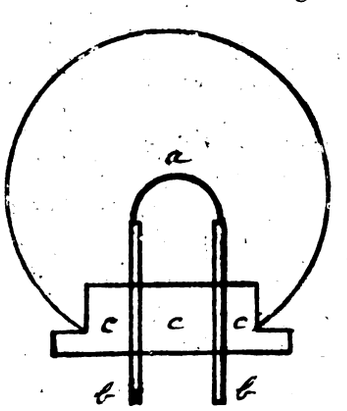

FIG. 6

submerged in oil or water, instead of the over-balance weight with slack chain, as in the patent No. 12,772 of 1849. This flotation plan is ingenious, and would, if properly applied, compensate the diminishing weight of the electrode more neatly than the old slack-chain arrangement. There is a singular want of clearness and accuracy about the description and drawings of these improvements. In fact, the letterpress is a jumble of the slow mechanical movement of the second patent and the "superseded" ratchet and click of the fifth patent, only, instead of calling it by that name, it is here called a friction clip. The drawing, too, shows, not a friction clip, as claimed, but what is practically the superseded ratchet and click, and is otherwise faulty.

When we come to Mr. Petrie's historical review, we shall see an explanation of this confusion. In 1849 Petrie designed a lamp with friction clips, the rough sketch and notes of which, as of all the electric light projects, were accessible to those interested in the business. Someone (hardly, we think, Mr. Staite himself), having seen these and thinking he understood them, tried his hand at a patent in Staite's name, and this is the result. Petrie, who drafted the third, fourth, and fifth specifications of the series, had no hand in it, and, indeed, did not know of its existence until I drew his attention to it three years ago.

Soon after this Mr. Staite's health broke down under the worry, anxiety, and toil of eight years of experimenting, lecturing, and exploiting, and after his private fortune had been dissipated in the enterprise. By the end of

* The lamp which was used, as just mentioned, with such good effect in the centre of the terrace at Worsley Hall belonged to this set.

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1848, as he tells us in a lecture of that period, he had spent upwards of £5,000 "in bringing the light to its present perfection," and his son adds that "he must have sunk at least £10,000 more in the succeeding years, for all of which there was no return of a pecuniary kind—nothing but worry, annoyances, and regrets."

During the summer of 1847 Mr. Staite came into contact with a trio of City men—Messrs. F. Field, W. C. Evans, and J. Brunton, and the result was the formation of a syndicate for further exploiting the electric light, and providing funds for experiments, new patents, etc. After the successful displays of Petrie's lamp in the autumn of 1848, a company—the Patent Electric Light Company—was formed, and a provisional prospectus was issued and published in the *Times* of Dec. 6, 1848. The capital was to be £250,000 in £25 shares, and Mr. John Atwood (late

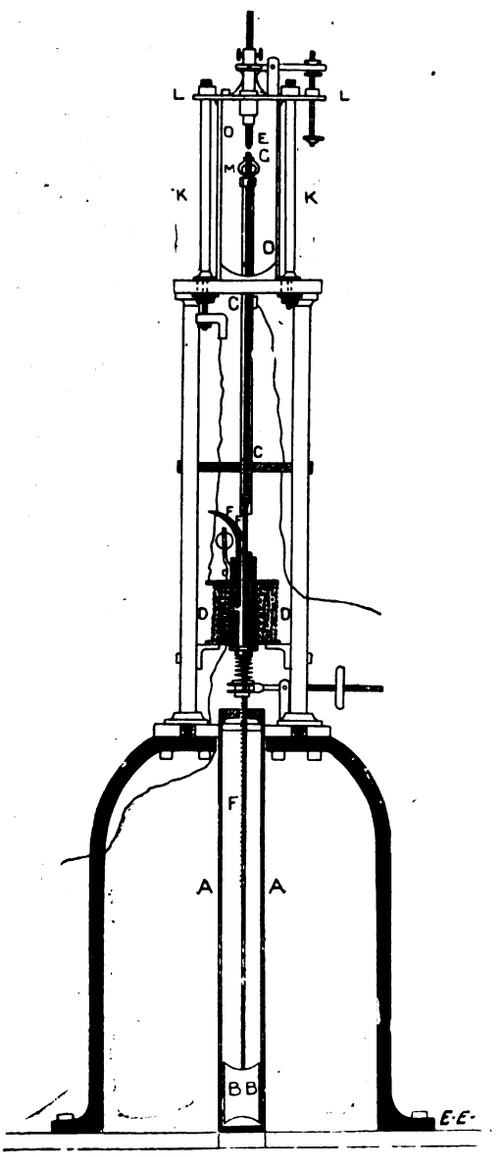

FIG. 7]

M.P. for Harwich) was spoken of as chairman, with Mr. Andrew Lighton as one of the directors. The prospectus was reissued about the middle of 1849, with a few verbal alterations and a change of solicitors' names; but from first to last the enterprise was woefully mismanaged, and after dragging on for two or three years, the company fizzled out.

Possibly the gas companies had some influence on the promoters, and that it was a case with them of running with the hare and keeping in with the hounds. We read in the *Illustrated London News* (Dec. 2, 1848) that "holders of gas property are suffering from a positive panic. The gas engineers are besieged with enquiries from all parts of the country, and, if we are rightly informed, works in contemplation have actually been postponed to ascertain the practicability of this new invention." Be this as it may, the extraordinary entanglement into which Staite's financial friends brought the business soon made it impossible to exhibit the lamps within an area of 100 miles around London, or even to show them in the rooms of the Institution of Civil Engineers, and without the lead of London he felt that all his labour in the provinces would be in vain. All this weighed heavily on his mind, and, in time, affected his constitution, never robust. His medical attendant, advising complete rest, ordered him to Buxton; whence, not obtaining the benefit desired, he was ordered to Caen, in Normandy. There he died early in October, 1854, at the early age of 44, "apparently from no disease, but from a complete collapse of vital power." The body was brought to England, and all that remains of this pioneer of electric lighting lies under a modest stone in the churchyard of Wallasey, Cheshire.

His widow, whom he left in straightened circumstances (with three children), and who long survived him, received two grants of £100 each from the Royal Bounty Fund (the second in November, 1882) on the recommendations of Lord Palmerston and Mr. Gladstone, and "in consideration of her husband's work in the development of electric lighting."

Staite was a Bristol man, was born on April 19, 1809, and in early life was a partner in the business of John Webb and Co., iron merchants. Subsequently he appears to have formed a connection with Mr. Kennard, a London engineer, in conjunction with whom he designed, about 1841, a rotary steam-engine on the turbine principle, with improved orifices for the steam-jets. The machine was used at the workshops of the Baker-street Bazaar, but was soon given up on being found to use more fuel per horse-power than the ordinary piston engine. It is interesting to note that more than 50 years after, the present patent steam-turbine on the same principle came into successful operation and ensured the triumph of the jet system which Staite had so nearly attained.

In 1844 Mr. Staite patented a method of obtaining extracts and essences, which for a time had a better success both operatively and pecuniarily. The method was based on a principle of wide application in the arts. Mr. Petrie applied it (some years after Staite) to various processes at the chemical works of Thomas Farmer. Many years later Sir William Siemens applied it in his well-known "regenerative" process of smelting; while its latest and ingenious application is seen in the apparatus for producing unlimited cold without evaporating liquids.

In 1850 he patented "improvements in pipes for smoking," consisting of a cool recess beneath the bowl for the reception of the empyreumatic oil, and in the same year, as we have already seen, he was full of his idea of an electro-caloric locomotive, which the *Mining Journal* announced "as one of the grandest discoveries of the age in connection with electricity."

In the period between 1846 and 1848, before the electric light began to engross all his thoughts, he found amusement and relaxation in literary composition of the versicle order. Besides a number of fugitive pieces, grave and gay—"hymns and humorous pieces"—which are still in the possession of his family, he published (1) "Lays and Legends of Normandy" (1846), many of which were set to music by various composers, and (2) "Fables for Children, Young and Old, in Humorous Verse" (1847), a second and much enlarged edition of which was published in 1848.

Staite, according to Mr. Petrie, who knew him well, was of a weak and impressionable disposition, easily swayed by associates whose influence on his character and conduct was not always of the best; but, generally, he was cheerful, simple, and affable in manner, as his lays and legends, and fables for children so happily testify. He was not deeply grounded in science, but he made up the deficiency by a quick, observant intelligence, and by diligent, if desultory, reading. This, joined to his genial and fluent speech, and his great ability as a lecturer, inspired confidence and attracted to him many friends.

"His actual position and work," says Mr. Petrie, "in regard to the electric light may be compared with that of Waghorn in relation to the overland route to India. Waghorn could not engineer the railway or the Suez Canal, nor could he provide the funds; but he per-

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severingly called the attention of others to the benefits of the scheme, and thereby, at length, successfully realised it. Staite possessed this quality, but in a higher degree. He was not merely an organiser—an exploiter—but with the quickness of genius he was able to grasp and develop, in some sort, a scientific idea when once suggested to him." In this way the electromagnetic regulator may be said to be as much his as Petrie's, or, as the latter handsomely puts it, "it is the joint product of their sagacity, meeting in unreserved communion." And Staite, on his part, as handsomely acknowledged Petrie's share in their inventions. "He used to tell his friends how appositely one of his fables—'The Cloud and the Sunbeam'—symbolised the relation between them: the one being the needful complement of the other—Petrie, the grave raincloud essential for growth from the earth, and himself the genial sunshine to forward and ripen the crops." In the fable here referred to a farmer is supposed to overhear the cloud and the sunbeam wrangling as to the value of their respective shares in the ripening of his corn. Then

> The farmer heard their story through,
> And said, "What stupid folks *be* you,
> With rain alone the crops don't thrive,
> 'Tis sunshine keeps 'em all alive;
> But if no genial showers we get,
> They burn right up, for want of wet.
> To *both* I look to bring me store,
> So *work together* as before!"

Mr. Petrie's connection with the electric light, though not so disastrous as poor Staite's, was still very unfortunate. After years of thought and labour he found himself involved in serious pecuniary losses (apart from his share in the patents becoming worthless), while his connection as a civil engineer was broken by his exclusive attention to the electric light. The gross mismanagement of the financial department, and the incomprehensible actions of the syndicate in the matter of prohibitions and interdictions, made him despair of success, and he was thankful when the ruin was complete, so that he could cut the business and return to his former occupations. When urged, after Staite's death, to start afresh as manager of the scientific department, he peremptorily refused, and from that time until 1899, when I approached him, he never recurred, at least publicly, to this, for him, sad episode in his life.

If ever there were men who deserved success, William Edwards Staite and William Petrie were such men. For many years they devoted their best energies to the perfecting (as far as was then possible) and popularising of the electric light, for all of which, as we have seen, there was no return at the time, and for which they have not even received that recognition from their modern and more fortunate imitators, or from the electrical profession generally, which most assuredly they deserve.

Staite and Petrie produced, not one, but something like a dozen different forms of lamps and mechanisms, which I make bold to say were as efficient as any of the kindred devices of the present day, or which could easily have been made so with a little practice. As Staite himself says in his letter to the Manchester Committee: "Like all other new systems, the electric lamp only requires practice, and that daily experience which would be acquired to simplify details. Gaslight for a long period after its first practical introduction to public uses could not be pronounced *perfect*, and it took nearly 20 years to render that system as complete and manageable as we find it at the present moment, though occasional explosions and irregularities now take place. But it was not deemed necessary to postpone its introduction to the public service on account of assumed or real minor difficulties, which nothing but experience and the working of the system could have overcome."

This is very true: so it was with the first forms of telegraphs and telephones, and so it is with every new application of science. But Staite and Petrie, in addition to "minor difficulties," had to contend with two others, which, in fact, were the real ones, and both of which were beyond their control. In the first place, as we now know, the use of battery power was fatal to any sort of success (apart altogether from the question of cost), and in their day there was no other source available.

Then, in the next place, the world was not ready for the new illuminant, so that more perfect and economical arrangements than theirs would not have succeeded. In 1857 we had the "Alliance" and the Holme's magneto-electric machines, and the Serrin lamp (an imitation, by the way, of Staite and Petrie's), both adequate for practical purposes, and yet after a short existence they practically disappeared. More efficient dynamos were brought out by Wilde in 1865, by the Varleys in 1866, and by Siemens and Wheatstone in 1867, followed a few years later (1870-72) by the Gramme machines; yet with these vastly improved means of producing strong and steady currents there was little progress for many years. Thus, according to Hippolyte Fontaine, the number of industrial applications of the electric light was only four in 1874, 12 in 1875, 85 in 1876, 350 in 1877, and about 500 in 1878, with a total illuminating power of 1,500,000 candles.

The preface to the Staite papers, to which I have so often referred, ends with a few pathetic words, which are so appropriate to my purpose in writing these articles that I may be excused for quoting them: "One hundred years hence, when the electric light shall have largely superseded other systems of illumination, which I feel convinced it must do in the end, these records of its primitive struggles will be read probably with lively interest. They have been preserved out of no feeling of vanity, but chiefly with the desire that authentic accounts of the triumphs of a great invention (great, at least, in its scope and tendency) should exist for reference long after the generation who first witnessed them shall have passed away and their impressions forgotten."

Fifty years have passed, and in the fifty that are to come people are likely to see the fulfilment of this prophecy. Meanwhile, if I have succeeded in evoking any of this "lively interest" in the "primitive struggles" of the pioneers of a great invention, as yet only half perfected, I will be gratified, for my object will have been attained.

BRITISH ASSOCIATION.

The annual meeting of the British Association was inaugurated at Belfast on Wednesday night by a general gathering of the members in the Grosvenor Hall to hear the address of the president, Prof. Dewar. The following morning the meetings of the various sections were opened for the presentation of papers, of which we are now able to give a full list—at least, so far as they are of interest to the engineering profession. The provisional programme for the opening session yesterday in Section G (Engineering) included the presidential address of Prof. John Perry, and a paper by Mr. H. A. Humphrey on "Recent Progress in Large Gas-Engines." At the meeting to-day (Friday) the Hon. C. A. Parsons will present a paper on "The Steam-Turbine," to be followed by a report by the Road Traction Committee. Mr. Vaughan Cornish will give a paper on "Undulations Produced in a Road by Using Sledges," and another by Mr. J. Brown will treat of the elastic wheel. The other papers to be read at to-day's meeting are: "The Rainfall of Ireland," by Mr. H. R. Mill; "Water Power in Ireland," by Mr. F. J. Dick; "Direct-Reducing Levelling Staff," by Mr. G. W. Herdman; "Exhibition Bridge Models," by Mr. Berkeley H. Wyse; and "Science of the Workshops," by Mr. W. Taylor. The papers to be read at Monday's session include "The Future of the Telephone in the United Kingdom," by Mr. J. E. Kingsbury; "A New Magnetic Testing Instrument," by Mr. F. Holden; "Alloys of Aluminium," by Prof E. Wilson; "Exhibition of Electrical Apparatus," by Mr. M. B. Field; and "A New Flashlight Lighthouse," by Mr. T. R. Wigham. The day's meeting will probably close with a discussion with Section L on the subject of the training of engineers. At Tuesday's session the committee on small screw gauges will present their report, to be followed by several more papers. Among these will be "The Combustion of Bituminous Coal," by Mr. W. H. Boots; "The Prevention of Smoke," by Mr. J. S. Raworth; "The Solignac Boiler," by Mr. W. H. Boots; "The Making of a Dynamo," by Mr. H. A.

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Mavor; "Gas-Engine Explosions," by Mr. H. Wimperis; and "Notes on Tide, Currents, and Wind Waves, by Mr. G. H. Kinahan Winne. This concludes the business programme of the Engineering Section. The general arrangements for Section A include a meeting of the Department for Astronomy and Cosmical Physics to-day (Friday). On Monday the section meets in three departments — *i.e.*, Mathematics, Physics and Astronomy, Meteorology and Seismology. The following day the proceedings of this section will be devoted to the consideration of papers on electricity and magnetism, and a joint discussion with Section L on a report on the teaching of mathematics is also arranged for. Papers on General Physics, Heat, and Light, will be presented at Wednesday's session.

The list of papers to be read before this section includes the following: Report of the Electrical Standards Committee; "Electrical Oscillations," by Prof. W. B. Morton; "Magnetic Detectors in Space Telegraphy," by Prof. E. Wilson; "Graphical Method of Determining the Discharge of a Condenser through a Variable Self-Induction," by Dr. E. W. Marchant; "Preliminary Experiments on a New Standard of Light," by Mr. J. E. Petarch; "Rotation of the Ether with the Earth," by Prof. E. Trouten; "Temperature of Radiant Energy," by Dr. J. Larmor; and "A High-Pressure Gauge for Artillery," by Mr. J. E. Petavel and Captain Bruce Kingsmill. Prof. Trouten will describe his experiments on the magnetic field due to the motion of a charged condenser. In Section B a paper by Dr. F. Clowes on "The Action of Distilled Water on Lead" will interest electrical engineers. In Section E Mr. R. B. Buckley has promised a paper on "Colonisation and Irrigation in British East Africa," and a paper on the survey of Scottish lakes, which is being carried out under Sir John Murray, is also expected. Prof. Johnson will discuss the subject of peat, and Mr. Porter has a paper on the Cork valleys. Mr. Benjamin Allen's paper on the effect of the adoption of free trade in Ireland is likely to be amongst the first papers read in Section F. Others will be presented by the Right Hon. Horace Plunkett dealing with technical instruction and industrial development, and by Miss Hutchings and Miss Harrison respectively on "Factory Legislation." "Municipal Trading" is the title of a paper by the Hon. R. Porter. Dr. W. R. Scott has one on the "Position of Economics and the Applied Sciences in the University Training of Man." "Industrial Superannuation" will be dealt with by Dr. Alexander, and "Trusts" by Prof. Graham. In Section L there is a paper on "Recent Reforms in Irish Education—Primary and Secondary—with a View to their Co-ordination," by Dr. W. J. M. Starkie, followed by a report on the "Teaching of Mathematics," and another on "Conditions of Health Essential to the Carrying on of Work of Instruction."

The meeting to-day opens with a debate on "Irish Educational Work." The following papers will also be read: "Intermediate Education in Ireland—Review and Prospect," by Mr. R. M. Jones; the "Introduction of Practical Instruction into Irish National Schools," by Mr. W. Mayhowe Heller, B.Sc.; "Technical Instruction in Relation to Industrial Development in Ireland," by the Right Hon. Horace Plunket; and a report on "Teaching of Science in Elementary Schools."

On Monday the meeting will open with a debate on "The Training of Teachers," by Prof. Withers, Miss Walter, and others, followed by a paper on "The Subjects to be taught as Science, and the order in which they should come," by Dr. Kimmins. On Tuesday there will be a debate on the "Teaching of English," by Mr. P. T. Hartog, Canon Lyttleton, and others; and a joint discussion with Section G on "The Training of Engineers." At the concluding meeting on Wednesday the papers will be on "Educational Experiments, Native Study in Urban and Rural Schools: Its Scope and Limitations," by Mr. R. Hedger Wallace; "School Museums," by Mr. J. H. Leonard; and "University Education in Relation to the Study of Science as a Professional Qualification," by Mr. W. M. Hartley, F.R.S. The first evening lecture of the meeting will be given by Prof. J. J. Thomson to-night on "Bacquerel Rays and Ratio-Activity."

LEGAL INTELLIGENCE.

MAZARRON ELECTRIC LIGHT COMPANY.

In the Vacation Court on Wednesday, in the matter of this company, **Mr. Robertson**, on behalf of one Richard, a debenture holder, moved for the appointment of a receiver and manager of the defendant company's business.

Mr. G. E. Tyrell, for the company, said the plaintiff held £100 debentures out of £5,000, and he was instructed that if the motion stood for a week, plaintiff's claim would be paid off.

Mr. Robertson, for the petitioner, said the company's affairs were in a very unsatisfactory condition. He put in the affidavit of the plaintiff, who stated that he had to sue the company as manager for salary, and that the judgment he obtained was unsatisfied.

His Lordship directed the motion to stand for a week.

THE OVERCROWDING QUESTION AT LEEDS.

On Friday last the Leeds stipendiary heard an interesting case involving the right of the Leeds tramway authorities to permit excess passengers to stand inside their cars. James Norton Newell, a tram conductor in the service of the Corporation, was summoned by Mr. John S. Marriner, a local solicitor, for a breach of the tramway by-laws in this respect. Up to three months ago the conductors were not allowed to carry more than the regulation number, but since then orders have been given to them to permit eight passengers to stand inside during wet weather and holidays.

The **Magistrate**, in giving his decision, said it was alleged that officials of the local authority had deliberately directed those over whom they exercised control to violate the very laws of which a printed copy had been supplied for their instruction and guidance. If this were so, it seemed to him that no language was too strong to condemn the action of those who had incited—nay, directed—the men to commit open and flagrant breaches of the law. If such a state of things were to be tolerated, they should have a combination or blend of municipal government with municipal trading, which might then be aptly described as municipal chaos. His Worship bound the defendant in the sum of £5 to come up for judgment within six months, adding that if he repeated the offence he would be fined the full penalty.

HUDDERSFIELD TRAMWAYS.

At the Borough Police Court, Huddersfield, this week the chief constable asked leave to withdraw the summons against three offenders under the Corporation tramway by-laws. As reported in our last issue, the previous week the magistrates' clerk held that the by-laws were inoperative, and the cases were adjourned in order that the town clerk might be consulted, and, if deemed necessary, attend and argue the question of law. The chief constable now stated that the town clerk was away, and as the charges were not of great moment he would, with the permission of the bench, withdraw them. In the event of any other similar cases arising he would consult the town clerk before taking proceedings. The application was granted.

FORTHCOMING EVENTS.

SATURDAY, SEPT. 13.

Association of Municipal and County Engineers.—Meeting at Shipley.

The following fixtures for meetings have also been made:

Municipal and County Engineers.—District meetings. Midland: Sept. 27, West Bromwich. Eastern: Oct. 25, King's Lynn. Home: September or October, Aldershot.

Institution of Heating and Ventilating Engineers.—Sept. 23, autumn meeting, Birmingham. Sept. 24, excursion to Warwick and Stratford-on-Avon.

NEW COMPANIES REGISTERED.

William Ryder, Limited.—Capital, £25,000. Objects: to acquire and carry on the business of William Ryder, Beehive Works, Folds-road, Bolton, Lancashire, as electrical engineers, etc.

Western Electric Railways Company, Limited.—Capital, £120,000. Objects: to construct and maintain any rail or tram or light railways, whether underground, overhead, or otherwise, and whether worked by steam, electrical, or horse traction, etc.

APPOINTMENTS VACANT.

Switchboard Attendant, Eccles Corporation Electricity Works, £62 per annum, Sept. 31. Particulars may be obtained from the Town Clerk, Town Hall, Eccles.

Various, Tonbridge Urban District Council, Sept. 22. Full particulars can be obtained from Mr. J. A. B. Horsley, engineer, Electricity Works, Tonbridge.

Foreman, Hackney Borough Council Electricity Works, Sept. 19. Particulars may be obtained from the Borough Electrical Engineer, Millfields-road, Clapton.

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CONTENTS.

Notes	361	Questions and Answers	380
Sunderland Electricity Works	366	Companies' Meetings and Reports	387
Staite and Petrie's Electric Light—1846-1853	374	Contracts for Electrical Supplies	387
British Association	376	Lighting Notes	389
Legal Intelligence	377	Traction Notes	391
Forthcoming Events	377	Provisional Patents, 1902	394
New Companies Registered	377	Specifications Accepted	395
Appointments Vacant	377	Companies' Stock and Share List	395
The British Association	378	Traffic Returns	396
Correspondence	379		
Reviews	379		

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THE BRITISH ASSOCIATION.

It is inevitable that the minds of those whose memories go back to the last meeting of the British Association at Belfast should make mental comparison between then and now. The president (Prof. Dewar), in his address, tacitly acknowledges this, and, strong in the knowledge that what he has to say will command admiring attention, does not hesitate to refer at some length to the presidential address delivered by Tyndall to the association at Belfast twenty-eight years ago. It is, indeed, singular that the world learns its lessons slowly, but it needs the trumpet note of a Tyndall to hurry its pace, and we have no doubt that the commotion caused by the former presidential address brought about a broad-mindedness and toleration in those who were compelled to think about it that could have been brought about in no other way. Prof. Dewar has not followed in the footsteps of his great predecessor, but has forsworn metaphysical problems to give a most charming and complete monograph upon "cold." This is the direction in which he has specialised, and his discoveries and results have gratified and astonished the scientific world. His goal is to obtain a temperature 273deg. below the temperature of freezing water—a temperature understood to be the zero temperature of this universe. The history of cold and the absolute zero, is it not written in this address how experimentalists from the time of Bacon and Boyle have worked and obtained results, from which came deductions, mathematical equations, and further results, till in the attempt to liquefy helium it must have touched a temperature of 9deg. or 10deg. for a short time without showing any signs of liquefaction, so that science can claim to have gone as far as 262deg. or 263deg. out of the 273deg. required below the freezing point of water to reach absolute zero. Reference was made in the concluding portion of the address to a long series of experiments made in conjunction with Prof. Fleming on the electric and magnetic properties of bodies at low temperatures. "The investigations have shown that electric conductivity in pure metals varies almost inversely as the absolute temperature down to *minus* 200deg.," but this law does not seem to hold good at still lower temperatures, and the observations appear "to point to an ultimate finite resistance." At the temperature of the boiling point of hydrogen, copper has only 1 per cent.; gold and platinum, 3 per cent.; and silver, 4 per cent. of the resistance they possessed at zero C. What a revolution would be formed in electric engineering work if the temperature of the conductors could be cheaply reduced and maintained at such low temperatures, as they would become almost perfect conductors with scarcely any resistance. But the application of the results of experimental work was beyond the scope of Prof. Dewar's address. He pointed out what great strides had been taken, stating briefly the results obtained, leaving the practical world to work out the utility. Prof. Dewar summarises these investigations as follows: "The study of dielectric constants at low temperatures has resulted in the discovery of some interesting facts. A fundamental deduction from Maxwell's theory is that the square of the refractive index of a body should be the same number as its dielectric constant. So far, however, from this being the case generally, the exceptions are far more numerous than the coincidences. It has been shown in the case of many substances, such as ice and glass, that an increase in the frequency of the alternating E.M.F. results in a reduction of the dielectric constant to a value more consistent with Maxwell's law. By experiments upon many substances it is shown that even a moderate increase of frequency brings the large dielectric constant to values quite

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near to that required by Maxwell's law. It was thus shown that low temperature has the same effect as high frequency in annulling the abnormal dielectric values. The exact measurement of the dielectric constant of liquid oxygen as well as its magnetic permeability, combined with the optical determination of the refractive index, showed that liquid oxygen strictly obeys Maxwell's electro-optic law, even at very low electric frequencies. In magnetic work the result of greatest value is the proof that magnetic susceptibility varies inversely as the absolute temperature. This shows that the magnetisation of paramagnetic bodies is an affair of orientation of molecules, and it suggests that at the absolute zero all the feebly paramagnetic bodies will be strongly magnetic. The diamagnetism of bismuth was found to be increased at low temperatures. The magnetic moment of a steel magnet is temporarily increased by cooling in liquid air, but the increase seems to have reached a limit, because on further cooling to the temperature of liquid hydrogen hardly any further change was observed. The study of the thermo-electric relations of the metals at low temperatures resulted in a great extension of the well-known Tait thermo-electric diagram. Tait found that the thermo-electric power of the metals could be expressed by a linear function of the absolute temperature, but at the extreme range of temperature now under consideration this law was found not to hold generally; and, further, it appeared that many abrupt electric changes take place, which originate probably from specific molecular changes occurring in the metal. The thermo-electric neutral points of certain metals, such as lead and gold, which are located about or below the boiling point of hydrogen, have been found to be a convenient means of defining specific temperatures in this exceptional part of the scale." We would like to direct attention to the president's remarks on the "endowment of education," but must forbear except to say how fully we agree with him in estimating the value of the scientific work carried out at the Royal Institution during the past century. It is an ever-present trouble with us, however, to be compelled to recognise the ignorance of those who should teach—not the masters and mistresses in our schools—but the writers in the daily papers, whose notes and articles are read by an ever-increasing number of readers, and who propagate the grossest errors, which all the teaching of the schools is incapable of counteracting.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEAM TURBINES.

SIR,—In reply to a letter on this question in your last week's issue, the most recent book on this subject is one by Mr. R. M. Neilson, published by Longmans and Co., the price being 7s 6d. This will probably give your correspondent all the information he requires.—Yours, etc.,

A WORKER.

THE CITY AND SURREY ELECTRIC RAILWAY COMPANY, LIMITED.

SIR,—At a meeting of the above-named company held on Aug. 8 last, we were asked whether we would join the Board of the National Electric Traction Company, Limited, with which it was proposed to amalgamate. We have consequently endeavoured to obtain as much information as possible as to the position and prospects of both companies, but the situation as disclosed by the materials which have been furnished does not, in our opinion, justify us in accepting office. The National Electric Traction Company, Limited, has been officially informed of our decision; but as we have failed to obtain any list of applicants for shares of the City and Surrey Company, we trust that you will insert this letter, as we have no other means of carrying our decision to them —Yours, etc.,

(Signed) S. P. BRAUN. W. T. HOLMES. A. HOWELL.

REVIEWS.

Electric Power Transmission. Third edition, revised and enlarged. By LOUIS BELL, Ph.D. Published by *Electrical World and Engineer*, New York.

According to the preface, this book is "designed to set forth in the simplest possible manner the fundamental facts concerning present practice in electrical power transmission." While, therefore, this volume does not contain constructional details of transmission apparatus, it is, nevertheless, a book to be consulted as giving a general account of the subject of which it treats. The work has a distinctly American character. For example, take this from the preface to the third edition: "Each upward step in working voltage has lessened the uncertainty that veils the upper limit of commercial practice, and to-day the engineer who confines himself to 10,000 volts in a transmission of 15 or 20 miles may fairly be regarded as ultra-conservative." We must wait for the electrification of our main-line railways before classifying ourselves according to Dr. Bell's ideas. The author first deals with some elementary principles regarding forms of energy, electromagnetic induction, etc. The general conditions relating to power transmission by ropes, water, compressed air, and gas are touched on, and these are compared with electrical transmission, to the advantage of the latter. The author concludes that for a straight-away transmission of a few miles of, say, 500 kw. and upwards (at 10,000 to 12,000 volts) one may fairly expect to get at full load as much as 94 per cent. from generator and motor, and perhaps 98 per cent from the line, giving a total efficiency of $0{\cdot}94 \times 0{\cdot}94 \times 0{\cdot}98 = 0{\cdot}866$ at full load. Is it not high time that an international symbolism was settled for electrical units? The author does not err greatly in this respect, but he does use I to mean "inductance" or "reactance," whereas its most usual meaning is in connection with "current." Why not use Lp for "reactance," and I', I, and i for "maximum" "R.M.S." and "instantaneous" values of the current respectively. The terms "capacity-impedance" and "negative reactance" are mentioned, and the author immediately states that this quantity is often termed "condensance." This latter is a good term, being analogous with "resistance" and "reactance," but it is a pity to multiply names. On p. 107 an overhead line is mentioned having a cross-section of about 300,000cm. (*sic*), a sufficiently formidable conductor from the intelligent foreigner's point of view, who might think that "cm." was a misprint for "cm.²."

A description is given in Chapter V. of transmission by alternating currents, and this system is compared with high-tension direct-current transmission. Synchronous and induction motors are dealt with generally, and diagrams of connections, photographs of the appearance of some of these types, and performance curves are reproduced. Under the heading "Current Reorganisers," an account is given of commutators, motor-generators, rotary converters, and rectifiers, together with photographic plates illustrating these machines. In this book of 625 pages, only about 33 are devoted to engines and boilers, but then the title of the book does not necessarily include "generation." Various forms of water-turbines, waterwheel governors, and the methods of computing the flow of water are described. The author considers also "The Line," "Line Construction," "Centres of Distribution," "The Commercial Problem," "High-Voltage Transmission." Under the latter heading a photograph is given showing a high-tension transmission pole carrying three bare overhead wires at a height of about 40ft. above the ground. The particular pole is "near the basin of the Great

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Salt Lake, where the dust is of a strongly saline character. The salt gets distributed not only on the insulators, but on the cross-arms, pins, and poles, and is sufficient not only to ensure leakage, but to cause actual arcs to break out between wire and wire. Such arcs quickly dissipate themselves, but whilst they last the phenomenon is little short of terrific." An interesting table is given at the end of the book of 88 different power installations in the United States, Canada, and Mexico, working at or above 10,000 volts. Of these, 46 per cent. are three-phase 60 ~, and 22 per cent. are two-phase 60 ~. There are also two at 25 ~ (one being Niagara), two at 50 ~, and one at 133 ~. The remainder are at various frequencies from 29 to 66 ~. With regard to voltage, 56 per cent. of the stations run at from 10,000 to 12,000 volts, and about 26 per cent. run at from 12,000 to 20,000 volts. Six run at from 30,000 to 40,000 volts, one runs at 50,000 volts, and two at 60,000 volts. R. P. L.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

515. Two two-phase similar machines in parallel are supplying 50 amperes each phase external load, and they share the load equally on one phase, but one machine takes 28 amperes and the other 22 amperes on the second phase. Why is this?—L. R.

516. Which is the best way of coupling circuits on a three-phase system—star or mesh? Explain advantages or disadvantages of one system over the other.—A. B. C.

ANSWERS.

Question No. 509.—An air-pump driven by an electric motor has to maintain in an air-chamber a pressure of not less than 60lb. nor more than 80lb. per square inch. At present the motor is stopped and started according to the reading of the pressure gauge, which entails frequent attention. Is there any method of automatically controlling the pump?

[The following is a selection of the numerous answers to Question No. 509. We leave it to the enquirer to pick out the arrangement best suited to his particular case.—ED. *E. E.*]

Answer to No. 509 (*awarded* 7*s.* 6*d.*).—There are various ways of stopping and starting an air-pump motor automatically, so that the pressure in the air-chamber is not less than 60lb. nor more than 80lb. per square inch. The motor should be controlled by an automatic, slow-moving, many-way resistance switch, which will control the motor without the need of an attendant. One switch suitable for this purpose is made by Messrs. Royce, Limited, Manchester. This type of switch is now in use for the hotwell at Tynemouth electric power station.

Fig. 1 shows the arrangement of a reversing switch, and a single-way switch suitable for pump work is practically the same. A rope wheel, about 15in. diameter, is fixed at one end of a shaft, which passes into the switch. On the same shaft a crank and crank-pin are keyed; this crank-pin drives the top barrel through a spring box. This barrel is made up of two distinct pieces, one positive and one negative. Each piece consists of a brass tube mounted on the centre spindle and insulated therefrom. On the tube are mounted two contacts (not three as shown), one for the main and one for the armature and shunt. Fixed on the cast-iron base and insulated from it are four finger contacts, similar in construction to those used on tramway controllers, one finger for each contact on the barrel. At the other end to the pulley a sprocket wheel is fixed, so that the top barrel is either in the off or on position, and it is impossible for it to remain in an intermediate position. On the lower base another barrel is mounted, having 10 contacts. On the centre spindle of this barrel a small pinion is fixed; this pinion gears into a rack, on which a weight is mounted. A piston working in a dash-pot filled with oil is connected to the lower portion of the rack. On the under side of the top base a ratchet coil is fixed, which is in series with the shunt of the motor. The core of the coil gears into a wheel fixed on the lower spindle. Twenty finger contacts are mounted on the bottom base and

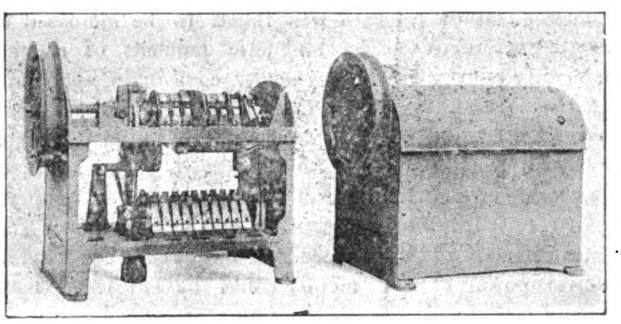

FIG. 1.

insulated from it. These contacts are connected to the resistance, which is separate. The top barrel is moved round by the rope wheel, making the circuit through the armature and field. The shunt circuit being closed, the core in the ratchet is lifted up, and that allows the weight on the rack to move the rack down, and so turns the bottom barrel round, cutting the resistance out of circuit; the dash-pot preventing the barrel from moving round too quickly.

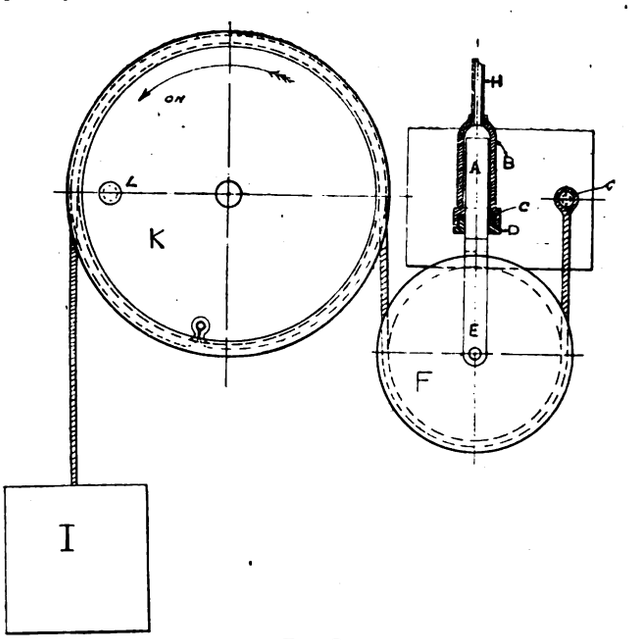

FIG. 2.

Fig. 2 shows the general arrangement of the gear for working the pump switch: A, small piston; B, cylinder which is mounted on a piece of ½in. wrought plate; C, soapstone packing for piston; D, gland nut; E, eye on end of piston for rope pulley; F, rope pulley; G, stud for fixing one end of rope; H, pipe from air-pump; I, weight to counterbalance action of piston; K, switch pulley. The weight, I, tends to pull round the switch into the "on" position, so that when the pressure falls the motor is switched on. With an increase of pressure the piston counterbalances the weight and moves round the switch into the "off" position. By this means an attendant is not required, except for starting in the morning and for closing down at night. When the pump is not

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required the switch wheel, K, is locked in the "off" position by pushing the pin, L, through the wheel into the

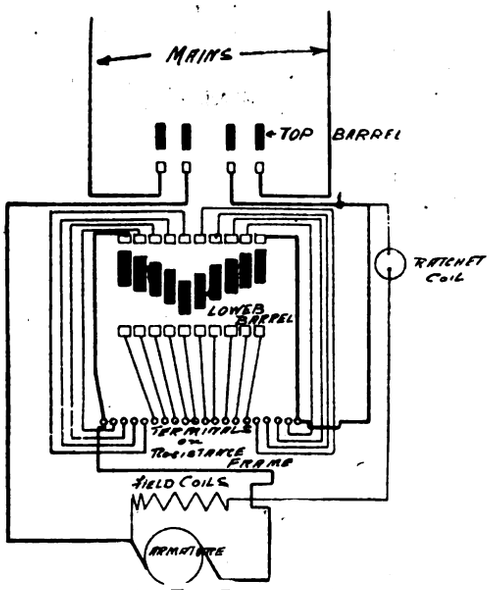

FIG. 3.

switch frame. Fig. 3 shows the arrangement of connections for the switch and resistance.—C. G.

Answer to No. 509 (*awarded* 7*s.* 6*d.*).—The motor driving an air-pump can be automatically controlled by the following means: C is a cylinder about 4in. diameter, in which works a cup leather bucket or plunger, P, air pressure being admitted by means of a small pipe to the under side of the plunger, which acts by means of a connecting rod on a lever, *l*, to which is attached a spring balance with adjusting screw, S, and a rod, *b*, to which is bolted the plate, *p*; *p* should be secured into a separate flange with a set pin, the whole being insulated from the rod, *b*, by porcelain insulators, so that the plate, *p*, can be easily renewed. I is a bent iron bar insulated from casing, Z, which contains a solution of water and soda made to suitable density. The bracket, X, is

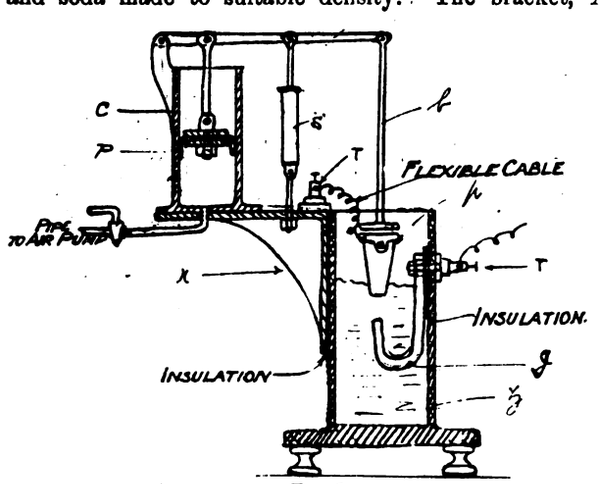

FIG. 1

insulated from casing, Z. T and T¹ are terminals connected to *p* and I. As the air pressure under plunger, P, falls, the spring, *s*, pulls down lever, *l*, and lowers the plate, *p*, into the liquid, completing the circuit and starting the motor; if the pressure is not high enough to overcome the spring, the plate is lowered still further into the liquid, decreasing the resistance to the current and speeding up the motor. When the plate, *p*, and the bent iron, I, are in contact, the air pressure is low and the motor making its highest speed. As the air pressure increases the reverse action takes place, until the plate is withdrawn from the liquid, and the motor stops. If a liquid starting resistance is objected to, the same object could be obtained by means of a lever connected directly to an ordinary metallic regulating switch, which would be acted upon by the air pressure and regulated by the spring balance in precisely the same manner as the liquid controller.

The liquid switch is the best for the purpose, as the speed of the motor can be regulated to a nicety by varying the level of the water, and, moreover, there are no metallic contacts to burn and cause the switch to "stick." On

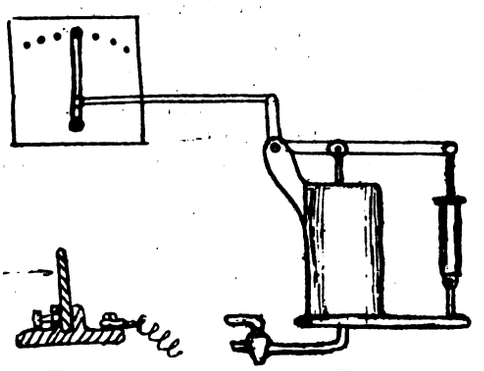

FIG. 2 FIG. 3.

starting up, with no air pressure, of course the spring balance would have to be slacked back and the lever lifted before the D.P. switch was put in.—T. R. O.

Answer to No. 509 (*awarded* 7*s.* 6*d.*).—I think this end may be accomplished in three ways—viz.:

1. By always letting the motor run at full speed pumping air into the air-chamber and having a release valve on this working at 80lb., or a little earlier if thought advisable. Any type of ordinary boiler safety valve would answer this purpose very well. This method would answer, and has the fact of there being scarcely any mechanism in it, but then there is the fact that the motor must always run and waste power when air-chamber valve is blowing off, and it also has the disadvantage that the pressure in the air-chamber will not be constant, though nearly so. The pressure in the air-chamber will usually be nearly 80lb. per square inch. There should be no chance of the pressure getting below 60lb., however, if the motor acts satisfactorily now.

2. By having an arrangement to stop motor when pressure gets above 80lb., and also to start motor when it gets below 60lb. This is considerably more complicated,

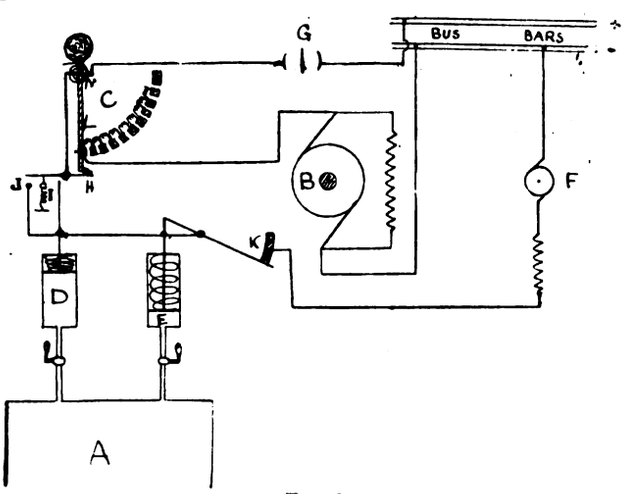

FIG. 1.

and necessitates the use of another small motor. Fig. 1 represents the necessary connections and apparatus to obtain this end, where A represents air-chamber; B, motor driving air-pump; C, starting rheostat for same; D, high-pressure release working at 80lb.; E, low-pressure contact maker working at 60lb.; F, small motor driving worm gearing moving rheostat handle round; G, main switch on positive side; H, catch to hold rheostat arm; I, spring to keep catch in position; J and K, starting motor contact pin. The action is this: Let us suppose that the air-pump has been working, and the pressure in the air chamber, A, has reached 80lb. Now, the piston in D has got pressed up so far that the rod presses against the catch, H, and releases the rheostat arm, L, which is pulled back over the contacts by the spring, M, and so breaks the air-pump motor circuit. The spring, I, pulls back the pawl, H, till this comes against the starting motor contact pin, J. D and E could be com-

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bined, but I think it better separate. Now, in time the pressure in A will fall until it gets to 60lb., when the piston in E will be released, so that the rod will pull its arm on to contact K. Now, both the starting contacts, J and K, are closed, and the motor, F, will start. This is a series motor, so as to have a big starting torque, and drives through worm or other gearing the rheostat arm, L, which starts up the air-pump motor. When the motor gets to full speed and the rheostat arm to the last contact, the pawl, H, catches it, at the same time breaking the starting motor circuit at J. In time, as the pressure in the air-chamber increases, the contact at K will also be broken, as the piston in E gets forced up against its opposing spring.

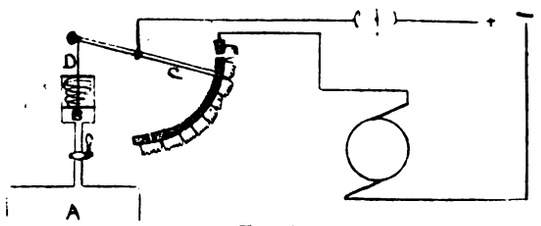

FIG. 1.

This system has the advantage over that described before in that the motor is not always running, but then the pressure will not nearly be so constant, and this is far more complicated; but all that is to be done to start up after a stop is to close switch G.

3. In the third system the idea in E (Fig. 1) is further developed. The action is thus: The spring in B is set so that the rheostat arm, C, is about in the middle of the contacts when the pressure is 70lb. Now, if this increases, D gets pushed up, and C comes round over contacts, putting in more resistance in motor circuit, and so reducing its speed, and *vice versâ*. The advantage of this system is that an approximately constant air pressure is obtained, but then the motor is always running, and also there will be trouble due to sparking at the contacts. This can, however, be avoided considerably by having a lot of these with very little differences of resistance between. On the whole I think I should advise "F. W." to try system 1, as this is the least complicated, has a low initial cost, and keeps the pressure fairly constant at the higher limit.—E. R. ALEXANDER.

Answer to No. 509 (*awarded* 7*s.* 6*d.*).—This may be done by a starting switch actuated by means of a solenoid (Fig. 1). To the iron plunger is fastened a brass piston

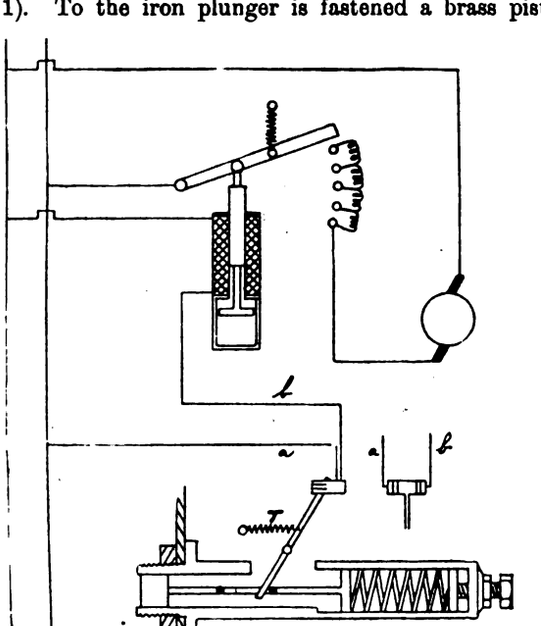

FIG. 1.

working in a dash-pot; the piston should be made a slack fit and the pot partly filled with oil. The down stroke, starting the motor, will then be made slowly, the helical spring pulling switch quickly on the off position when motor is to be stopped. To energise solenoid when pressure in air-chamber falls to 60lb., a fitting, as per Fig. 1, would answer the purpose. It is fastened to side of air-chamber; one end has an airtight piston, the other end works against a helical spring that can be adjusted by screw and lock nut. As shown, pressure is 60lb., and lever is pulled over to start motor; on pressure rising to any desired amount, piston would be forced outwards and the other stop move lever; tension spring, T, would then give a quick break.

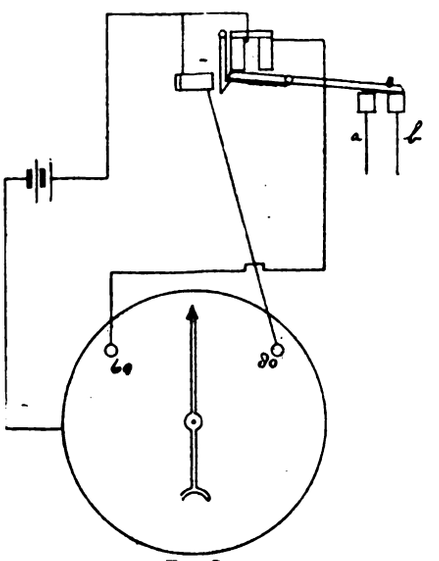

FIG. 2.

An alternative method (Fig. 2) would be to have two Leclanché cells, one pole to be connected to body of gauge, the other through two electromagnets to insulated pins 60 and 80 respectively. These electromagnets will then be in circuit alternately as pointer of gauge reads 60lb. or 80lb. It will be seen that catch holds lever, so that circuit is made by means of a U piece of copper in the two mercury-cups, when catch is pulled to one side (at 80lb.), rocking lever moves by gravity and breaks circuit. *a* and *b* are lettered for same wires in both sketches.—M. M.

Answer to No. 509 (*awarded* 7*s.* 6*d.*).—An arrangement for automatically controlling an electric motor driving an air compressor, so as to keep the pressure between 60lb. and 80lb. per square inch, is shown in Fig. 1. A spring or weight-loaded piston (shown in detail in Fig. 2) rises and falls according to the pressure in the receiver. On its downward journey, when the pressure is falling, it carries with it the operating lever, which in turn engages with the weighted lever, A, and as the piston nears the bottom

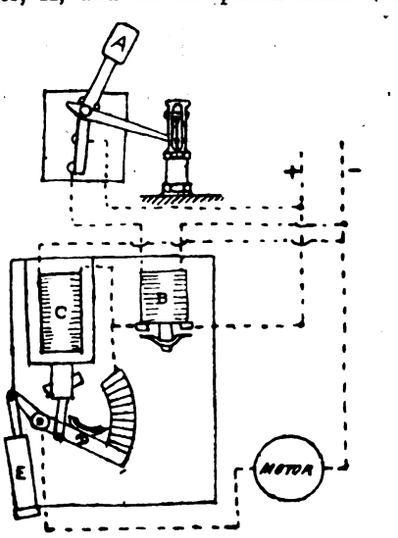

FIG. 1.

the weighted lever falls over to the right, and completes the circuit of the solenoid-controlled main switch, B, this switches on current to the motor with all resistance in the armature circuit and also energises the solenoid, C, which gradually draws up the switch arm, D, cutting out the series resistance slowly as the motor comes up to speed.

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A dash-pot; E, counteracts on the pull of the solenoid, C, so as to rendering the cutting out of the resistance being done slowly. Now, as the compressor brings the pressure in the receiver up to about 80lb., the piston rises and throws the weighted lever, A, over to the left, which breaks the circuit of solenoid, B, and this cuts off current from the motor and solenoid, C, which allows the switch

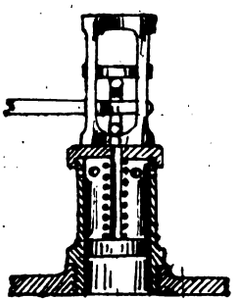

FIG. 2.

arm, D, to fall and cut in the series resistance ready for restarting the motor. I have seen a similar apparatus to the above working, and I believe it was supplied by the Sturtevant Engineering Company, of London.—P. C.

Answer to No. 509 (*awarded* 7*s.* 6*d.*).—There are a number of devices which could be employed to automatically operate the air-pump. The method described herewith would serve as an efficient controller. The action is as follows: In the position shown in the accompanying sketch the motor and compressor are at a standstill, and the reading of the pressure gauge, which is connected to the air-chamber, is about 65lb. per square inch. As soon as, by reason of a further decrease of the pressure in the air-vessel, the minimum contact of the gauge, M, is closed, and the electromagnet, G, excited. The armature of this

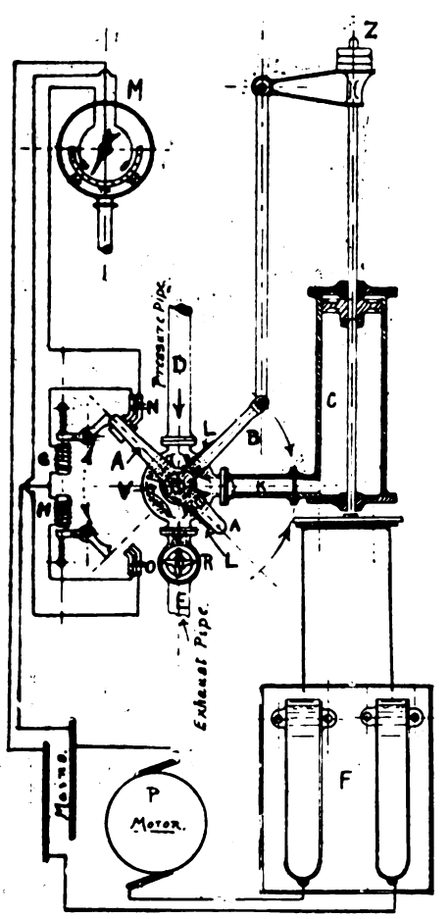

FIG. 1.

magnet, it will be seen, is made so as to act as a catch for arm A, and as soon as G attracts it, arm A is free. A spiral spring, L L, such as are used on ordinary starting switches, operates on the arm A, and is fixed between arms A and B. By reason of this spring, then, as soon as the arm A is released, contact N is interrupted, and contact O closed. At the same time the valve, V, which is attached to arm A is turned through 90deg. When the valve occupies the position as in the sketch, direct communication is established between the air-chamber through pipes, D and K, and cylinder, C; but when the valve is turned through 90deg., D is cut off and communication made between the cylinders and exhaust pipe, E. The cylinder, C, being cut off from the air chamber, and opened to exhaust through pipe E, the piston in C falls downwards, with a speed regulated at convenience by valve R and weight, Z. By the descent of the piston the liquid starting resistance is actuated, and motor, P, and the compressor are put in action. Thus air is being forced into the air-chamber, and the pressure in same gradually increases until the maximum contact at the pressure gauge is closed. By reason of this contact being closed, another magnet, H, is excited, the armature of which is exactly the same, and performs the same functions as the armature of magnet G. When the magnet H attracts its armature, arm A is again liberated, and by reason of spring, L L, it is being forced upwards. The action of spring, L L, is as follows: one end is connected to arm A and one end to arm B, and when in the position as shown in sketch tends to force A downwards. This it does as soon as the magnet G attracts its armature. Now, we have seen that when the arm A is at O, the cylinder is opened to exhaust, and the piston falls. In falling, besides actuating the resistance, it moves arm B downwards. This movement of B causes the spring to be stretched in the opposite direction, and it will now force A in an upward direction as soon as the arm is released. In this way, then, as soon as magnet H attracts its armature, arm A is forced upwards and restored to the position as shown in sketch. At the same time valve, V, is reversed, and cuts off exhaust, E, and once more restores communication between the air-chamber and cylinder, C, by means of pipes, D and K. The inrush of air quickly raises the piston in C, which pulls the starting gear out of action, at the same time raising arm B, and so winding the spring up ready to force the arm A down as soon as the minimum contact is closed. In this manner the motor is automatically controlled. By arranging movable contacts on the pressure gauge, any variations of the maximum or minimum pressures could be obtained.

An important consideration in connection with this arrangement is the absence of sparking at the contacts on M. For suppose the needle to close the minimum-contact magnet, G, is excited, and arm A forced to O. Now, as soon as A leaves N the circuit of magnet G is broken by reason of the contacts at N being separate. Consequently, when the needle leaves the contact owing to increased pressure, the circuit of which that is a part being broken beforehand by the arm A there is no spark.—W. F. S

Answer to No. 509 (*awarded* 7*s.* 6*d.*).—There are several methods of automatically controlling motors that could be

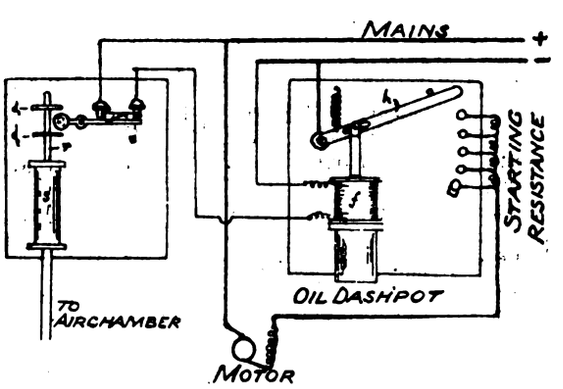

FIG. 1.

applied in the case mentioned in the question. Fig. 1 shows about the best and most suitable of these. It consists of an automatic motor starting switch and a small quick-break knife switch, which is opened and closed by the variation of the pressure of air in the bottom of the cylinder, *s*, that is connected to the air-chamber by a suitable pipe. The

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cylinder, *s*, is fitted with a spring in its upper part that presses a piston down against the air pressure in much the same way as a steam-engine indicator works. To this piston is fixed a rod, *r*, that projects through the upper cover of the cylinder, and that opens and closes the small knife switch by pressing one of the discs, d_1 and d_2, against the vulcanite ball that is screwed to an extension of the switch arm. The position of the discs on the rod is adjusted to close the switch when the minimum pressure is reached, and to open it when the maximum pressure has been attained. When the switch is closed it completes the circuit to the coil, *f*, of the starting switch, allowing the current from the mains to circulate through it; this coil draws down an iron core that is attached to the switch arm, *h*, which it draws over a series of contacts, and thereby cuts out resistance from the motor circuit. This cutting out of resistance must, of course, be done slowly, to allow the motor to gain speed gradually; hence the necessity of the oil dash-pot under the coil, *f*, the piston of which is connected to the iron core by a brass rod. As soon as the air pressure reaches its maximum the small knife switch is opened, then the starting switch arm, being no longer held on by the coil, *f*, is pulled off by a spring, thus stopping the motor.—A. J., SWANSEA.

Answer to No. 509 (*awarded* 7*s.* 6*d.*).—There are many comparatively easy methods of automatically starting and stopping the air-pump motor so as to keep the variation of pressure in the air-chamber within any given reasonable

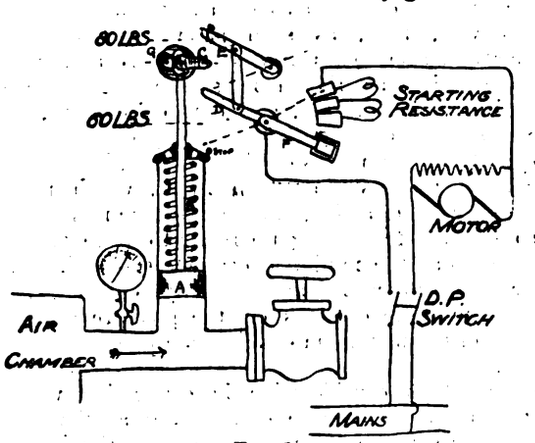

FIG. 1.

limits Perhaps one of the best is by taking advantage of the deflection of a spring which is acted on by a piston in direct communication with the air-chamber. The rough sketch given shows the principle of this method fairly clearly, so that very few words of explanation are necessary. A is a piston about 2in. in diameter, which is acted upon by the air pressure on its under side. Any movement due to this is opposed by the spring, B, which is of such a strength that the vertical movement of the "pawl," C, for the required range of pressure—*i.e.*, 60lb. to 80lb.—is about that shown in the sketch, or a little less than the distance between the two levers, D and E. The cylindrical space on top of the piston is left open to the atmosphere, so that any air which leaks past the piston may not tend to set up a back pressure. The lever D has attached to it, but insulated from it, the switch arm, F, which slides over a series of contacts in the usual way. In order that the pawl, C, may come gently into action, it is allowed a small amount of play between two stops, and is kept central by means of a spring, G, as shown in sketch. The sketch shows the motor stopped. The pressure in the air-chamber will be somewhere between the two limits. Suppose the pressure falls to 60lb. The spring B will then extend, and the pawl will come into contact with the lever D, shift the switch off the dead contact, and complete the motor circuit through the starting resistances, gradually cutting the latter out. The switchgear will then assume the position shown by the dotted lines, and the motor will be running at its full speed. If, now, the pressure in the chamber rises to about 80lb., the pawl will come into contact with the lever E and gradually shut the motor down. The motor will then remain at rest until the pressure drops down to 60 again. This apparatus can be easily regulated for any range of pressures by simply varying the distance between the two levers D and E and the strength of the spring B.

Another method of automatically controlling the motor would be to actuate the starting switch by a solenoid pulling against a spring. This solenoid would be excited from a relay off the mains. The relay could be worked by a dry cell, the current flowing whenever the needle on pressure gauge made contact with a small pin or brush fixed on the dial of the instrument but insulated from it. This method is, however, rather more complicated than the one described above, and it is also, I should think, not quite so reliable in working.—T. SQUARE.

Answer to No. 509 (*awarded* 5*s.*).—In such a case I have used the following disposition (Fig. 1): A is a cylinder

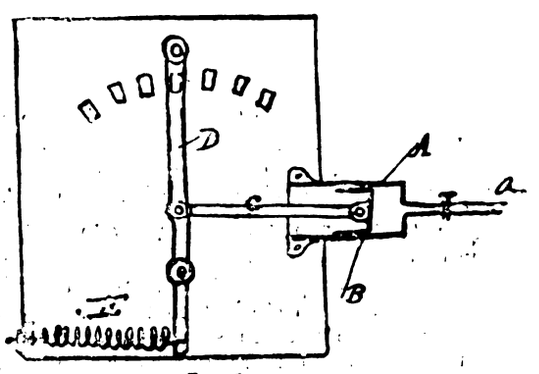

FIG. 1.

receiving the compressed air from the air-chamber by the pipe, *a*; B, a piston in this cylinder, connected to the rheostat arm, D, by the connecting rod, C; a spring, E, pulls always this arm from left to right. When there is no pressure in the air-chamber, or the pressure is under 60lb. per square inch, the spring keeps the rheostat arm on the right side, and the motor runs at full speed. When the pressure increases, the piston begins to move from right to left, and so the rheostat arm and the motor speed down, till, when the pressure is 80lb., the arm is on the left end and the motor stops. It is very easy to calculate the size of the cylinder and of the spring. In Fig. 2 the spring is

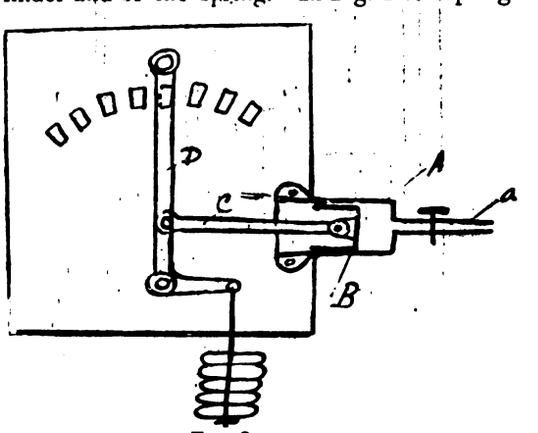

FIG. 2.

supplied with a counterweight, which works much better, and in which the weight can be changed according to the pressure.—G. T.

Answer to No. 509 (*awarded* 5*s.*).—One of the best methods for automatically controlling motor-driven air-compressors is that used by the Christensen Engineering Company, Milwaukee, U.S.A. It is employed by them in connection with air-brakes for electric trams and railways, but, of course, can be used in conjunction with motor-driven air-compressors for many other purposes for which compressed air is fitted. The automatic control is a simple piece of apparatus, consisting of an ordinary pressure-gauge mechanism connected with the air reservoir, having, instead of the usual pointer, a special hand, *a* (see diagram), fitted with a carbon contact at the end. On the dial of the instrument there are two carbon contact studs placed at positions of maximum and minimum pressure

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(in your correspondent's case 80lb. and 60lb. per square inch respectively). These contact studs are connected, as shown, to two solenoids, so that upon the hand coming in contact with the stud at the position of minimum pressure current passes through the coil, *b*. This

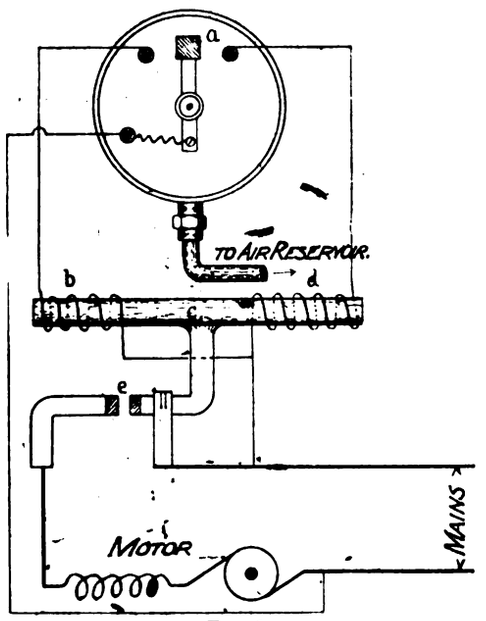

FIG. 1

coil operates a soft iron plunger, *c*, to which the contact-pieces, *e*, for the motor circuit are attached, thereby closing the circuit and starting the motor. As soon as the pressure reaches the desired maximum the hand strikes the other stud, and current passes through the second solenoid, *d*, thereby pulling the plunger in the opposite direction and opening the motor circuit. A magnetic blow-out is provided for extinguishing the arc and preventing the burning of the contact pieces. By this mechanism it is possible to get a very close margin between maximum and minimum pressures. This margin is readily altered by moving the contact-pieces. This instrument is intended to be used with a series motor. Special arrangements would have to be made for shunt motors (starting resistances, etc.) and for alternate-current motors.—P. H. H.

Answer to No. 509 (*awarded* 5*s.*).—Since no details of the motor are given, it may be assumed that it is shunt wound, since fairly constant speed is required. The first first method of regulating which suggests itself is that of introducing resistances into the shunt circuit. By automatically cutting out a suitable resistance when the pressure becomes too high, and placing resistance in series when the pressure falls, the desired result may be obtained. A simple form of switch is shown in sketch; the gauge is provided with two stops, *s s*, insulated from the framework of the instrument, in such positions that contact is made by

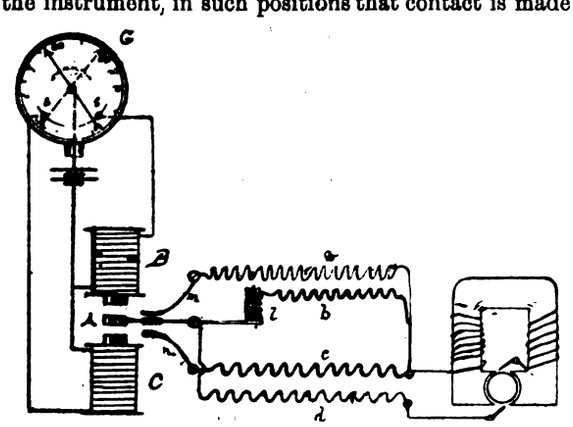

FIG. 1.

the indicator at the outside limits of pressure—60lb. and 80lb. per square inch. Platinum contact points should be used. When either of the stops is in contact with the pointer one or other of the strong electromagnets is excited; the armature, A, is attracted to the magnet and resistance put in or out. At a pressure of, say, 70lb. the shunt current passes through coils, *b* and *d*, the weight of the armature keeping the lever pressed against the spring, *l*. When the pressure falls and A is attracted to B, contact is made between the armature lever and the spring, *m*, thereby placing the higher resistance, *a*, in series. The spring, *m*, should make contact before *l* breaks contact to avoid breaking the shunt circuit. When contact with the other stop is made, A is drawn down, placing the coils *b* and *c* in parallel, thus reducing the resistance in circuit. The current in the shunt will be small, probably one or two amperes at most, and, providing that the circuit is not broken, there should be no difficulty in adjusting the springs so that good contacts are obtained. L. D. W.

Answer to No. 509 (*awarded* 5*s.*).—No details are given of the motor, but I will assume it is a continuous-current motor, series or compound wound, working at a pressure of from 100 to 220 volts. The stopping and starting of an electric motor is quite a different thing to a steam-engine. All the engines I have seen used for air compressing have had their governors arranged so as to automatically cut off steam or admit it as required. Naturally, one wants the same thing done with an electric motor, only the fact of having to insert resistance in the armature circuit and slowly cut it out makes the matter difficult.

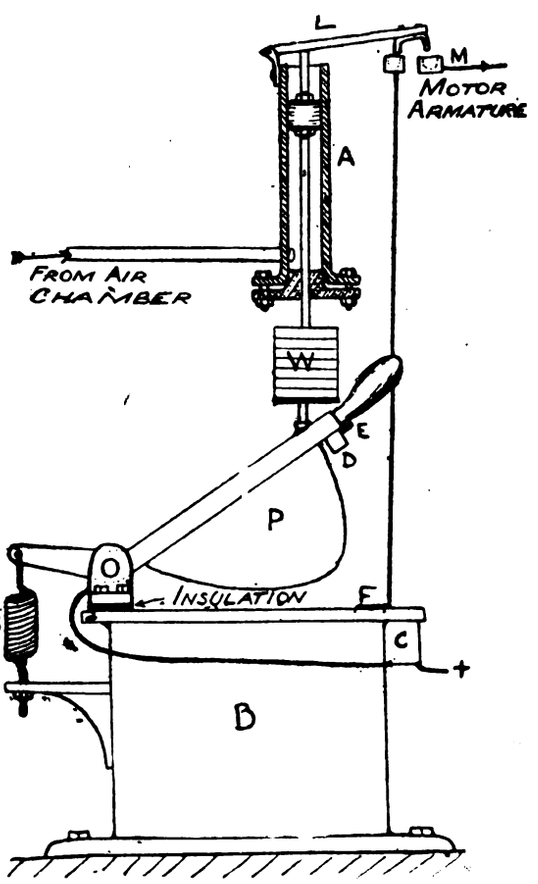

FIG. 1.

The apparatus described will answer "F. W.'s" requirements satisfactorily, I believe. Fix a pipe from the air-chamber to a cylinder, A, in which a piston can freely move up and down, in such a manner that the pressure of the air will tend to raise piston. Counterbalance this effect by suspending a weight on the piston rod. To the top of cylinder, A, fix a lever, L, so that when piston is at top position it will raise L. At the free end of the lever fix a ∩ piece of copper dipping into two mercury cups, M. Immediately under this apparatus fix a liquid starting resistance, which works in this manner. B is a tank containing a solution of carbonate of potash or dilute sulphuric acid. A cast-iron plate, P, can be pushed down into the liquid, if the tension exerted by a powerful spring, S, is overcome, and when it is fully immersed in the liquid a contact piece, D, makes contact with F, thus cutting out the resistance altogether. At the

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same time, an electromagnet, C, holds an armature, E, fast, preventing the plate, P, springing out of the liquid unless the current is switched off. I have had this type of liquid resistance in use for some time, and it acts very well. It is cheap and efficient. Suppose the air pressure in the tank has risen above 80lb. pressure. The piston in the cylinder, A, will be pushed up, and cause L to lift contact-pieces out of the mercury-cups. This allows the electro-magnet, C, to liberate E, and the motor stops. In a short time the air pressure falls, and allows the piston to gradually descend, and the weight slowly pushes the resistance in and starts the motor, causing the pressure to again rise Thus the pressure is kept fairly constant, and the motor started and stopped automatically. The electro-magnet, C, may be shunt wound instead of series wound, as shown, but then it would be necessary to arrange for some shunt-breaking device at the mercury-cups to avoid excessive sparking.—W. A. T.

Answer to No. 509 (*awarded* 5*s.*).—This is a common requirement on electric railway locomotives fitted with Westinghouse brakes and air-compressors. It is generally met by the employment of a simple air-piston actuated by the presence of the air in the air-chamber. This piston is

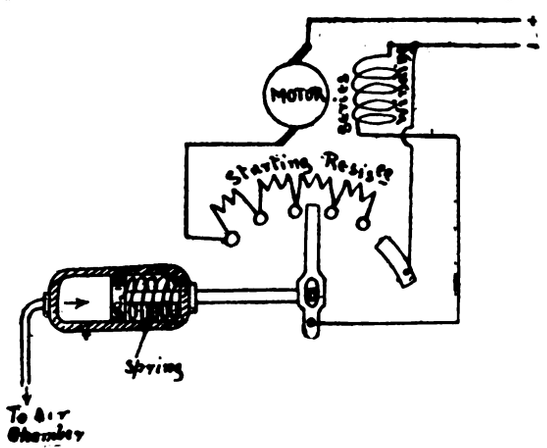

Fig. 1.

connected to the handle of the ordinary motor-starting switch. The switch is kept in the "on" position by means of a spring acting in opposition to the air-piston. As soon as the pressure in the air-chamber exceeds, say, 70lb., the spring would be overcome and the switch handle moved

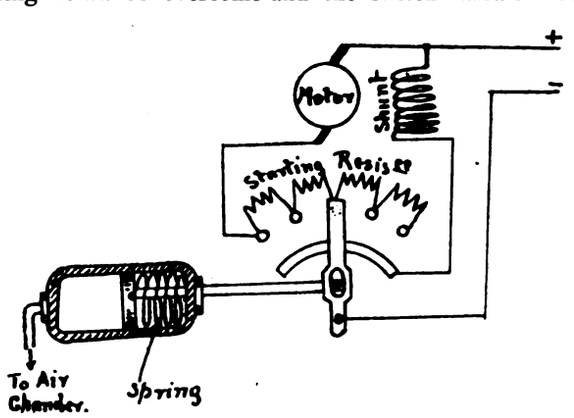

Fig. 2.

over towards the "off" position. When the pressure falls below 70lb. again, the spring overpowers the piston and switches the motor into circuit again. Figs. 1 and 2 show the arrangement for series and shunt motors respectively.—Q.

Answer to No. 509 (*awarded* 5*s.*).—A method for keeping the pressure in the air-chamber between 60lb. and 80lb. per square inch would be found in inserting an automatically varying resistance in the motor circuit. This could be done in the following manner (see sketch) : A V is the air vent; A S, adjusting stud; S S, spiral spring; C, cylinder; P, piston; P P, pressure pipe from air-chamber; W W, wires in series with motor circuit; I P, two iron plates insulated from each other; L R, liquid resistance. The air pressure enters cylinder through pipe, P P, and with the pressure at 60lb. per square inch the resistance is arranged for the motor to run full, or nearly full speed. As the pressure rises it forces the piston up into the cylinder, compressing the spring, and at the same time raising the plates out of the liquid, adding resistance to the motor circuit, causing the motor and pump to run slower, with a consequent drop in air pressure, which causes the spring to force the piston down again, also the

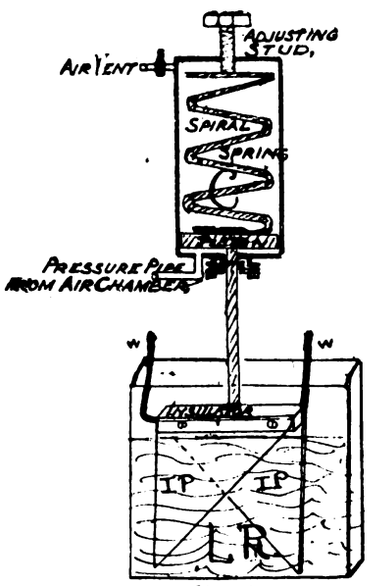

Fig. 1.

plates cutting out resistance, so that the motor again runs faster. The plates could be fixed on an angular insulating block so as to be nearer each other at the top than at the bottom, so as to get the necessary variation in the resistance. The air-vent cock at top of cylinder could be regulated so as to assist the spring and act as a buffer. With the several means of regulation—namely, the adjusting stud, air-vent, the size of and distance apart of the plates, and strength of the acid in the liquid—this apparatus would give "F. W." a method of automatically regulating the air in the air-chamber.—H. G.

Answer to No. 509 (*awarded* 5*s.*).—The accompanying diagram shows an attachment to an ordinary regulating

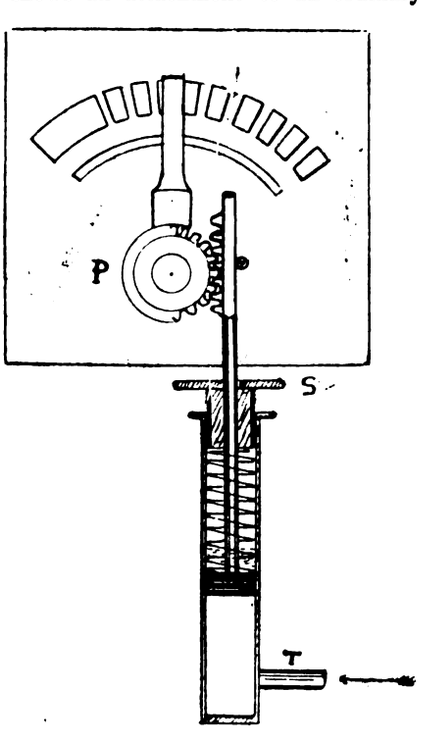

Fig. 1.

and starting switch arranged to suit the requirement set forth in the above question. The inlet tube, T, is connected to the air-chamber, which may be so adjusted by

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means of the screw cap, S, so that sufficient tension is placed on the spiral spring so as to have the same pressure or the necessary equivalent to that in the air-chamber. The pinion shown at P may be attached to the ordinary starting switch by having room left on the shaft. To make the arrangement more reliable, the space just over the bucket or plunger is filled with some heavy oil; then, providing there is no undue friction, the apparatus may be regulated so as to be very sensitive so as to respond to very slight variations in pressure by the regulation of the screw, S.—K.

Answer to No. 509 (*awarded* 5*s*).—Owing to the ease with which a motor can be started or stopped, there is no difficulty in fulfilling the requirements of the question. The difficulty will rather be found in selecting the best out of the many suitable methods which are open for adoption. The writer is partial to the use of the Sturtevant self-starting rheostats, as he has found these to give perfectly satisfactory results in every case. These self-starting rheostats really consist of two pieces of apparatus—one is a solenoid-controlled starting switch and the other a solenoid main switch. All that is required to be done to start the motor is to close any switch capable of dealing with, say, one ampere: this small current energises the solenoids; the main solenoid switch is then immediately closed, but the lever of the starting switch is only moved slowly from step to step, as the movement of the lever is controlled by means of a dash-pot. The speed at which the lever moves can be regulated by varying the thickness of the liquid in the dash-pot. The dash-pot is placed in the extreme bottom corner of the base on which the starting switch is mounted, so that no harm shall result if any of the oil works out. When it is required to stop the motor, the small switch controlling the supply of current to the solenoids is opened. The main switch immediately opens and stops the supply of current to the motor, while the starting switch lever, which is actuated by means of a spring, moves back to the "off" position in the same manner as in any other starting switch fitted with automatic no-load release, the only difference being that owing to the retarding action of the dash-pot the speed is slower. Similar switches are made by other manufacturers, and if one or other of these makes is adopted, all that is necessary is to connect to the vessel a small cylinder of very small bore in which works a piston, so connected to the switch controlling the solenoids that it closes the switch when the pressure falls to 60lb., and opens it when the pressure rises to 80lb. It must be remembered, especially if the voltage of the supply current is high, that this small switch must be fitted with a quick break, so that it will not be sufficient to attach the piston in such a way that it will be very gently opened or closed; such an arrangement would result in arcing and the rapid deterioration of the small switch. Both Messrs. Royce and the Electric Transmission Company build starting switches in which quick make and break are secured by the action of a falling weight. The same principle can be adopted in this case: the piston in connection with the vessel will act against a spring or other retarding device, so that for any given pressure the piston will always have a definite position in the cylinder. Now this piston can be coupled to a small barrel which winds and unwinds a cord to which is attached a weight, the weight making quick make and break in the manner adopted by the above firms. Another simple arrangement would be to use a small switch in which the quick action is obtained by turning the switch lever up an inclined plane, the base being cut into a series of planes with perpendicular drops, while on alternate planes the switch is closed, and on the others the switch is open. Both quick make and break are thus secured, and as the handle of the switch has always to be turned in the same direction there is no difficulty in connecting the small piston to it, as we are only getting the conversion of reciprocating motion into circular motion in the same way as is done in engine work. Several makes of these switches are on the market, and the arrangement would not be costly. The greatest expense would be in the self-starting rheostat; on the other hand, the method would be perfectly automatic and absolutely reliable.—M.

COMPANIES' MEETINGS AND REPORTS.

BRITISH COLUMBIA ELECTRIC RAILWAY.

An extraordinary general meeting of the shareholders in this Company was held on Tuesday at Cannon-street Hotel, E.C., Mr. R. M. Horne-Payne presiding, for the purpose of passing resolutions for the alteration of the articles of association.

The **Chairman,** in moving the resolutions, said it was necessary that they should be passed in order that the Company might be able to raise the further capital which was urgently required. Alluding to the report he made upon his visit to British Columbia last year, the chairman said that in that report he pointed out how the Company had grown since it was formed in 1897. He showed that their profits had risen from £20,000 in 1897 to £45,000 this year, and that the lights they were supplying had increased from 19,000 to 69,000, and foreshadowed a further large increase both in their earnings and in the number of lights they would have to supply. In the report, also, he pointed out that it was essential that further capital should be raised in order to provide the machinery necessary for supplying the further demands made upon them. If they failed to comply with these demands, no doubt another company would speedily come into existence, which would mean the cutting of rates and other things, which would not be advantageous to a company like theirs. Already another such company was being talked of, and it was imperative that the directors should be able to take advantage of the great increase in population and prosperity to sell more of their light and power.

Mr. Morton seconded the motion, which was unanimously carried.

YORK TRAMWAYS.

Presiding over the half-yearly meeting of this Company at York on Thursday week, **Mr. J. Kincaid** remarked that it was very desirable that some arrangement should be come to so that horse traction could be done away with and electricity used, which would be to the great advantage of the public. He hoped the Corporation would endeavour to meet the Company, so that some equitable agreement might be arrived at. The Company could not, of course, sacrifice anything, but the Corporation ought to act in the interests of the citizens. The Company had always taken the first step in these advances, and he would suggest that they put it to the Corporation that some extension of the tramways should be made so as to make them more useful to the public. An extension to Acomb would no doubt be very valuable to the residents in that district, and he thought it could be worked satisfactorily. If the meeting approved of the suggestion that the Company should present the matter to the Corporation, he thought the directors would decide to write to the town clerk and ask him to bring the matter forward.

The resolution was adopted, and the meeting ended.

CHLORIDE ELECTRICAL STORAGE.

The directors in their report for the year ending June 30, 1902, state that the progress of the business of the Company has been maintained during that period. During the year the directors have taken in hand the matter of reducing and adjusting the capital and assets, with the unanimous co-operation of all classes of shareholders, and, they venture to submit, with a result which will be much to the benefit of the Company. The directors have to congratulate the shareholders on the high class of business for which they continue to receive orders, showing the undoubted value of the Chloride battery. The Company keeps itself abreast of all advances that are being made in technical knowledge with reference to the construction and use of storage batteries, and the directors are satisfied that at the present time the Chloride battery has substantial advantages in durability and efficiency over all others. The balance-sheet shows a trading profit for the financial year of £12,901. 7s. 5d. After providing debenture interest, other expenditure, and depreciation (as per balance-sheet), amounting to £5,753. 12s. 6d., there remains a disposable balance of £7,147. 14s. 11d., which the directors propose to deal with as follows: to pay a dividend as from April 14, 1902 (the date of the order of court authorising the reduction of capital) to the end of the financial year on the preference shares of 6 per cent. per annum (less income tax) and on the ordinary shares of 8 per cent. per annum (free of income tax), and to carry forward the balance of £5,801 6s. 7d.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Durban.—Tenders will be invited shortly for plant for a new electric power station, entailing an expenditure of £25,000.

Cape Town.—The engineers' plans for the new harbour works provide for lighting by electricity, the extensive plant for which will shortly be ordered.

Ladysmith.—Tenders are invited by the Municipality for the supply, delivery, and erection of the complete lighting plant, inclusive of overhead mains.

Grimsby.—The Corporation invite tenders for the supply of continuous-current motors for letting on the hire system. Tenders by Sept. 20. See advertisement.

Dundee.—The Gas Commissioners invite tenders for the supply of carbons for public lamps, delivered at the Electrical Power Station, Dundee. Tenders by Sept. 24. See advertisement.

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Tientsin (China).—Mr. A. W. Harvey Pellingham, secretary of the British Colony at Tientsin, China, invite tenders for installation and working of electricity works. Tenders by Nov. 30.

Burton-upon-Trent.—The Corporation invite tenders for the supply and laying of electric mains, conduits, junction boxes, etc., in connection with the tramways. Tenders by Sept. 30. See advertisement.

Blackburn.—The Town Council invite tenders for the supply, delivery, and erection, at the electricity works, Blackburn, of one electrically-driven travelling crane. Tenders by Sept. 22. See advertisement.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at the Electricity Works, Swindon, Wilts, of one complete lighting switchboard, with all instruments and accessories. Tenders by Sept. 19. See advertisement.

Bedford.—The Corporation invite tenders for the supply and delivery of two boiler feed-pumps. Specifications, etc., can be obtained from Mr. R. W. L. Phillips, borough electrical engineer, Cauldwell-road, Bedford. Tenders by Sept. 15.

Dundee.—The Gas Commissioners invite tenders for the supply and erection, at the Electrical Power Station, Dundee, of water-tube boilers, with mechanical stokers and superheaters, and induced-draught apparatus. Tenders by Sept. 24. See advertisement.

Orence.—The Municipal Authorities invite tenders for the installation and working for 20 years of electric lighting the above. One hundred 16-c.p. lamps will be paid for at the rate of 3,500 pesetas per annum. Tenders to the above authorities, province Celanova, by Sept. 23.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories Tenders by Sept. 15. See advertisement.

Cabeza del Buey (Spain).—The Municipal Authorities invite tenders for installation and working, for not more than 25 years, of electric lighting; about 3,000 c.p. are now required, for which a maximum of 3·33 pesetas per annum will be paid. Tenders by Sept. 19 to the above authorities, province of Badajoz.

Southampton.—The Corporation invite tenders for the construction of tramways in Onslow-road, Bevoir-valley, and Portswood-road, having a total length of about 2,058 yards of single track. Specification, etc., may be obtained and plans inspected at the Borough Engineer's Office, Southampton. Tenders by 2 p.m. on 17th inst.

Shanghai.—Messrs. Preece and Cardew are authorised to receive tenders for the supply and delivery c.i.f. of two 500-kw. steam alternators (the engines to be enclosed double-acting type and alternators to have stationary armatures, pressure 2,100 volts, periodicity 100), switchboards, and two condensers and circulating water pumps. Tenders by Oct. 30. See advertisement.

Bury (Lancs.).—The Tramways Committee invite tenders for the work required in the construction of the permanent way in several parts of the borough—viz.: Fairfield section, Bolton-road section, Heywood-street section, and Knowsley-street section. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by 24th inst.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

Pietermaritzburg.—Tenders are invited for the supply and delivery, free on rail, Pietermaritzburg, Natal, South Africa, of six miles of Vignoles rails, 704 pairs of fishplates (complete with bolts and nuts), 21,120 dog spikes, 1,408 crab bolts, nuts, and fang clips, and 1,760 copper bonds. Specifications, etc., may be obtained from the office of the Borough Engineer, Pietermaritzburg, or from the Corporation's London agents, Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, London, W. Tenders by Sept. 15.

Dungannon (Ireland).—The Urban District Council invite tenders for the supply, delivery, and erection of the plant and material, and for the carrying out of the work comprised in the adjoined sections: (Section A) dynamos (two 35 kw.), switchboard; (B) gas plant—(Sub-Section a) engines (two 60 b.h.p.), (b) producer-gas plant; (C) battery; (D) underground feeder and distributing mains; (E) public lamps and connections to mains. Specifications, etc., can be obtained from Mr. James M. Hamilton clerk of the Council, Dungannon. Tenders by Sept. 24.

Ashford (Middlesex).—The Managers of the West London School District invite tenders for the following in connection with the electric lighting of their schools at Ashford, Middlesex: (Contract No. 1) dynamos, booster, storage battery, switchboard, etc.; (2) feeders and wiring. Specifications, etc., may be inspected at the offices of the consulting electrical engineer, Mr. T. J. Digby, 32, Shaftesbury-avenue, W., or at the Schools, and obtained from Mr. F. G. Beeching, clerk to the Managers, West London District Schools, Ashford Middlesex. Tenders by 6 p.m. on 25th inst.

Pietermaritzburg.—Tenders are invited for the supply and delivery, free on rail, Pietermaritzburg, Natal, South Africa, of eight miles of girder rails, 938 pairs of fishplates (complete with bolts and nuts), 938 sole-plates (complete with bolts, nuts, and clamps), and 2,345 copper bonds. Specifications, etc., may be obtained from the office of the Borough Engineer, Pietermaritzburg, or from the Corporation's London agents, Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, London, W. Tenders by Sept. 15.

Madrid.—The Postal Telegraph Department invite tenders for laying of 71 miles of submarine cable between Santa Isabel (Fernando Po) and King Bell's Town (Cameroons). The maximum subvention will be 8,400 pesetas per mile. A building is to be erected at the landing point; the contractors must furnish trial apparatus and pay 75 pesetas per day to each member of the commission of inspection, which has been appointed by the Government, until acceptance of the cable. A provisional deposit of 30,000 pesetas and a final deposit of 10 per cent. of the value of the contract will be required. Tenders by Sept. 30, which are to be addressed to the above authorities, from whom further information may be obtained.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of land-owners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

King's Norton, Birmingham.—The Urban District Council are prepared to lease their powers obtained under their electric lighting order in 1898. The area of supply comprises the whole of the civil parishes of King's Norton and Northfield, in the county of Worcester. The streets scheduled for supply within period limited by the order are all within the wards of Moseley and King's Heath, which together contain a population of 20,400. Prints of the order may be obtained from the Government printers, Messrs. Eyre and Spottiswoode. The engineer is Mr. A. W. Cross, A.M.I.C.E., 23, Valentine-road, King's Heath, Birmingham, to whom enquiries for further particulars should be addressed. Preliminary offers must be addressed to Mr. Edwin Docker, clerk to the Council, 10, Newhall-street, Birmingham, and reach his office by Sept. 18.

Reading.—The Corporation invite tenders for work in connection with the tramways—viz.: (Section A) comprising the supply, delivery, drawing-in and connecting up of all feeder cables, rail return cables, test wires, etc., with joint-boxes and jointing, and the carrying out of tests; (B) comprising the supply, delivery, erection, and connecting up of all poles, brackets, wires, cables, insulators, switch-boxes, and other fittings, and the carrying out of tests. Specifications, etc., may be obtained at the office of the engineers, Messrs. J. Bowen and I. E. Winslow, Town Hall, Reading; for Sections A and B, £5. 5s.; for Section A only, £3. 3s.; for Section B only, £5. 5s. These deposits will be returned after the Corporation shall have come to a decision upon the tenders received, provided that a bona fide tender has been sent in on the form bound up with the specifications, etc., from which it must not be detached. For the convenience of tenderers a duplicate copy of the bill or bills of quantities and schedules will be supplied on payment of £1. 1s. (not returnable). A copy of the specification and drawings may be seen at, but not obtained from, the office of Mr. I. E. Winslow, 35, Parliament-street, Westminster, S.W. Tenders by 12 noon on Sept. 18.

RESULTS OF TENDERS.

Mexborough.—The Council have accepted the tender of Belliss and Morcom for the supply of one 150-h.p. engine, with Mavor and Coulson's dynamo.

Darlington.—The Corporation have placed an order for the supply of meters for the ensuing 12 months, the number of meters to be ordered being 100, with Ferranti Limited, of Hollinwood.

India.—The Bengal Iron and Steel Company have placed a further order with Crompton and Co., Limited, of Chelmsford, for two dynamos for direct coupling to Willans engines of 300 h.p.

Shanghai (China).—The tender of Belliss and Morcom has been accepted for the supply of one engine for coupling to Mather and Platt's dynamo to Messrs. Preece and Cardew's specification.

Bournemouth.—The Bournemouth and Poole Electricity Supply Company have accepted the tender of Belliss and Morcom for supply of steam-engines, with condensing plant and Siemens dynamos.

Yorkshire.—The Wheldale Iron and Coal Company have decided to instal a 200-h.p. Willans engine for direct coupling to a dynamo of Holmes and Co.'s make, the combined plant being used for electrical power work in connection with their colliery.

Newport (Mon.).—The Town Council have accepted the following tenders in connection with the extensions of plant at the power station: Messrs. Markham, engine, £4,300; Witting Bros., generator, £1,975; Babcock and Wilcox, boilers, £1,964.

Exeter.—The City Council have accepted the following tenders for erecting an electric lighting station on the western bank of the River Exe: J. Brealy, St. Thomas, Exeter, £14,008; British Westinghouse Company, supplying plant and equipment to same, £29,707.

Bury (Lancs.).—The Tramways Committee have accepted the following tenders for supply and delivery of rails and fishplates; fishbolts and nuts, tiebars; points and crossings; and sole or anchor

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plates: W. Scott, Limited, Steelworks, Leeds, rails and fishplates; Ibbotson Bros. and Co., Globe Works, Sheffield, fishbolts and nuts; Cooper Patent Anchor Rail Joint Company, Central Bank-chambers, Leeds, anchor plates.

Doncaster.—The Corporation have received the following tenders for the supply, delivery, and fixing of an ejector condenser plant, with all necessary pumps, piping, etc., at the Corporation electricity works, Doncaster:

Geipel and Lange, Parliament-mansions, Westminster, S.W. (accepted)	£1,069	10	9
T. Ledward and Co., 11, Tothill-street, S.W.	1,213	0	0
Korting Bros., 53, Victoria-street, S.W.	1,095	5	0
Klein Engineering Company, 94, Market-street, Manchester	1,075	0	0
R. Morton and Sons, Belhaven Works, Wishaw, N.B.	1,051	0	0

London.—The Metropolitan Asylums Board have received the following tenders for an electric fire-alarm installation at the Orchard Hospital:

Cox-Walkers, Darlington (accepted)	295	0	0
Private Wire and Telephone Installation Company, Westminster, S.W.	419	0	0
Scholes and Son, Manchester	423	0	0
Electric Installation and Maintenance Company, Buckingham Palace-road, S.W.	438	1	5
J. Bakewell and Co., Queen Victoria-street, E.C.	455	15	6
J. Sax and Co., Limited, Rupert-street, W.	475	0	0
Jackson Bros., Plaistow	697	14	6

South Africa.—The equipment of the new Natal Government Railway machine shops at Durban is being supplied by the South African General Electric Company, through Mr. J. Kirkwood, the local manager. It includes 119 electric motors, varying from 15 h.p. to ½ h.p., and six 300-i.h.p. steam dynamos. There is also on order a special machine to supply current at different voltages for the machine shop. At the Maritzburg machine shops a three-phase plant is being erected to supply lighting and power.—Ferranti Limited have secured a contract from the Bloemfontein Town Council for the supply of their cellular switchgear for a large switchboard to be installed in the town's central station.—The tender of Messrs. Davies and Spain for two motors, one of 20 h.p. and another of 8 h.p., has been accepted by the Johannesburg Town Council.—Two 35-ton and one 5-ton cranes have been supplied to the Natal Government new railway machine shops by the South African General Electric Company, while six electrically-driven capstans for shunting purposes are on order.—*British and South African Export Gazette.*

BUSINESS NOTES.

LIGHTING AND GENERAL.

Yarmouth.—The Council have increased Mr. Bryant's salary by £50.

Battersea.—Mr. S. Hale has been appointed chairman of the Lighting Committee.

Rhodesia.—The Sabiwa Central gold mine are considering the purchase of electrical plant.

Stock Exchange.—A boom is expected in electrical schemes, especially in electric power and traction schemes

Airdrie.—The Scottish House-to-House Electricity Company, Limited, have commenced lighting the street lamps.

Caerphilly.—Mr. R. H. Fletcher has been appointed to report on the proposed application for an electric lighting provisional order.

Middleton.—A reduction of the price of electricity for power and lighting—the latter being from 2½d. to 2d. per unit—has been agreed to.

Wellingborough.—Plans of the electric lighting station have been approved by the General Purposes Committee of the Urban District Council.

Birkenhead.—The Electricity Committee have resolved to lay electricity cables in Bessborough-road, Heathfield-road, and Kingsland-road.

Wigan.—Mr. H. Percy Boulnois has held an enquiry into the application of the Town Council for sanction to borrow £10,000 for electric motors, etc.

Bridgend.—The Council have arranged to borrow £1,350 from the Public Works Loans Commissioners for the purchase of land for electrical purposes.

Walton-on-Naze.—The Urban District Council have decided to light the town with electricity. The decision has yet to be confirmed at a subsequent meeting in public.

Harrogate.—Plans for the electric lighting of the kursaal are being prepared, and tenders will be issued shortly. Mains will be laid in St. James's Park Estate, and transformers erected.

Darlington.—The Rural District Council have informed the National Telephone Company that they must put wires in the village of Blackwell underground, as poles were objected to.

Chapel-en-le-Frith.—The Corporation of Sheffield intend to include Castleton and Hope in their municipal telephone scheme and have been asked to include Bamford and Ashopton also.

French Telephones.—The telephone has been a Government monopoly in France since 1899, but Paris has only 33,000 telephones, and the rest of France put together about the same number.

New Book.—"Exercises in Electrical Engineering," by Magnus Maclean, M.A., D.Sc., F.R.S.E. (1s. 6d.), has just been issued by Biggs and Co., 139-140, Salisbury-court, Fleet-street, London, E.C.

Kirkcaldy.—The Town Council have agreed, in connection with the payments to contractors for the tramway and electric lighting scheme, to obtain a short loan from the bank for £6,000 for two months.

Eton.—Mr. E. Bailey-Denton, consulting engineer to the Council, has prepared a report upon an electrical plant for the pumping station in the place of steam, which he estimates would effect a saving of £100 to the Council.

Liverpool.—The Electric Power and Lighting Committee of the Corporation have received sanction to the borrowing by the Council of the sum of £300,000 for purposes connected with the supply of electrical energy.

Wireless Telegraphy.—Four of the Ostend mail packets are now fitted with wireless telegraphy, and arrangements are being made by which passengers will be able to receive and dispatch private messages during the voyage.

Northampton Institute.—The full day courses in mechanical, electrical, and horological engineering will commence on Sept. 29, 1902. The entrance examination will take place on the 24th and 25th inst. See advertisement.

Canada-Cape Service.—The contract between the Imperial and Dominion Governments and the Allan, Elder-Dempster, and Furness Lines for the South African service stipulates that all the boats must be equipped with electric light.

Hove Electric Lighting Company, Limited.—The directors have resolved to pay an interim dividend on Oct. 15 next on the paid-up share capital of the Company at the rate of 7 per cent. per annum for the six months ended June 30 last.

Colchester.—The electrical engineer's last report states as follows: output of electricity in units during July, 1902, 8,533, (1901, 4,644); number of consumers at end of July 286 (179); total number of 8-c.p. lamps connected at end of July 16,926 (11,116).

Batley.—The Town Council have confirmed the appointment of Mr. S. Jones, of Doncaster, as clerk of works at the new electricity works. It is anticipated that when the building is complete and the plant installed, Mr. Jones will be appointed electrical engineer.

Auckland (N.Z.).—The Council are consulting Mr. Goodman on the question of electric lighting. The Government have placed on the estimates for 1902-3 the sum of £15,000 for the upkeep of the public gardens, electric light, drainage, etc., at Rotorua.

Newport (Mon.).—It is probable that the specification for the County Council's new lunatic asylum at Coulson will be amended so as to include the provision of an electric lighting and power plant at the asylum. It was first intended to take the supply from the Borough Council's mains.

Worcester.—The City Council last week discussed a motion to the effect that Mr. A. R. Bennett, of Glasgow, be asked to advise the General Purposes Committee as to the desirability of establishing a municipal telephone exchange, and as to the initial and annual cost. No decision was arrived at.

Romford.—An offer by the United Electric Light and Power Company to construct local electricity supply works is under consideration by the Urban District Council, who hold a provisional order for the supply of electricity in their district. The Council are about to consult Mr. W. C. C. Hawtayne.

Brentwood.—The Urban District Council have called a meeting of the ratepayers to consider whether they shall take steps to obtain an electric supply provisional order, or whether the matter shall be left to a private company who have expressed an intention of applying for powers to supply electricity in the district.

Buxton.—A cable will be laid to Haddon Hall Hydro at a cost of £225. Mr. Leeming has been appointed honorary electrical engineer in connection with the Röntgen rays installation at the Devonshire Hospital. An equivalent of 12,499 8-c.p. lamps has been connected, and 508 8-c.p. lamps are awaiting connection.

Cleckheaton.—We are informed that the fires were lighted in the furnaces at the electricity works on the 11th inst. Slow fires will be maintained in the destructor cells during the next three or four weeks to thoroughly dry the brickwork before the official starting of the plant. Messrs. Baker and Appleby are the consulting engineers.

American Pacific Cable.—It is reported that the Commercial Cable Company will reject the Government's terms for the Pacific cable. The company especially disliked the requirement for an independent cable from the Philippines to China, duplicating the Eastern extension of the company's line, and infringing its exclusive claim.

Dingwall.—The Town Council have accepted an electric light scheme prepared by Mr. Deacon, engineer for the electric scheme now being introduced into Strathpeffer. This scheme shows that Major Blunt is willing to provide a transforming station and provide electric light for Dingwall himself, so that the Council would have no responsibility.

Morley.—The Electric Lighting Committee have resolved to offer a small steam exciter for sale by tender. The electrical engineer (Mr. H. Drewett) in his last report states that the output from the works during the four weeks ending Aug. 9 was 4,062 units, as compared with 3,361 units for the corresponding period of last year, being an increase of 601 units.

Grate Stokers.—The Underground Electric Railways Company (of London), Limited, at Lots-road, Chelsea, have ordered from Messrs. Babcox and Wilcox 128 chain grate stokers, which are to be used in connection with 64 of that firm's boilers recently sold to this company. We are informed that this is the largest order for chain grate stokers that has ever been booked at one time.

Sunderland.—At a recent meeting of the Electricity Committee the question of supplying electric power to manufacturers, shipbuilders, etc., was considered, one firm having made an application

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for such service. It was ultimately decided to inform the company that a royalty charge of 1d. per 100 volts would be made in the event of the agreement with the Corporation being ratified.

Northfleet.—The Kent Electric Power Syndicate will shortly submit proposals to the Council for the working of the electric lighting order. The Corporation of Gravesend have offered to supply electricity in bulk for lighting and power purposes to the Northfleet Council. The Telephone Company are being asked to fix their wires to the tramway company's poles, and so save the erection of additional poles along the road.

Canterbury.—The Town Council have adopted a report of the Lighting Committee recommending that the public lighting cable be laid in Hawks-lane; that the engine-room plant be taken over from the contractors when the slight defects noticed on the tests of the plant have been made good to the satisfaction of the consulting engineer; and that the boiler-house, condensing, and switchboard plant be taken over at once.

Steyning East.—At the last meeting of the Rural District Council a letter was read from a resident asking permission to lay a cable to his house from the Brighton electricity mains, and the clerk was instructed to write to the Brighton Corporation enquiring upon what terms they would rent a meter to the Council, so that they might supply the current, the Chairman stating that if a profit was to be made upon the transaction the Council ought to have it. Other applications of a similar character have been received.

Plant for Sale.—The Gas and Electricity Committee of the borough of Stafford invite offers for six battery-regulating switches, circular type, 19 contacts, capacity 300 amperes, of E.C.C. make. Messrs. Moore, Loughlin, and Co, Limited (in liquidation), Manchester, will sell by public tender their valuable stock-in-trade, machinery, plant, and fixtures. Their building is also well adapted for an engineering works or factory for the manufacture of heavy or light articles. Further particulars appear in our advertisement columns.

Redruth.—The electric lighting is, so far as it has been carried out, satisfactory, but many complaints are made as to the non-lighting of the branch streets and outskirts of the town, the darkness during the past few weeks having been very inconvenient. It is, however, stated that the lights will be fixed as soon as possible—probably before the end of this month. The roads, which have been in a deplorable state during the construction of the tramway, are to be put into proper order by the local authorities, the tramway company paying the cost.

Limerick.—The Board of Trade having asked for a definition of the terms and conditions under which the proposed transfer of the electric lighting undertaking to the Gas Committee would be carried out, it has been decided that the area of supply should be the area as defined by the electric lighting order of 1892—namely, the borough of Limerick—and that the periods for which the proposed transfer is to take place be five years, renewable during the period for which the loan was granted. With regard to the building of the power-house an arrangement was come to by which it is hoped Mr. Bourke, the contractor, will get a sufficient number of workmen to enable him to complete the building within the specified time.

Strokestown.—We are informed that Mr. Joseph Hayden has just completed what promises to be a most successful electric lighting scheme for Strokestown, co. Roscommon. There is a 29-h.p. engine by Tangyes, Limited, Birmingham, coupled to a compound dynamo of 1,900 revolutions per minute. The pressure will be 220 volts. Consumers will be charged £1 per annum for each 16 c.p. lamp. The present scheme will provide public establishments with an ample supply of current for £6 each per annum. Traders using light in their business places will also be supplied with unlimited current for domestic purposes. The time to which lamps will be lighted is from dusk till 11 o'clock. Everything is in readiness for starting the public as well as the private lighting.

S.A. Appointment.—Mr. A. Laing has been appointed in charge of telegraphs, Johannesburg. Mr. Laing started his telegraphic career in the Stirling Post Office, but soon obtained a transfer to Edinburgh, in which office he remained until he left for Natal—14 years ago. He may be described, says the *Scotsman*, as one of the telegraphic pioneers of that colony. Mr. Laing was appointed to the general manager's office in 1890, and in that office has played an important part in the management and organisation of the department. As a reward for his services, he received the controllership of Pietermaritzburg some 12 months ago. The Johannesburg appointment is one of the two most important in the Transvaal service. On the eve of his departure for Johannesburg, the Pietermaritzburg staff presented their late controller with a gold watch and chain in token of the respect and esteem in which he was held.

Wakefield.—Steps are being taken to erect a sub-station in Kirkgate. The engineer has procured the switchgear required, and will dispose of three transformer cases purchased from Messrs. Fowler and Co. (Leeds), Limited. The Westinghouse Company have obtained another order for various meters for stock. The 400-kw. steam alternator of Messrs. Ferranti Limited is completed. At the last meeting of the Guardians a letter was read from the Wakefield Gaslight Company, Limited, stating that their attention had been drawn to the fact that owing to the gas-pipes at the workhouse having been found to be in a deficient state, and that their repair would cost £200, it had been decided to put in an electric light installation at a cost of £1,800. The company offered to overhaul the gas-pipes and put in new pipes where necessary free of charge. The matter was referred to committee for consideration.

Long-Distance Telephone.—Telephonic communications will be established in November between Rome and Milan, and between Rome and France, England, and Switzerland. The Belgian and the British telegraphic authorities have been busy getting the cable laid to establish telephonic communication across the North Sea between St. Margaret's Bay, near Dover, and the little Belgian bathing resort of La Panne. Most successful trials have been made between Brussels and England on one line, the other not being ready as yet, for there will be two lines in use from the start. The communications will be obtainable from either Brussels or Antwerp to London, it being possible for the public to correspond from their own houses without having to go to a public call office. The negotiations in respect of the details of the convention are not quite concluded, but it may be said that the price of each communication of three minutes will be 8s, or 10fr.

East Barnet.—The Electric Lighting Committee are considering a letter from the North Metropolitan Electrical Power Distribution Company, saying that the Metropolitan Electric Tramways Company, with which they were in association, were, by agreement made with the Herts County Council, taking over the construction and working of the Hertfordshire light railways, some of which would run in East Barnet district, the North Metropolitan Company would therefore be able to supply residents and traders, and they asked whether an arrangement could be effected whereby the Electrical Power Company should undertake the statutory obligations of the provisional order for electricity supply. A motion to apply for sanction to borrow money to carry out the electric lighting scheme, plans for which are being prepared by the engineer to the Council, and the cost of which is estimated at £30,000, was mentioned last week, and discussion postponed to a future meeting.

St. Annes.—The electrical engineer in his last report states that the work had been progressing smoothly during the past month, in spite of July having been the lightest month of the year as regards the output. The output and lamp connections will show an increase over the corresponding period of 1901. They had sold during July 5,845 units, against 4,082 during the corresponding period of 1901; the units sold for the year being 27,489, against 20,000 during the corresponding four months of 1901. The cost of production exclusive of capital charges was 2·95d. per unit, against 3·34d. in 1901. The actual number of consumers connected to the mains is now 117, with a total of 8,337 equivalent 8-c.p lamps, this time last year there being only 33 consumers with 3,807 8-c p. connections. The question of lighting the undermentioned streets is before the Electric Lighting Sub-Committee: Orchard-road, Twiggy-lane, street off St. Alban's-road, and the steam laundry, also an extension to Headroomgate-road.

Alnwick.—The electric supply has been successfully inaugurated with between 2,000 and 3,000 incandescent lamps, which will be supplied at 5½d. per unit. The Northern Counties Electric Supply Company, Limited, early last year obtained a provisional order for the supply of electricity to the town, and after obtaining the sanction of the Urban District Council started to erect works, under the supervision of the manager, Mr. C. W. Fairweather, Mr. C. S. Vesey-Brown being the consulting engineer. The Callender Cable Company laid the cables. The building was erected by Messrs. J. and G. Douglas Bros., of Heaton-on-Tyne. There are two Babcock-Willcox boilers, fitted with mechanical chain grate stokers; two compound three-crank engines, by Ruston, Proctor, and Co., Limited, Lincoln, coupled direct to 75-kw. dynamos by Crompton and Co., of Chelmsford, at 470 revolutions per minute and 150 h.p. Messrs. Dorman and Smith supplied the switchboard. The Chloride Electrical Storage Company have also provided 250 storage cells.

Accidents.—A verdict of "accidentally drowned" was returned in the case of the joiner who met his death at the Halifax electricity works by falling into the hot-tank of the cooling tower. At the inquest upon the body of Henry Yeomans, who died on Friday of last week from a fall at the Walsall Corporation electrical works, Mr. A. Wyllie, the electrical engineer, said he could not understand how the deceased could come into contact with the bars charged with electricity. There were "dead" bars in front which the deceased would naturally take hold of in climbing. He believed the "live" bars were altogether inaccessible to the deceased, being over 15ft. from the ground. He did not think there could be any leakage from the bars charged with electricity. The jury returned a verdict of "accidental death." A similar verdict was recorded in the case of a lamp-trimmer at Yarmouth, who fell from a standard while changing globes. An electric cable fire occurred on Tuesday attributed to a defect in the underground electric cable of the Charing Cross and Strand Electric Corporation outside the Comedy Theatre in Panton-street, Haymarket. Some damage was done by the fusion of wires in a laundry and also upon the premises of a print-seller in Panton-street.

Glasgow.—The Council have decided to petition the Government with a view to the proposal of the Chamber of Commerce being carried out as soon as possible with regard to underground telegraph wires, which has already been fully referred to. The Telephone Committee have now 6,310 instruments wired up, and orders for 1,600 are in hand. Reference was made at last week's meeting of the Council to a leader in the *Glasgow Herald*, in which it was said that the telephone department was being worked at a loss of £10,000, and that although skilful book-keeping might keep this off the rates for some time, it was bound to come. He wished to ask the convener if there was the slightest foundation for this alarming statement. The Chairman of the Committee (Mr. James Alexander) said he was glad that attention had been drawn to this subject. He was surprised that the *Herald* should allow a statement of that sort to go forth without better information. Had they gone to Treasurer Murray, Bailie D. M. Stevenson, Bailie Maclay, or Mr. Burrell (experts on finance) they would have told them that, instead of being worked at a loss, there was not the slightest doubt that within a short time there would be a profit of £10,000. But they were not carrying on the enterprise for a large profit. They were carrying it on for the benefit of the ratepayers. If they wanted to make money, it would be an easy matter to raise the charge from £5 to £10. But so far as it had gone, this was one of the best municipal enterprises.

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Ayr.—Mr. A. J. Fuller, the burgh electrical engineer, in his annual report, just issued, states that there has not been a single accident within the works during the whole period; while outside little or no trouble was experienced beyond the necessary inconvenience caused by changing over from the two-wire alternating-current system to the three-wire continuous-current system. The number of consumers is now 530, an increase of 80 over last year. The total cost of production of the current, including management, was £4,483. 3s. 9d., or 1·62d. per unit, as against £3,914. 11s. 8d., or 1·88d. for the previous year. The revenue was £6,973. 16s. 2d., as against £5,590. 19s. 5d. in the previous year. This means a surplus of £2,490. 12s. 5d., but after allowing for £3,247. 4s. 3d. interest and sinking fund, there remains a deficit of £756. 11s. 10d. The capital expenditure at the end of the year was £78,999, as against £56,158 at the end of the previous year. The number of units sold was 655,518, including 132,405 to the tramways, as against 490,496 in the previous year. The prices charged were: for private lighting, 5d. per unit; for public lighting, 1½d. per unit; for traction, 1½d. and 1d. per unit; and for power 3d. per unit. The number of units for private lighting had increased by 12·8 per cent., and the revenue by 13·1 per cent. The total output had increased by 36·6 per cent. Including interest and sinking fund, the total cost per unit sold was 2·83d. The actual cost of production was 1·62d. per unit, as against 2·1d. in the previous year. The average price for all units sold was 2·55d. per unit, as compared with 2·83d., the total cost per unit.

Post Office Telephones.—According to a special in the *Pall Mall Gazette*, great progress has been made in central London with the Post Office telephones—north, east, south, and west. Large gangs of men are engaged. Roughly speaking, 160 miles of trenches have been excavated, in which 600 miles of ducts and pipes have been laid, and in the pipes cables representing about 70,000 miles of wire. The area mentioned includes Clerkenwell, Mayfair, and Southwark. As the work progresses intercommunication is established with the National system, and 2,600 subscribers have availed themselves of the facilities now afforded. An exchange will be opened as soon as possible in Mayfair, which includes a large West-end district. Telephone exchanges have just been opened in Westminster, Kensington, Putney, Kingston, and Wimbledon, and rapid progress has been made in laying ducts and cables to Richmond, Chiswick, and Twickenham. In certain sections gangs of men work in shifts, day and night. The Post Office system is connected with the National from stage to stage. The experience of the past 12 months shows that the joint arrangement works smoothly, and that the hostility evoked when the arrangement was made has now subsided. Not much has yet been accomplished in the northern division, but the work is being pushed forward in Hampstead, gangs of men being engaged digging trenches and laying cables in various parts of the borough, and in six months it is anticipated that it will be equipped with a good telephone system. In the first areas completed the Post Office have about 4,000 renters.

Sheffield.—The minutes of the Electric Light Committee submitted to the last Council meeting contain the report of Mr. A R. Bennett on the proposed municipal telephone system for Sheffield already noted. On considering it, the committee not only decided to recommend an application to the Postmaster-General for a license to establish a municipal telephone system in the Sheffield area, but passed the following resolution: "That the town clerk be instructed to communicate with the National Telephone Company, Limited, as to whether they are prepared to sell their undertaking to the Corporation upon the terms of Clause 30 of the Postmaster-General's license, with the addition of a reasonable sum for goodwill in respect of the unexpired term of the company's license at the date of the granting of a license to the Corporation." The Electric Light Committee have ordered to be entered on their minutes (1) the following resolutions passed at a meeting of the Incorporated Municipal Electrical Association on Feb. 21, 1902: "That in the opinion of this association, electricity supply undertakings having to be maintained in a thorough state of efficiency out of revenue, no depreciation or further writing off of capital is necessary when the period allowed for repayment of loans is not greater than 30 years, as the equated life of the works exceeds this period"; and (2): "That the Parliamentary Committee be requested to include the following provisions in the next Bill to be promoted by the Corporation—viz.: to authorise the Corporation to purchase electric motors for the purpose of letting the same out on hire; to authorise the Corporation to expend moneys for putting in installations of electric light and power, and to empower the Corporation to accept payment for the same by instalments or to let the same out on hire; to obtain power to postpone the payment of contributions to the sinking fund in respect of all capital expenditure on the new power station at Old Park Wood for five years after the completion of the works."

The Russian Electro-Technical Industry.—To those who look upon Russia only as a huge and arid waste in which serfdom has vanished only in name, or as the seething hot-bed of Nihilism and anarchy, the following brief sketch of the world's most up-to-date industry there will be an eye-opener. The United States Consul at Odessa, in a report on electro-technical industry in Russia, an extract of which appeared in the *Western Mail*, states that until recent times the electric industry has made extremely slow progress in Russia. Unfavourable circumstances have combined to impede the industry and prevent it from reaching the level found in other countries. One of the principal causes of this lack of development was the absence of schools in which to educate electricians. Of late, however, the Government, private companies, and individuals have opened special schools for electricians, and, in addition, the special art and artisan schools have introduced an electrotechnical course. The influence of these special schools and courses has not been slow to make itself felt, and of recent years the electric industry has made immense progress. Many towns and cities are lighted by electricity and electric tramways are numerous. Nearly all of the large factories and industrial establishments have adopted electric lighting and have applied electricity to the distribution of motive power. Electric energy has also been utilised in mining enterprises, particularly in the South of Russia. The use of electricity in soldering, in the extraction and refining of metals, as well as in certain electro-chemical works, and in the production of carbons and hypochlorites, is now well developed in Russia. With the increased and varied applications the demand for apparatus has grown enormously, and dynamo machines, motors, transformers, lamps, conductors, etc., find a large sale. In response to this demand, workshops and factories have been established which produce more particularly the accessory supplies and conductors. There are but two factories in Russia which produce electric machines and lamps, and in consequence most of these are imported. Germany and Switzerland furnish the largest number; next comes England, and then follow the United States, France, and Belgium. Concluding, the consul advises his up-to-date countrymen to follow German methods of business, because "they are ever present and always patient; they study their customers, ascertain their financial condition, give long credit with reasonable interest, and employ men who are either German-speaking Russians or Germans born in Russia, who, of course, speak both Russian and German."

TRACTION.

Doncaster.—The electric cars now run between the railway station and the racecourse.

Nottingham.—Certain property is about to be acquired in Low-road by the Corporation for tramway offices.

Yarmouth.—Penny fares are to be introduced at the end of the season on the municipal electric tramways here.

Blackpool.—It is proposed to borrow £633 for additional expenditure incurred in the purchase and equipment of new tramcars.

Tyneside.—The section of the Tyneside tramways between North Shields and Wallsend has now been open for public traffic for about a week.

Southwick.—The matter of a direct line of tramways from Southwick to Roker has been referred to a sub-committee of the Council.

Steyning West.—At the next meeting of the District Council the draft agreement with the tramways company will be submitted for approval.

Yeaden.—The District Council have asked the promoters of the tramway from Leeds to Guiseley what their propositions are in regard to their district.

Standish.—It is promised that the authorised extension of the Wigan tramways to this place will be taken in hand without unnecessary delay.

Folkestone.—The General Purposes Committee have been empowered to take the necessary steps to put in force the powers conferred by the Folkestone tramway order.

Redruth.—Work on the electric tramway between Redruth and Camborne is nearing completion for Board of Trade inspection. Within a few days a trial car will be run over the line.

Southwark.—The Borough Council have approved plans submitted by the County Council for the construction and reconstruction of certain tramways in the borough for electric traction.

Wallsend.—The tramway company have agreed to indemnify the Council against liability in return for their permission to run cars over the Willington Bridge, and also as regards High-street East.

Sheffield.—An agreement is proposed between the Sheffield Corporation and the Rotherham Corporation as to the tramway traffic arrangements between Fitzalan-square and the centre of Rotherham.

Wellingborough.—The Council have received the signed agreement from the British Electric Traction Company for the street widening in connection with the Wellingborough and district tramway scheme.

Carlisle.—The Town Council have adopted a form of certificate to be held by electric tram-drivers in the city, after they have undergone a course of instruction and shown that they are qualified for their work.

Salford.—Sir Frederick Bramwell has been appointed referee in the tramways arbitration between Salford and the Manchester Carriage and Tramways Company. He will make an inspection of the lines on the 25th inst.

Airdrie.—It was decided by the Town Council last week to oppose the application of the Airdrie and Coatbridge Tramways Company for a further extension of time in which to construct the tramways authorised by their order.

Romford.—Mr. Hawtayne is to be asked to furnish a report on the offer of the United Electric Light and Power Company to construct electricity supply works at Romford and to lay down a system of electric tramways.

Littlehampton.—A deputation from the British Electric Traction Company will shortly wait upon the Town Council to discuss the desirability of extending the company's systems of tramways along the coast from Worthing.

Ainsdale.—The Parochial Committee have appointed a deputation to wait on the British Electric Traction Company to ascertain all the information possible with a view to the tramways being extended to Ainsdale from Birkdale.

Bath.—Negotiations are proceeding between the promoters of the electric tramways and the Town Council with a view to the current for the trams being provided by an extension of the Corporation electricity works in Dorchester-street.

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Darlington.—It is proposed to apply to the Local Government Board for power to borrow £14,600 for extending the electric power station, such an addition being necessary before the electric tramways can be supplied with energy.

Musselburgh.—The Town Council are supporting the application to the Board of Trade by the promoters of the Musselburgh electric tramway for an extension of the time by one year in which the undertaking should be carried out.

Exeter.—A meeting of the City Council has been called with a view to passing the statutory resolution asking the Board of Trade's sanction to the Council serving upon the present tramway company notice to sell their undertaking to the Council.

Clacton.—A committee of the Urban District Council has been appointed to meet the promoters of the Clacton and St. Osyth light railway to consider what arrangements can be made as to the Clacton tramways and electric lighting question.

Keighley.—The promoters of the electric railway between Shipley and Keighley have practically come to terms with the Shipley and Bingley Councils, and it is expected there will be an early understanding with the Keighley Corporation.

Southport.—The local trades council have passed a resolution to be forwarded to the Corporation that in their opinion Sunday trams at Southport are unnecessary, and would prove injurious to the best interests of the workers in the town and district.

Worsley.—It is stated that the next section of the South Lancashire tramways to be constructed will run through this district. The line from Leigh, after passing through Boothstown and Worsley, will join the Eccles tramways at Worsley-road, Winton.

Darwen.—No decision has yet been come to in regard to school children's fares on the tramcars. It was stated at the last meeting of the Council that the department was not in such a satisfactory condition that they could afford to make many concessions.

Blackburn.—The overcrowding of the tramcars was the subject of a short discussion at the last meeting of the Town Council. It was stated on behalf of the committee that it was a difficult matter to control, and no remedy being suggested, the matter dropped.

Cranes.—We understand from the *British and South African Export Gazette* that extensive orders for electric cranes will shortly be placed by the Table Bay Harbour Board for the equipping of the several piers and quays at Cape Town provided for in the new improvement scheme.

Urmston.—The local authority are in favour of a line of tramways being constructed by the Manchester Suburban Tramways Company through Urmston to Stretford, but the engineer to the scheme is to meet their surveyor before they give their formal consent to the proposal.

Bridlington.—A special meeting of the Town Council has decided to offer the strongest opposition to the application about to be made to the Board of Trade by the promoters of the Flamborough-Bridlington light railway for another extension of the provisional order granted in 1897.

Stretford.—It is expected that during the current month all contracts will be let in connection with the supply of electricity to the district. As regards the laying of the tracks for the electric tramways, arrangements have not yet been come to with the Manchester Tramways Company.

Wigan.—An agreement has been completed between the Corporation and the Pemberton Urban District Council, securing to the former a lease of the tramways in the township of Pemberton. Application is to be made in the next session of Parliament for power to construct several new tramways.

Hampton Wick.—The clerk to the District Council has been directed to write to the Local Government Board and ask if they could inform the Council what proposals have been made by the tramway company, in accordance with Section 20 of their Act of 1900, for providing housing accommodation for the working classes.

Ossett.—It will be decided at the next meeting of the Town Council whether or not a poll of the ratepayers shall be taken upon the question of the advisability or otherwise of the Council applying to the Board of Trade for a provisional order enabling them to construct tramways within the borough, with a view to the lines being leased to a company.

Cardiff.—A long discussion took place at the meeting of the Town Council on Monday with respect to the engagement of other than local men on the tramways. A recommendation in favour of licensing eight men as drivers—seven of whom were alleged to be "outsiders"—was referred back to the committee for the place of residence to be given in each case.

Maritzburg.—The Corporation are now actively proceeding with the construction of the municipal electric tramway, and quite recently their London agents (Messrs. Ford Bros.) invited tenders for the supply of a large quantity of Vignoles rails, fishplates, and other material. Tenders for the necessary rolling-stock, motors, etc, will, we understand, shortly be invited.

Antwerp.—It is stated in Antwerp that the Belgian Government have practically decided to construct an electric railway between Brussels and Antwerp. This will be the first long-distance express electric service in Europe. The contract will call for a speed of about 60 miles an hour. The route is 26 miles long, and the trains are to cover the distance in 25 minutes.

Batley.—The laying of the tramways in Batley, as in other parts of the district, is proceeding apace. While the agreement with the British Electric Traction Company for a lease of the lines has not yet been signed, it is on the eve of being concluded. Mr. S. Jones, of Doncaster has been appointed clerk of works during the erection and equipment of the electricity station.

Bournemouth.—A number of minor matters in connection with the tramways were dealt with at the last meeting of the Borough Council. Complaint was made of delay in the construction of some of the lines, and a memorial received on the subject is to be considered at a special meeting of the committee.

Bradford.—The tramways receipts for the week ending Aug. 31 amounted to £3,479, as compared with £1,185 for the corresponding week of last year, an increase of £2,294. The Corporation are negotiating with the Shelf Tramway Company for the purchase of their undertaking. The offer is shortly to be submitted to a meeting of the shareholders in the company for approval or otherwise.

Dudley.—A special meeting of the Town Council was held on Tuesday to consider the expediency of the Corporation becoming the owners by purchase of the whole of the tramways and light railways in the borough. A resoultion in these terms was adopted. The Tramway Committee recommend the Council to sanction the use of double-decked tramcars on the Kingswinford light railway.

Perth.—In reply to the decision of the Town Council to compulsorily purchase the undertaking of the Perth Tramways Company by arbitration, the shareholders of the company have passed a resolution in favour of applying to the town for a concession of 32 years, in order that the company might themselves convert the tramways to electric traction, taking the supply of electricity from the town.

Bury.—A special meeting of the Town Council was called for yesterday for the purpose of taking into consideration the propriety of giving notice to the Bury, Rochdale, and Oldham Tramway Company, Limited, requiring the company to sell to the Council so much of their undertaking as lies within the borough. The work of laying the new tramlines will be commenced at the earliest possible date.

Pretoria.—The directors of the Pretoria Tramway Company have made application to the Government for leave to resume the running of their trams. The permission, says the *British and South African Export Gazette*, will doubtless be granted, pending the Town Council's maturing their plans for a municipal electric system. Twelve months' notice only is required to terminate the concessionaires' operations.

Paisley.—Mr. W. M. Murphy, promoter of the new Paisley electric tramways, is at present negotiating for the purchase of the existing Paisley tramways, which he hopes soon to get possession of. When the purchase is completed, and the approval of the local authorities of the plans obtained, he intends to proceed with the undertaking. The information has been anxiously looked for locally a considerable time by the public.

Newport (Mon.).—The proposed new tramways are estimated to cost £7,801 for rails and fishplates, and for these a new tender has been found necessary. The delay in the completion of the electric power station is engaging the attention of the Electrical Committee, and they have decided to convert the centre area of lighting from alternating to continuous current at a cost of £2,235. The committee have decided to supply current for power purposes on the maximum demand system, at an initial rate of 2d. per unit for a daily average demand of two hours, and at 1d. per unit over that time.

Additional Traffic Returns.—Anglo-Argentine, £245 increase; Barcelona Ensanche y Gracia, £79 decrease; Barcelona, £180 increase; Brisbane, £592 increase (month of August, £11,442, increase £2,942; Buenos Ayres and Belgrano Electric (month of June, receipts £12,229 increase £470), £182 increase; Calcutta, £246 increase; Cape Town (month of June), receipts £14,148, expenditure £6,689; Isle of Thanet Electric, £210 increase; Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £190 increase; Port Elizabeth (month of June), receipts £3,849, expenditure £1,891.

Ayr.—The tramways accounts just issued, although they show a complete year of the capital account, the undertaking having been opened on Sept. 26, 1901, only show about eight months of a revenue account. In that time there was a total income of £4,971, and the total working expenses amounted to £2,852, so that the result is a credit balance of £2,121. When this balance is placed against interest, repayment of loans, and depreciation, it still shows a balance of £242. 18s. 9d., which is carried to meet the reserve fund of £5,000. As regards depreciation, the sum of £1,036. 19s. 4d. has been written off in the eight months.

Electric Postal System.—A Reuter telegram from Rome of Wednesday's date states that the Minister of Posts and Telegraphs and the Under-Secretary of State for Posts and Telegraphs, together with the high officials of the Postal Department, have examined a scheme submitted by an engineer named Piscicelli for the establishment of an electric postal service. It is proposed by means of this system to transmit letters in aluminium boxes, travelling along overhead wires at the rate of 400 km. an hour. A letter could thus be sent from Rome to Naples in 25 minutes and from Rome to Paris in five hours Signor Galimberti has appointed a technical commission to report on the system before instituting a series of experiments between Rome and Naples.

Manchester.—A meeting of the Parliamentary Sub-Committee was held this week to consider a proposal to promote a Bill in the next session of Parliament to include certain tramway matters. These last embrace the following proposals: to authorise the construction of lines of tramway in the new road proposed to be constructed as a continuation of Forge-lane to Hulme Hall-lane; a tramway through Victoria-park from the terminus of the existing tramlines in Upper Brook-street to the authorised tramline in Diekenson-road; and a tramway in and along Devonshire-street from Hyde-road to Stockport-road. It is also proposed to amend Section 9 of the Act of 1899 and Section 22 of the Act of 1900 so as to provide that the powers of the last-mentioned section as to laying down double or interlacing lines in place of single lines and *vice versa*, and as to altering the positions of tramways and other matters, shall extend to tramways outside the city which are or shall be leased to the Corporation.

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The Thames Valley.—The extension of the electric tramcars in the Thames Valley from Twickenham to Teddington, and from Twickenham to Richmond Bridge, will, we understand, be opened next Monday, the 15th inst., and next spring will see the continuation of the lines to Kingston and Hampton Court.

Brighton.—The work of laying the proposed tramways in Old-steine and London-road is not to be proceeded with before Jan. 1 next. In the meantime tenders are to be invited for the construction of the tramways as well as for the wood paving of the roads in question, the whole of the work to be carried out at the same time.

Southend.—The first year's working of the electric tramways does not show a profit. An estimate of the probable receipts was slightly over £11,000, and this estimate, it is reported, was really below the total received up to July 18, when the trams had been running for a year; but the estimated expenses had also been exceeded. It is believed, however, that a substantial profit will be forthcoming after a short period.

Battersea.—In reply to a further communication from the London County Council as to whether, in the event of that body applying for powers next session to construct a tramway from Battersea Park-road to Buckingham Palace-road, the Borough Council would contribute one-third of the cost of the necessary street widenings, that Council have decided to abide by their previous decision—*i.e.*, not to give the required contribution.

A "Tramcar" Wedding.—A novel feature at the wedding last week at Newcastle-under-Lyme of Miss Griffith, daughter of the town clerk, was the use of the electric tramcars in addition to the private carriages for the conveyance of the guests from the parish church to the residence of the bride's parents, which is situated on the line of route. The Potteries Electric Traction Company put on several of their large cars, which were prettily decorated.

Leigh.—At the monthly meeting of the Town Council a discussion took place as to whether the South Lancashire Tramways Company should be permitted to run cars before the widening of Leigh-road and the arrangements for the lighting of the streets or roads in the borough through which the trams will pass are completed, and ultimately it was resolved that permission should be given to the company to run the trams on Oct. 15 as they desired on terms.

Harrogate.—The question of the proposed electric tramways for the borough was considered at the last meeting of the Town Council. As a result the borough surveyor was instructed to prepare plans for the respective routes. It was also resolved to approach the Knaresborough Rural Council and the Urban Council with the object of continuing the proposed terminus of the line at Starbeck to Knaresborough. Another section of the line will proceed through the principal streets to the Little Wonder.

Swansea.—At a meeting of the Electric Lighting Committee on Friday last reference was made to the Constitution-hill tramway, which has been at a standstill for some months past. The town clerk presented a report, which showed that the Board of Trade declared the powers of the promoters at an end, and the road authority might remove the line, the promoters to pay the cost of such removal, according to the Tramway Act of 1870. The town clerk also made a report with respect to the proposed extensions beyond the borough limits.

Aberdeen.—With reference to the proposal of the Corporation to apply for permission to construct a tramway to Torry, *viâ* Bridge-street, Guild-street, and Market-street, popular opinion in Torry is that it would not be in the interests of the community were the electric cars to be run by way of Bridge-street. At the last meeting of the Ward Committee a resolution was passed that, in the opinion of the committee, the only satisfactory route for the tramway system that would serve the wants of Torry would be the direct route to Union-street in connection with the George-street route.

Glasgow.—The Corporation tramways last week ran 252,674 car miles, carried 3,380,862 passengers, and drew in fares £12,505. 8s. 1d., compared with 237,895 car miles, 3,444,127 passengers, and £13,086. 6s. 4d. in fares in the corresponding week last year. Mr. Young, the tramways manager, reports that the great majority of the electric cars have been provided with the Tidswell guards, and that the others are being fitted up as expeditiously as possible. The committee have declined an application by the Cyclists' Touring Club asking permission to carry disabled cycles on the front platform of cars.

Bolton.—The tramways accounts for the past year show that the total income was £78,644. The principal expenditure items were: management account, £1,683; traffic account, £31,317; maintenance of permanent way, £3,583; maintenance of electrical equipment took £1,165, repairs and maintenance of rolling-stock £7,378; compensation in respect of accidents accounted for £1,374; depreciation absorbed £16,298 and interest £8,393, leaving £3,395, which was transferred to the borough fund in aid of rates. The capital account shows that £368,662 has been expended on works, plant, equipment, etc., to date.

Johannesburg.—Tramway matters in Johannesburg have advanced a further stage with the refusal by the Town Council of the tramway company's offer to equip their horse system with electricity, and by the appointment by the former of a special committee to consider the establishment of municipal tramways, with an instruction to bring up a full report at an early date providing for the establishment and working of municipal electric tramways in Johannesburg. The municipal project will doubtless involve the buying up of the company's interests, and proposals to this end will no doubt be included in the special committee's report.

Edgware.—At a meeting of the Parish Council recently, a resolution was unanimously passed protesting against the proposal of the Hendon Rural District Council to oppose the light railway to Stanmore at the expense of the general expenses of the Council. It was further agreed to write the Middlesex County Council urging them to push on with the construction of the light railways along the Edgware-road as quickly as possible. The Edgware Council is of opinion there is no other part of Middlesex more in need of better communication, and the hope is expressed that before long there will be an extension of the light railway system to Watford.

Burnley.—The Electricity Committee recently made a claim of £550 against the Tramways Committee in respect of the services of the electrical engineer and his staff during the reconstruction of the tramways It is now agreed that the committees controlling the borough surveyor's and electrical engineer's departments shall take into consideration the remuneration proposed to be made to those officers and their assistants in respect of the special services rendered by them in the reconstruction of the tramways, and that the Tramways Committee pay direct to those officers and their assistants such sums as may be considered reasonable by those committees

Durban.—During the consideration by the Town Council of the various tenders submitted for additional tramway material and rolling-stock for the Durban tramways, that of Messrs. Macartney, McElroy, and Co for £10,000 for additional cars came under review, and its acceptance was objected to by Councillor Middleton on the ground that a British firm actually manufacturing cars should be given the preference. In the animated discussion which followed the Mayor explained that the motors would be of British make, but the car bodies would have to be procured from America, as they were urgently wanted. An amendment that the matter be reconsidered was lost on the vote.

Plymouth.—On the minutes of the Tramways Committee coming up for consideration at the meeting of the Town Council on Monday, a member remarked that the position of the tramways was most unsatisfactory. Up to June 30 this year there had been no increase of receipts, but there had been an increase in expenditure of £1,330. The position was worse now. Since June there had been an increase in receipts compared with last year of £440, although since then the Beaumont-road extension had been opened, and there were extra receipts from the extension to Union-street and the running of workmen's cars. On the other hand, in the past 20 weeks they paid £1,000 more for current, and altogether the increased expenditure in that period amounted to £2,099.

Halifax.—A deputation from the Halifax and District Trades and Labour Council has waited upon the Town Council with a memorial urging the Council's consideration of various alleged grievances of tramway employés. It was stated that the conductors had to make up any deficiency in the fare-box, although in their opinion the deficiency was due to the mechanism of the box, and not to themselves. In some instances the box registered pounds without a coin being placed in it, and there had been cases of men leaving their employment rather than make up the deficiency. The men had no objection to the use of any particular box, or to a check being placed upon them, but they asked that the check should be a fair one. The memorial was referred to the committee.

Elland.—The local authority are making overtures to the Halifax Corporation for their consent to the handing over of their rights to lay tramways to Elland with the British Electric Traction Company. This step is the outcome of a sore feeling with Elland that they have not been fairly treated by Halifax. Their case is, when Elland accorded their support to the Corporation Bill in Parliament, Halifax promised to take trams to Elland within two years, and this has not been fulfilled. If Halifax grant the request which will be made to them, the Elland Council will approach the British Electric Traction Company, with whom Brighouse is already in negotiation for laying tramways to Huddersfield, and endeavour to arrange satisfactory terms. Elland will shortly be in a position to supply the electrical power from their works.

Reading.—From accounts appearing in the local newspapers we gather that much annoyance is being experienced by residents along the line of route where the work of taking up the old tramway lines and laying down the new metals for the electric system is being carried on. Especially is this the case along the King's-road, where the roadway is all picked up and traffic stopped. A similar state of things exists at the western end of the town, along the Oxford-road from the barracks to the railway bridge. Considerable delay in the work of constructing the lines and in excavating the roadways has been experienced owing to the heavy rain and unsettled weather; the men, however, as a rule, are working steadily and carefully and carrying out the work as expeditiously as is possible under the difficult circumstances.

Wolverhampton.—On the subject of workmen's cars it was stated at the last meeting of the Town Council that the Tramways Committee had already taken the matter into consideration, and the tramways manager was preparing a statement on the subject for a committee that would be held on the morrow. The committee had consulted Tettenhall Urban District Council and the workmen of Tettenhall. As soon as permission was received to run to the Dog and Gun workmen's cars would be started. The question of workmen's 'buses on Dudley-road would also be dealt with. The electric tramway through the rock at Tettenhall to the Dog and Gun Inn has now been completed. Owing to the absence of Colonel Yorke, who is in America, Lieut.-Colonel von Donop, R.E., has been appointed by the Board of Trade to make an official inspection of the line. This took place on Wednesday.

Newcastle.—A dispute has arisen between the Corporation tramway men and their employers over the dismissal of three of the former. A mass meeting has decided that if the men are not reinstated the others will come out on strike. A meeting of the Corporation has been held without any definite result. On Tuesday this week it was announced that as the result of an interview between Mr. Whitburn, the representative of the men, and Mr. Le Rossignol the trams

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way men's dispute is now settled, an amicable arrangement having been come to. Two of the men who were suspended have been given employment; the third man concerned in the dispute has obtained a situation elsewhere. The annual accounts of the city treasurer show that from Dec. 16, 1901 (the opening day), to March 23 last the traffic receipts of the Corporation tramway system amounted to £20,918. 0s. 7d., and the traffic expenses to £10,694. 15s.

Hull.—Experiments have been made by Lieut.-Colonel von Donop, Board of Trade inspector, in testing a number of tram lifeguards at the Liverpool-street tram sheds, Hull. The guards fixed for test were the Burns, the Barnard and Wilkinson, the Tidswell, the Snowden, and the Carr, four of which were patents registered by Hull men. The first to be tried was the Burns guard. Both large and small dummies, when placed along the track, were picked up beautifully by the roller. Lieut.-Colonel von Donop expressed himself very satisfied with the work of the roller, and said that it was a splendid idea, especially the reverse motion. He remarked that the Board of Trade would very much welcome this guard, if the roller was extended and the sheaths taken off. It would be a decided improvement on anything he had seen. The other guards were also tested. Subsequently the inspector saw the new tramway extension on the Holderness-road, and expressed himself satisfied with the manner in which the lines had been laid.

Leeds.—The receipts on the city tramways last week amounted to £5,329. 4s. 8d., as compared with £4,446. 12s. 3d. in the corresponding week of last year, an increase of £882. 12s. 5d. The City Council have sanctioned new by-laws allowing an excess of passengers on the tramcars on wet days and holidays. The conductor is to be the judge of weather. On holidays he is to have no option, but must admit eight extra passengers if there is room for them. Since the main-line routes of the tramways were completed, the Tramways Committee have had brought before them at various times questions as to the advisability of connecting or linking up certain of the lines with the idea of ultimately providing a circular route round the city. Some of the proposals have now been submitted in definite shape, together with projects for extending one or two tramways to the city boundary. The general manager, Mr. J. B. Hamilton, is to prepare a report on the matter to be presented to the committee next Monday, and whatever extensions are deemed advisable will be included in an early application for a provisional order to carry out the work.

Accident.—The accident at Glasgow on Saturday night, resulting in one death and injury to 27 other persons, has been made a good deal of in the daily newspapers from the point of view of the heavy casualty list; but when the facts come to be examined the accident was of quite an ordinary character, although three of the electric cars were involved in it. From the official account given by Mr. Young, the general manager of the Glasgow tramways, it seems that as the motorman of the first car was applying the hand brake at a stopping place, the brake ratchet handle came away in his hand owing to the locker pin having worked loose and come out, thus allowing the handle to get free from the spindle. These handles are examined daily, and no explanation can be given of this unique occurrence. Clearly the proper course for the motorman would have been to apply the power at that moment to keep the car forward. The other course was to reverse and apply the electric brake. We understand that the electrical equipment of the car has since been tested and found to be quite in order. The Board of Trade have appointed Major E. Druitt, R.E., to hold a local enquiry into the accident

Auckland (N.Z.).—The first lot of tramcars for the Auckland Electric Tramways Company have arrived from England to the company's Ponsonby depôt, the new building there being sufficiently far advanced to receive them. The cars arrived in sections and will be put together at an early date, an expert, Mr. S. A. Mahood, and his assistant, Mr. James, having come out from England with the cars for the purpose of fitting them together. There are about a dozen cars on the "Niwaru," and the remainder of the first consignment of 23 cars are on the "Waimate," which is due here on Friday first. These consist of 10 four-wheeled cars, five eight-wheeled combination cars, four double-deck cars, and four closed cars. The combination cars should prove highly popular in Auckland. They are of a long type, with the central section closed and the two end sections open. In a week or two the first of the new cars will be fitted up, and will be open for public inspection. The balance of the cars required for the city tramways are now on the water, and should arrive in about six or seven weeks.—*New Zealand Mining, Engineering, and Building Journal, June 26.*

Rotherham.—Arising out of the recent contract entered into for a supply of basic steel rails for the tramways a discussion arose at the last Town Council meeting, when a letter was read from Messrs. Kennedy and Jenkin on the subject. This stated that no contractor tendered directly for English rails made by the acid process. Messrs. Macartney and McElroy were asked if they could not obtain rails elsewhere, and they replied that they could not get either Bolckow's or the Barrow Company to quote at all. It was entirely owing to the fact that acid steel could apparently not be obtained that basic was accepted. Messrs. Kennedy should themselves have preferred acid steel, although they were very doubtful at the time whether they should get it. They are, however, certainly not of the opinion that basic steel is "very much inferior in point of quality" to acid steel. Messrs Walter Scott and Co. have agreed to work strictly to the specified chemical analysis, which is a most important point. The letter adds that Messrs. Kennedy have sufficient confidence in their rails to have accepted them for the London County Council tramways, where they are now being laid down. It was stated in the discussion that there was a difference of over £1,000 in the price of the rails.

Stoppages on the "Tubes."—Shortly after eight o'clock on Saturday morning a motor failed on the Twopenny Tube, near Holland Park Station, and the whole of the up traffic was suspended for 15 minutes. The official explanation of the breakdown is that it was due to the failure of the brush of the motor. On the previous afternoon a breakdown occurred on the City and South London Electric Railway owing to the fusing of one of the main cables in the generating station at Stockwell. The current being entirely cut off from the system all the trains ceased running, and the passengers in those trains which at the moment were between stations were obliged to alight and walk along the tunnels to the nearest exit. Traffic was suspended for 35 minutes. There was another breakdown on the City and South London Electric Railway on Tuesday evening. A little before six o'clock a train to the City came to a standstill almost immediately after leaving Stockwell Station, and when it had only proceeded about 200 yards through the tunnel. The stoppage was due to a slight mishap to the motor. Owing to the proximity to the depôt at Stockwell a fresh motor-engine was quickly procured, and the train and disabled engine were towed back into the station. Traffic was not delayed more than a quarter of an hour.

Liverpool.—The Corporation are about to equip a number of the electric cars with a device of Mr. C. R. Bellamy, the general manager, which it is claimed has solved the problem of wet seats outside. At a meeting of the committee yesterday week a councillor explained the invention, which has already been applied experimentally to an electric car. The device consists of a light frame of steel, 6ft 2in. from the roof, with a canvas cover and side curtains in sections, the whole of which can be raised or lowered in half a minute; or the sections can be worked separately. The canvas is, of course, waterproof; it is set back fore and aft a few feet, so as to avoid a draught coming up the staircase. The trolley pole will be removed from the deck of the car to the outside of the cover, so as to be no longer in contact with outside passengers, and the whole of the upper deck being quite clear, there will be sitting accommodation outside for 10 more persons. Altogether, it is estimated, the covered deck will hold 42 passengers and the inside 31, allowing for nine standing, or 73 in all. It was stated that the invention was not to be patented; it would be available to the whole tramway world for nothing in the shape of royalties, etc. After the committee meeting the members went for a run on one of the experimental cars. So impressed were they with the result that they confirmed a recommendation by the sub-committee to equip 30 additional cars just ordered with the apparatus, at a cost of £60 each, and to apply the cover to 12 other cars now approaching completion, at a similar cost per car. At night the car roofs will be lighted with three electric lamps, in addition to those at either end.

Dundee.—The first annual report of the Tramways Committee on the city tramways for the year ended May 15 last shows that the gross receipts have amounted to £35,874. 0s. 9d., and the working expenses to £24,042. 7s. 6d., leaving a balance of revenue over working expenses of £11,831. 13s. 3d. This balance has been appropriated in meeting interest (£5,076. 7s. 4d.), sinking fund (£3,415), depreciation (£903. 13s. 3d), and the annual payment to the former lessees (£2,100), as per agreement, a balance of £36 12s. 8d. being carried to credit of suspense account. During the year considerable sums have been expended on additional tramway lines, relaying and equipping old lines for electric traction, cars, etc., amounting in all to £66,187. 16s. 10d. This sum falls to be added to the capital account, which now stands at £232,313. 0s. 11d. Since the tramways were taken over by the Corporation, the following lines have been adapted for electric traction: Perth-road section, Lochee section, and the Fairmuir section. The following new lines have been constructed, and are also being worked by electricity: Lochee extension, Perth-road extension, Maryfield, Blackness, Seagate and Ferry-road, and Fairmuir. On account of the development of the system, ground has been acquired at the old cattle market in Lochee-road, on which a new depôt has been erected, with accommodation for 31 cars and the usual appurtenances, including a workshop where all repairs to cars and equipment can be carried out. Further, a new depôt has been erected at Maryfield capable of accommodating 40 cars. Arrangements are also being made for adapting part of the Lochee depôt for the accommodation of electric cars. During the year the whole of the rolling-stock has been fully maintained out of revenue. The following is a comparison of the traffic returns with the returns of the previous year: Year ending May 15, 1901—mileage, 446,360; passengers carried, 6,393,412; total receipts, £26,058. Year ending May 15, 1902—mileage, 752,814; passengers carried, 9,084,522; total receipts, £35,874. 0s. 9d.—an increase of 306,464, 2,691,110, and £9,816. 0s. 8d. respectively.

PROVISIONAL PATENTS, 1902.

SEPT. 1.

904a. Improvements relating to galvanometers. Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London. (Date claimed under Patents Rule 19, April 18, 1902.)

19109. An improved chain for suspending electroliers. Isaac Clements and Charles Clements, 36, Temple street, Birmingham.

19110. Improvements in electric arc lamps. Frederick James Green, 18, Orchard-street, Portman-square, London.

19112. Improvements in or connected with electric railways and tramways on the stud contact system. George Wilkinson, Commercial-street, Halifax.

19172. Improvements in or relating to devices for operating trolley arms. Eugène Limauge, 111, Hatton-garden, London.

19280. Improvements in electric baths. Josef Zwiebel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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19188. An improved electric heater or "radiator." Edward George Rivers, Beverley Lodge, Richmond, Surrey.

19191. Improvements in electric measuring instruments. Walker Moseley, 32, Linden-grove, Peckham, London.

19194. Improvements in or connected with magnetic compasses. Andrew Hilliard Atteridge, Norfolk House, Norfolk-street, Strand, London.

SEPT. 2.

19208. Improvements in or relating to trolleys for electric traction. Samuel Roberts, 57, Barton-arcade, Manchester.

19225. Improvements in storage batteries. Wallace Fairweather, 62, St. Vincent-street, Glasgow. (The International Battery Company, United States.) (Complete specification.)

19272. Improvements in incandescent electric lamps. Albert William Wallace Miller, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19283. Improvements in electric transmission and controlling gear. John Johnston and Archibald Edward Dobbs, 18, Southampton-buildings, Chancery-lane, London.

19211. Improvements in electric burglar and like alarms. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The firm of Töpffer and Schädel, Germany.) (Complete specification.)

SEPT. 3.

19305. An improved apparatus or device for use in applying bituminous or similar composition to conduits for electric cables, or to drain-pipes, or like goods to form jointing rings thereon. William Oates, Palatine-chambers, Market-street, Halifax.

SEPT. 4.

19366. Improvements in or relating to electric cable conductors. William Ernest Hitch, 40, Station-road, King's Heath, Birmingham.

19368. Improvements in electrodes. James Hargreaves, Farnworth-in-Widnes, Lancs.

19377. An improved form of electrical choking coil. Frederick James Green, 18, Orchard-street, Portman-square, London.

19420. An improvement in electric switches. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Sprague Electric Company, United States.) (Complete specification.)

19422. Improvements in electric switches with automatic electromagnetic release. George William Green and Richard Poole, 12, Mortlake-road, Kew.

19428. Improvements in electromagnetic brakes. Joseph Gershom Childs, 145, Farringdon-road, London.

19431. Improvements in lifeguards for electric cars and other vehicles. John Farrar Mason and Harry Kremnitz, 6, Lord-street, Liverpool.

19432. A combined pull-down fitting and universal shade filter for general electric lighting purposes. Robert Walter Braham, 60, Red Lion-street, Clerkenwell, London.

SEPT. 5.

19452. Improvements in electric sparking plugs. Thomas Henry Williams, 125, High Holborn, London.

19483. Apparatus for teaching wireless telegraphy. Louis Ancel, 56, Ludgate-hill, London. (Complete specification.)

19488. An improved electrolytic electricity meter. José Batlle y Hernandez, Eduardo Mier y Muira, Luis de la Peña, and José Benito y Ortega, 23, Coleman-street, London. (Complete specification.)

SEPT. 6.

19522. Improvements in electric heating stoves. Veritys, Limited, and Percy Garniss Ebbutt, 11, Burlington-chambers, New-street, Birmingham. (Complete specification.)

19529. An electrical ignition device suitable for petrol motors and the like. Joseph Hutchinson Clarke, 10, St. George's-crescent, Liverpool.

19562. Improvements in emergency brakes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19563. Improvements in and relating to electrical switch devices applicable to rheostats, commutators, and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19564. Improvements in electrical switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19565. Improved method of manufacturing insulating bushings. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19566. Improvements in and relating to electric switch regulators. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19567. Improvements in trolley wheels. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19568. Improvements in and relating to the cooling of electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19571. Improvements in systems of electrical distribution. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19572. Improvements in trolley wheels. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19573. Improvements in and connected with contact shoes for electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

19579. Process and apparatus for the detection of short-circuits in electric batteries. Hermann Beckmann, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 25.

1901.

11348. Syntonic space telegraphy. Lodge and Muirhead.

17489. Armature windings for dynamo-electric machines. Hobart.

17658. Electric meters. Saldana.

18093. Electric gas lighters. De Thiersant (La Soc. Radiguet Massiot.)

18622. Electric clocks. Conrady.

19468. Manufacture of carbon anodes. von Welsbach.

19829. Track construction of electric railways or tramways operated on the conduit system. Chapman.

19878. Electric meters. Hatfield.

20788. Apparatus for trueing up commutators of dynamos. Drake and Gorham.

21170. Electric cables. O'Gorman.

21253. Electric time switches. Offord and Jevons.

21387. Electrical apparatus for registering the discharge of liquids by pumps. Hertslet, Morris, and Knott.

22202. Tools for use in producing sheet metal cases for electricity meters. S. J. and E. Fellows, Limited, and Corker.

22367. Automatic guards or protectors for electric or other tramway cars and the like. Dewar.

1902.

4091. Electric arc lamps. Heany.

8288. Electrical smelting of ores and refining of metals and furnaces therefor. Stassano.

10083. Method of producing electric insulating bodies Haddan. ("Pryisolith" Isolating Material Manufacturing Company, Limited.)

11044. Electric arc lamps. Girdlestone and Thorkelin.

11509. Process for the production of electrodes for secondary batteries. Thompson. (Akkumulatoren und Electricitäts-Werke Aktiengesellschaft vorm. W. A. Boese und Co.)

14205. Electrical sparking devices for explosion engines. Brasier. (Date applied for under International Convention, Feb. 11, 1902.)

14342. Electric couplings. Mackenzie. (C. K. Manufacturing Company.)

14572. Lightning arrester for electrical installations. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

14683. Driving mechanism suitable for electrically-driven machine tools. Wüst-Kunz. (Date applied for under International Convention, July 20, 1901.)

14773. Apparatus for controlling from a distance electromotors serving to actuate ships' rudders, sluice gates, swingbridges, and the like. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

15095. Instruments for indicating the phase and frequency relations of alternating-current circuits. Conrad. (Date applied for under International Convention, July 12, 1901.)

16556. Electric furnaces and production of chemicals in such furnaces. Brewer. (Taylor.)

16962. Electrical switches or cut-offs. Kennedy.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¼-⅜
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-⅜
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7¼-7¾
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¾-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	103-105
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1¾
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16¼
—— 6 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2¾-3
—— 5 per cent. Debentures	100 ..	101-106 p.

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Name.	Amount paid.	Last price.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	⅛-⅜
——— "A" Shares, 01-017,139	5 ..	1½-2½
——— 5 per cent. Debentures	100 ..	78-83
——— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅞-2¼
——— 7 per cent. Cumulative Pref.	2 ..	2¼-3
——— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10½
——— 4 per cent. 1st Mort. Deb. Stock	100 ..	100-103
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
——— 4½ per cent. Preference	5 ..	5½-5⅞
——— 4½ per cent. Debentures	100 ..	109-113
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20½-21½
——— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15½
Telegraph Construction and Maintenance	12 ..	38-41
——— 5 per cent. Bonds	100 ..	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4¼-4½
——— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3¾-4¼
——— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¾-5
——— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
——— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9-9½
——— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-80,000	10 ..	12½-13¼
——— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¾-12⅞
——— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1⅞
——— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
——— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
——— 5 per cent. Deb. Stock, Red.	100 ..	103-106
——— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
——— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
——— 5 per cent. Cum. Pref.	10 ..	11-12
——— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
——— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
——— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
——— 6 per cent. Cum. Pref.	all ..	14½-15½
——— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within	10 ..	11¼-11⅝
——— " " " " 1-82,500	5 ..	8¼-9
——— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	108-110
" " Prov. Crts.	50 ..	81-83
New General Traction, Ordinary	5 ..	2-3
——— 6 per cent. Cum. Pref.	10 ..	3-4
——— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅝
——— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8¼-9½
——— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
——— 4½ per cent. Debenture Stock	100 ..	108-111
South Lancashire Electric Traction and Power Company—		
——— £250,000 Ordinary	1 ..	1
——— £51,132 6 per cent. Preference	14s. ..	¾
——— £50,000 " "	1 ..	1
——— £500,000 4½ per cent. Debenture Stock	70 p.c. ..	70 p.c

Telephones.—

National Telephone, Preferred	100 ..	93-96
——— Deferred Stock	100 ..	55-57
——— 6 per cent. Cum. First Pref.	10 ..	12-13
——— 6 per cent. Cum. Second Pref.	10 ..	11-12
——— 5 per cent. Non. Cum. Third Pref.	5 ..	4¾-5⅛
——— 3½ per cent. Deb. Stock, Red.	100 ..	96-99
——— 4 per cent. Deb. Stock, Red.	100 ..	102-106
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	½-⅝
——— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	103-106
Bournemouth and Poole, Ordinary	10 ..	11½-12½
——— 4½ per cent. Cum. Pref.	10 ..	9½-10½
——— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	10½-10⅝
——— 7 per cent. Preference	5 ..	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7-8
——— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
——— " " " £10 Ord.	6 ..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-106
Charing Cross and Strand	5 ..	9-9¼
——— Nos. 50,001-70,000	5 ..	8-9
——— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
——— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¾-5¼
——— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-5⅜
——— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
——— 6 per cent. Cumulative Pref.	10 ..	12¼-13¼
——— 5 per cent. Debenture Stock	100 ..	122-127
——— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	8½-9¼
——— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
——— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅜
——— 6 per cent. Cum. Pref.	5 ..	6-6¼
——— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4¼
——— 5 per cent. Debenture Stock, Red.	100 ..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6¼
——— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¼
——— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1¾-2¼
——— 6 per cent. Pref.	5 ..	4¼-5¼
——— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	96-99
Metropolitan, Ordinary	10 ..	15-16
——— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113
——— 3½ per cent. Mortgage Debenture, Red.	100 ..	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
——— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	13½-14½
Oriental, 1879	1 ..	—
——— £5 Shares	5 ..	7-7½
——— £4½ Shares, New	4½ ..	6¼-6⅝
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
——— 4 per cent. Debenture Stock	100 ..	97-100
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
——— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
——— 7 per cent. Pref.	5 ..	8¾-9¼
——— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11-12
——— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	5¾-6¼

Electric Railways.—

Central London, Ordinary	100 ..	103-106
——— 4 per cent. Pref.	100 ..	104-107
——— " " deferred	100 ..	103-106
——— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	72-74
——— 4 per cent. Debenture Stock	100 ..	115-118
——— 5 per cent. Pref. Stock '91	100 ..	128-131
——— " " " '96	100 ..	126-129
——— " " " '01	100 ..	121-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
——— Ordinary, 1-50,000	— ..	7¾-8
——— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	80-95

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 30	1,291	848	+ 443	+ 3,695	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	Sept. 6	5,136	2,826	+2,310	+12,569	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	22½	—	—	—	—	1,140,000	—	—	—	—
Blackburn Corporation	" 5	987	777	+ 210	+ 3,643	24	—	—	26,064	—	738,557	—	11·86	—	—
Blackpool Corporation	" 4	2,072	1,942	+ 130	— 539	16½	—	Mar. 31	41,818	5,809,190	753,563	—	—	—	—
Blackpool-Fleetwood Tramways	" 6	1,655	1,733	— 78	— 932	16¼	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 7	1,731	1,464	+ 267	+ 4,759	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	" 7	3,692	1,191	+2,501	+67,794	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57*
Bristol Tramways Company	" 5	4,977	3,904	+1,073	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	" 6	210	194	+ 16	+ 426	—	—	" 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	" 8	5,662	5,532	+ 130	+ 5,316*h*	12	12	" 31	335,046	4,188,383	1,243,730*ha*	1·95	64·6*a*	27,900	34·1*a*
City and South London Railway	" 7	2,657	1,834	+ 823	+ 8,940	12½	9½	" 31	62,601*a*	7,008,842*a*	—	2·15	—	5,010	—
Cork E. T. and L. Company	" 4	872	526	+ 346	+ 3,361	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—			" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dover Corporation	" 6	300	290	+ 10	+ 126	4½	—	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin & Lucan Electric Railway	" 7	147	131	+ 16	— 52*h*	6½	6½	" 31	246,255	45,813,734	6,670,000	1·29	8·89	—	5·71
Dublin U. T., electric cars	" 5	4,480	4,205	+ 275	} — 229	46	46	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Dublin S. District, Electric	" 5	1,209	1,115	+ 84				" 31	582,146*e*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Dundee City Tramways	—	—	—	—	—	22	—	" 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Glasgow Corporation	" 6	12,584	13,435	— 851	—	104	95	Mar. 31	49,011	7,624,865	1,001,033	1·54	11·7	—	13·90
Halifax Corporation	—	—	—	—	—	27¾	18½	" 31	72,331	17,264,013	1,647,026	1·00	10·54	—	4·72
Huddersfield Corporation	Aug. 30	1,176	993	+ 183	—	—	—	Dec. 31	468,383	101,108,780	10,970,063	1·11	10·25	5,004	8·87
Hull Corporation, E. S.	Sept. 6	1,783	1,664	+ 119	+ 1,709	—	—	June 30	69,152	8,426,976	787,010*a*	—	21·07*a*	—	15·94*a*
Liverpool Corporation	Aug. 30	10,668	9,457	+1,211	+27,367	93	78	—	—	—	—	—	—	—	—
Liverpool Overhead Railway	Sept. 7	1,608	1,605	+ 3	— 1,063	15½	15½	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	" 6	2,103	1,168	+ 935	—	29	—	Mar. 31	191,837	49,176,631	3,791,993	0·93	11·82	4,150	—
Sheffield Corporation	" 7	4,374	—	—	—	46½	—	" 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Southampton Corporation	—	—	—	—	—	11	—	" 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31
Sunderland Corporation	" 7	1,321	1,193	+ 128	—	19	17								

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only.

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NOTES.

British Association.—Sir Norman Lockyer, K.C.B., F.R.S., was on Friday last elected president for the 1903 meeting of the above association, which will be held at Southport. Cambridge was selected as the place for the 1904 meeting.

American "Transactions."—Vol. xix., No. 5, of the *Transactions* of the American Institute of Electrical Engineers has reached us by the last mail. It is a particularly bulky issue, and contains reprints of a large number of papers, the majority of which were presented at the annual convention of the institute at Great Barrington in June last. There also appears in this issue the full report of the committee on standardisation, containing a revised series of recommendations.

New Zealand.—We understand that the Government of this colony are favourably considering the desirability of employing and importing an expert electrical engineer to examine and report on various schemes of electrical power development for various purposes. At the present time there are many such schemes on the *tapis* in New Zealand, and it seems to us the Government would be doing the right thing in engaging an expert to look after their interests in this development.

American Street Railway Exhibition. — An electric tramway exhibition, promoted by the American Street Railway Association, is to be held in Detroit, Mich., from the 8th to the 10th of next month. From what we hear, there has been a great demand for space in the hall where the exhibition will be held, exhibitors to the number of 85 having already been admitted. The show has been organised in connection with the annual convention of the above association at Detroit.

Electrical Works in the States.—Recent official statistics show that at the end of 1900 there were 580 establishments in the United States engaged in the manufacture of electrical apparatus. The capital invested in these works amounted to £16,626,190. Wages paid during the year amounted to £4,038,069. The cost of the material used was £9,783,288, and the value of the products, including custom work and repairing, was £18,269,778. In New York alone the number of establishments engaged in the manufacture of electrical apparatus stood at 134.

Fothergill Prize.—The council of the Society of Arts offer the above prize of £50 and a silver medal for a paper on "Existing Laws, By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions." The paper should consist of about 8,000 to 10,000 words, and be written with a view to its being read and discussed at an ordinary meeting of the society. Papers submitted for the prize must be sent to the secretary on or before Oct 1 next. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto. The judges will be appointed by the council.

Mineral Products of the States.—Of the various mineral products of the United States in the year 1901, platinum, it is satisfactory to note, shows the largest proportionate increase. The number of troy ounces of this valuable metal produced last year was 1,827 at a market value of £2,600, as compared with 400oz. and £500 the previous year. The production of aluminium was practically the same as in 1900, being 7,150,000lb., and giving a monetary return of £384,000. The copper product for the year 1901 amounted to 597,443,212lb., with a value of £17,325,853, to be compared with 606,117,166lb., at a value of £19,698,808, in the year 1900—a decrease of 2,372,955lb. in weight and over two millions sterling in money.

Battersea v. the Government.—In our last issue it was stated that the Battersea Corporation had refused consent to the Postmaster-General to allow certain pipes for telephone purposes to be laid within their area. The matter has now proceeded in the usual way to enable this consent to be dispensed with, and the Battersea Corporation will find that the obstruction they displayed in the past to electric lighting companies is not operative against the Government of the country. It is one thing refusing to sign an address to the King, which was within the power of the Battersea Corporation, but it is quite another when they try to obstruct work which has been authorised by Parliament, and which has to be carried out under the control of the Postmaster-General. It will be interesting to see what comes of the conference of the London local authorities called for Tuesday next.

The Late Sir F. Abel.—The funeral of the late Sir Frederick Abel, the distinguished chemist, at Nunhead Cemetery on Thursday last week, was attended by men representing every branch of science. All the important scientific institutions in London with which Sir F. Abel was connected sent representatives, as well as some of the great City companies, the Board of Trade, and the Athenæum Club. The King was represented by Lord E. Pelham-Clinton. There were present for the Institution of Electrical Engineers, of which the late chemist was one-time president, Mr. A. Siemens, Prof. Silvanus P. Thompson, Mr. W. H. Patchell, and Mr. W. G. McMillan (secretary); and for the Chemical Society, Prof. H. McLeod, F.R.S., and Dr. A. Scott, F.R.S. At Nunhead Cemetery the funeral *cortège* was met by a large number of persons, and many wreaths were subsequently placed upon the grave.

Electric Telpherage for Letters.—What we presume to be a system of "telpherage" is proposed by an Italian engineer for the transmission of letters and small postal packages from one town to another. Electricity is the motive power. Letters would be posted in special boxes provided in different parts of the town and forwarded automatically to the central post office, where they would be stamped by electricity and placed in aluminium boxes for transmission along overhead wires to the various towns for which they were destined. We gather from the messages of the daily paper correspondents that the system will be tried first between Rome and Naples, a distance of about 130 miles. It is claimed that a letter could be exchanged between these two cities in about 35 minutes. The Postmaster-General for Italy has appointed a technical commission to report on the system before instituting experiments.

London Telephones. — The *Times* correspondence columns last week contained a communication from "Subscribers" complaining of the condition of the subscribers to the National Telephone Company in London. They contend that this is very much changed for the worse since "the interference and subsequent capitulation of the Government" Both the attention and working, they add, are worse, and the interruptions more frequent and exasperating. They also condemn the new system of small electric lamp indicators, which they say do not work so well as the old-time process of "ringing-up" the exchange The letter concludes: "The only alternative open to the public—viz., the Post Office—is apparently not yet of any real value, not having outgrown its infancy. Parliament having virtually renewed the company's

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monopoly and the subscribers having no tangible redress, what are they to do?"

Western Society of Engineers.—The August number of the *Journal* of the above society, which has its headquarters at Chicago, opens with a description of the National Bureau of Standards of the United States, by Prof. S. W. Stratton, director of the bureau. Other contributions include a discussion on "The Metric System of Weights and Measures," and a paper by Mr. Wm. G. Sloan on "The American Engineer in England." As an example of American engineering in this country, the author of this paper refers to the large engineering works which have been put down at Trafford Park by the British Westinghouse Company for the manufacture of Westinghouse electrical machinery and appliances and gas-engines. He also cites a number of cases of the installation of American machinery in England, and concludes with the remark that there is a future for the American who can come to this country and bring American ideas with him.

Electrocapillary Properties of Organic Bases. The following is an abstract of an interesting paper by Mr. A. Gouy on this subject taken from the current number of the *Journal* of the Chemical Society: Organic bases are the more active as their molecular complexity increases. Their salts, too, are active. The experiments were made by comparing the electrocapillary curve of a solution of sulphuric acid with that of the same solution after the addition of a base, and both against that of a solution of sodium sulphate containing mercurous sulphate. The active anion depresses the positive branch of the curve, whilst the active cation depresses the negative branch. The strong bases have almost the same curve as the salts, but that of weak bases is lower than that of the corresponding salts. The effect of the free base is mainly due to the undissociated part; the effect produced by the salts is to be attributed to the active cations. In general, non-electrolytes are more active than electrolytes.

Electricity as a Divining Rod.—A note in the *St. James's Gazette* on Tuesday last reads as follows: "According to an American technical journal, electricity is now being used after the manner of the divining rod to discover metallic veins underground. Wires are run across the land which is to be surveyed, and the resistance between contacts placed at the ends of the wires is measured. A fall of resistance indicates proximity to a vein. On a certain occasion, it is stated, a resistance of 54,000 ohms fell to 56 ohms, and there was found beneath a rich vein of copper." We do not know the number of readers of the *St. James's Gazette* who will be misinformed by this rubbish, nor do we know the number of local papers which will copy the paragraph and thus get it read by a still larger number of readers, but we do know this, that whoever wrote the paragraph was absolutely ignorant of the subject about which he was writing, and everyone who reads it will be led into the belief that something is possible which is absolutely outside the possibilities of practical science. Unfortunately, there is hardly one issue of a political paper but which contains just as gross blunders upon scientific topics as the one we have quoted above.

Patent Amendments.—Amendments of considerable importance are announced as having come into force this week in the patent laws obtaining in all the "States of the Convention," which embrace the following countries: the United States, Belgium, Denmark, France, Italy, Japan, Netherlands, Norway, Portugal, Sweden, Switzerland, and Tunis. The principal amendments are stated to be as follows: Firstly, the priority granted to applicants for patents, designs, or trade marks in any of the States of the convention shall be 12 months for patents and four months for designs or trade marks, reckoned from the date of the application in the State in which the applicant is domiciled. Secondly, the patents applied for in any of the States of the convention by persons entitled to the privileges thereof shall be independent in duration of patents obtained for the same invention in other States whether parties to the convention or not. And, thirdly, no patent applied for under the convention shall incur forfeiture for non-working until the expiration of a minimum period of three years from the date of application. The extended period of priority given to applicants under the convention has been granted in Great Britain since Jan. 1, 1902, by the amending Act that came into force on that date.

An All-Stations Express.—At the British Association meeting at Belfast, Mr. J. Brown exhibited in the grounds of the Queen's College a model of his all-stations express, described in a paper before Section G. The ruling idea is that the rear carriage of the train should be slipped as the train approaches a station, and that at the same time the carriage standing in that station should be started electrically, and attain a speed sufficiently high to prevent a shock when picked up by the express. The speed used on the model was not high, and, as a rule, the carriage standing in the station had hardly started from rest before it was picked up. The shock was then often sufficient to prevent the couplings engaging, and to show that beyond being an interesting idea the proposal is not feasible commercially. In order to give the driver of the express a knowledge of how far he is from the carriage in front he has to pick up Mr. Brown has designed an electrical indicator, which would show the number of sections or the distance apart between the two The damage done to the tramcars at Glasgow in the recent accident, colliding at the low speed of from eight to ten miles an hour, was not brought forward at the discussion. It was suggested, however, that the scheme would be an exceedingly good one to get rid of obstructive railway directors and members of Parliament.

Telegraphy and Telephony in New Zealand — A satisfactory growth in both the telegraph and telephone fields in New Zealand is shown by the annual report of the Post and Telegraph Department of the colony for the year ended March 31 last. The gain in the number of telegrams sent over the various telegraph lines last year over the previous 12 months was 269,853, the total figures being 4,167,981 and 3,898,128 respectively. The value of the paid messages in 1900-01 was £122,781, as against £141,581 last year, an increase of £18,800 in revenue. At the close of the last fiscal year there were 21,705 miles of telegraphs in use, as compared with 20,682 miles the previous year, an increase of 1,023 miles. Telephony in New Zealand is also on the increase. As compared with 8,210 subscribers in the year 1900-01, there were 9,260 on March 31 last. With this increase in the number of subscribers of 1,050 there was a corresponding increase in the revenue to £55,542, as compared with £49,107 the previous year. The miles of telephone line in operation on March 31 last was 7,767 in opposition to 6,987 the previous year, thus showing a growth in the 12 months of 780 miles. The number of exchanges open on that date was 23 central and 35 sub-exchanges. The working expenses for the year amounted to £50,773, and the revenue given above to £55,542, a net balance remaining of £4,769. It is also noted in the report that the Pacific cable is expected to be completed to Vancouver and opened for through traffic about November next. The through rate to and from Europe by that route will be 3s. a word.

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Long-Distance Transmission. — California may truly be said to be the home of the transmission of electrical energy to long distances. It is here that the Bay Counties Power Company has succeeded in transmitting energy for commercial purposes over a distance of 223 miles. Not far behind this record comes a scheme to supply San Francisco with yet another source of energy, to be obtained from the Feather River over 180 miles away. The water of this river will be harnessed at a point known as the North Fork and conducted to the reservoirs which a new company is constructing These reservoirs, it is said, will be without parallel in the Western States, and will be so designed as to equalise the flow of the stream available for power to about 1,500 cubic feet per second. From the main reservoir the water will run through a specially-constructed canal about 10 miles in length into another reservoir, whence it will be carried by a series of tunnels for a distance of five miles to Mosquito Creek, where it will be given a vertical fall of 1,600ft., producing a total of about 270,000 h.p. The favourable character of the dam sites for these reservoirs, and the absence of serious engineering obstacles on the conduits, will render this enormous undertaking comparatively inexpensive, and, it is estimated, vastly cheaper per unit of power than any other Western power plant yet constructed. When it is remembered that the total development of power at Niagara thus far has not exceeded 100,000 h.p., a better conception of the magnitude of this new enterprise and its possibilities may be had.

Underground Telegraphs.—The various Scotch chambers of commerce are showing great activity in the attempt to persuade the Government to complete a comprehensive system of underground telegraphs between London and Scotland, with a view to avoiding the great hindrance to commerce which results from a breakdown in the overhead system. The Postal Telegraph Department in London has been approached on the subject times out of number, and the numerous replies of the late Postmaster-General (Lord Londonderry) to the memorialists have given ground for the belief that in time Scotland may be connected with the Metropolis by an underground telegraph line. It has been definitely stated that in the next financial year it is hoped to extend the London-Birmingham underground line further northwards, and to commence another section to go from Preston northwards. In view of this promise, and the fact that the time is now approaching for the preparation of the parliamentary estimates, the Aberdeen Chamber of Commerce have addressed another communication to the present head of the Post Office, Mr. Austen Chamberlain, urging the necessity of a sufficient grant being obtained to extend the underground telegraph system so as to embrace the more important cities in Scotland, including Aberdeen. The memorial of the Aberdeen Chamber also calls attention to the fact that the season of the year has arrived when difficulties connected with the overhead telegraph system may be expected, and urges that in anticipation of the grant the necessary engineering arrangements should be made so that no time may be lost in connecting the important centres of population by safe and assured underground wires.

Telegraphs of the World.—There is now in the press, and will shortly be issued by the United States Treasury Bureau of Statistics, a monograph giving an extended account of the land and submarine telegraphs of the world. Dealing first with the submarine telegraphs, it shows that the total number in operation in the different quarters of the globe is at present 1,750, with an aggregate length of nearly 200,000 miles. The total cost of these cables is estimated at £55,000,000; the number of messages annually transmitted over them is put at more than six million. Adding to the submarine lines the land telegraph systems by which they are connected, the total length of the telegraph lines of the world is 1,180,000 miles, the length of their single wires 3,800,000 miles, and the total number of messages annually sent over them about 400,000,000, or an average of more than 1,000,000 each day. Practically every sea and ocean is traversed by submarine lines, the Pacific Ocean being the one notable exception. In the past the chief obstacle to the construction of a trans-Pacific cable has been that mid-ocean resting places could not be satisfactorily obtained or arranged, but, as is common knowledge now, this difficulty has been overcome and the British Government are laying a cable across the Pacific which will bring the Australasian colonies in direct communication telegraphically with the mother country. Also the United States is about to lay a Pacific cable extending from the Californian coast to the Philippines. The longest submarine cable now in operation is that between Brest, in France, and Cape Cod, in the United States, which covers a distance of 3,250 miles, and this record will not be broken by either of the two Pacific cables referred to.

Wireless Telegraphy.—While the question of the commercial practicability of wireless telegraphy on land still hangs in the balance, there can be no doubt but that its performance on the sea has shown it to provide a means of communication at long distances the value of which can as yet hardly be estimated. Land for wireless telegraphy is admittedly about four times as obstructive as water, and the difficulties to be surmounted in the former case are naturally of a character which will require years of work to meet them successfully. The recent announcement that Mr. Marconi hopes soon to be able to exchange messages on a commercial scale between Italy and his station in Cornwall has, therefore, a special interest in the fact that a good part of the transmission will be overland. Spain will have to be crossed, with its never-ending ranges of hills, nearly all of which contain large quantities of iron ore. The effect this will have on electric waves is as yet only a matter of speculation. The Alps also have to be passed, which, by reason of their altitude, may be thought to cause a serious obstruction. Notwithstanding these difficulties, however, it is stated that perfect messages by wireless telegraphy have been exchanged between this country and Italy. There is now in course of erection at Spezzia, in Italy, a wireless telegraph station, which, when completed, will, it is hoped, allow of the exchange of commercial messages with this country. Mr. Marconi's latest claim is contained in a message from Rome, which states that he has found a means of overcoming the difficulties in the way of transmission which are connected with light, and affirming the possibility of establishing "wireless" communication between an Atlantic squadron and another fleet in the Mediterranean.

Electric Glass Smelting.—The pioneer electrical installation for the smelting of glass by the electric current on a commercial scale has been put down at Deutsch Matier, in Tyrol, and will be in operation in the course of a few months. The first successful attempts in glass manufacture by electrical methods were made some four years ago at Cologne by Becker. This experimenter, in order to avoid the danger of devitrification through the heat generated by the arc being too intense, devised an ingenious arrangement of a series of arcs, and the glass in a molten state followed into crucibles which were

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heated by coal or some other means. His collaborator in these experiments (Volker), however, devised another arrangement in which on each side of the receptacles he ranged electrodes, and by this means kept the glass in a molten condition for some time. But in this system there was the danger of the glass being deteriorated by the crumbling carbon, by which its purity was ruined, and it was rendered unsaleable. To obviate this difficulty, the electrodes were placed behind perforated diaphragms. Volker also devised a system by which he could melt the glass, not with the arc, but by a direct current of high resistance, by making briquettes of the smelting materials and the carbon, and thus fusing the components. At first the consumption of the current was found to be too heavy. For example, a kilogrammme of glass required four horse-power hours to produce it. This consumption of current, however, has now been reduced to 1½ and 1¼ horse-power hours, and it is claimed that at the works in question the cost of production will be still further cheapened. It remains to be seen whether the manufacture of glass by this electrical process has any and what special advantages over the ordinary smelting process at present universally employed.

Electro-Metallurgical Treatment of Ironsand A proposal has, we understand, been made to the Government of New Zealand by the Compagnie Electro-Thermique, of Paris, to establish large works in the colony for the electro-metallurgical treatment of the important ironsand deposits of Taranaki and other places. The help of the Government in the formation of a local company with this object is solicited. The importance of the deposits which form so much of the foreshore in New Zealand, the rich quality of the sand, the high prices of metals, and the ever-increasing demand for iron and steel, offer, it is claimed, a very good foundation for the formation of a large metallurgical establishment. The electric process for the manufacture of iron and steel which the above company is exploiting is the invention of Messrs. Keller and Zeleux, and depends essentially on the use of electric furnaces supplied with current by dynamos driven by hydraulic motors. It is thus based on the utilisation of natural forces as found in waterfalls, which are found in great numbers in New Zealand. Many rivers in the colony which might be harnessed descend from Mount Egmont and traverse the ironsand deposits before reaching the sea. In the district of Taranaki it is therefore possible to develop at one point, or neighbouring points, great power, which might be used as a heating agent in the electrical furnace, and also as a means of producing motive power for the machinery necessary in the working up of the raw product. The company conjectures that electrical works would not be expensive to establish in New Zealand, and considering the general advantages of the electrical method over the ordinary blast furnace, it urges the Government to grant facilities for the establishment of electro-metallurgical works in that country. We understand that the Government have agreed to receive a representative of the company on the subject and give every assistance in obtaining information as to the iron deposits of the colony.

Tramway "Crushes."—Such spectacles as those which occur daily at Blackfriars and Westminster of the struggle of crowds of people for seats on the tramcars, and to which attention was recently called by the accidental death of an old man, are unfortunately not confined to horse tramway systems only. During the "rush hours" of the day practically the same thing is to be seen at the Shepherd's Bush terminus of the London United Tramways, where the number of people to be catered for by the company is greatly in excess of that on the South London tramways. The question which arises is, Cannot anything be done to improve matters by adopting some one or other of the many "crush-stopping" systems in force in the provinces and on the Continent? For example, in Paris the passengers take numbered tickets at a kiosk near the terminus of the tramway system. The conductor of the next departing car, who knows to what number tickets have been issued, calls out the figures, and each passenger on hearing his number takes his seat It must be admitted that such a method as this wastes a considerable amount of time, and would hardly answer where great numbers have to be provided for and there is a rapid service of cars. There is, however, what is known as the "pen" method, which is said to be working very satisfactorily in Sheffield at the present time. At the principal termini of the tramway system in the city the passengers walk between parallel barriers to the car entrance, entering the vehicle two at a time. Good order is thus maintained, and passengers are able to board the cars expeditiously, and without being subjected to any crushing. Blackpool is meeting the difficulty in altogether a different way. A new style of car is being tried, which is so built that a large number of passengers can enter it almost simultaneously. This is effected by providing two stairways to the top of the car. Broad steps reach right across the rear breadth of the car, and the two stairways run upwards on either side of the entrance of the inside of the car. Several styles of car have also recently been adopted in New York with a view to providing better facilities for the entrance and exit of passengers.

Telephones.—Mr. J. E. Kingsbury's paper on "The Future of the Telephone in the United Kingdom" before Section G of the British Association at Belfast, takes much the same lines as we have done in leading articles on the same question. It clearly shows that the present competition between municipalities and the National Telephone Company is no solution to the muddle in which the various Governments of this country have allowed telephone matters to drift into. In the discussion which followed the paper Sir W. H. Preece instanced the fact we commented on recently, that when any discussion on telephones arises personalities are sure to be introduced. He himself had been accused of being a partisan of the National Telephone Company because he was in favour of monopoly. Sir Wm. Preece contended that all the telephones in the United Kingdom should be under the control of an Imperial department, and supported his contention by exemplifying the success of the Post Office. The opposite side was taken by a member of the Manchester Corporation, who disputed Mr. Kingsbury's statement as to the failure of the Manchester Mutual Telephone Company. He claimed that they succeeded in that city in getting all the various surrounding district councils to work with them in the matter, and that they would make the new service a success. He argued that if two services could be obtained for approximately the price now paid to the National Telephone system, the effect of the competition must be beneficial. Mr. Chas. Hawksley, the president of the Institution of Civil Engineers, held that the difficulty arose out of the modern rage for placing in the hands of municipalities, or, still worse, in the hands of the Government, undertakings which ought to be controlled by private enterprise. On the question of depreciation, he thought that undertakings which had a perpetual life, if they maintained these works in good condition out of revenue, need not charge depreciation as well. The evidence of the past expe-

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rience of the gas and water companies was all against competition in public services. Mr. Kingsbury's reply emphasised the fact that the telephone licenses now granted to corporations place them in no better position than the company, as the licenses lapse in a comparatively short number of years. There was, hence, no opportunity for the surviving of the fittest, as both the licenses had exactly the same period of life. He claimed that it never had been shown either in this country or on the Continent that on large city telephone systems a service could be provided at £5 per annum with a profit. The question which interested the commercial side of the nation was as to what the future advantages of the telephone to the community would be, and not the way in which those advantage were to be obtained.

Possibilities of Wireless Telegraphy.—Such is the title of a very interesting article which is contributed by Mr. Chas. Bright to the current number of the *Monthly Review*. Avowedly, the writer starts out with a double object—viz., to show that wireless telegraphy cannot, at present, be regarded as a serious competitor with cable telegraphy on a commercial basis; to point to the varied possibilities of ætheric, or so-called "wireless," telegraphy, even in the form we now know it. Discussing the first of these two claims, Mr. Bright refers particularly to the question of secrecy. As yet he sees no absolutely sure means of preventing a third party or climatic conditions effecting an interruption of a "wireless" message. To render wireless telegraphy a really practical business and an efficient means of "all-British" communication in times of war as in peace, the following conditions will require to be attained: First, the apparatus must be capable of being "tuned" to a certain pitch in such a way that the message is strictly confined to that particular receiver. On the other hand, to meet naval requirements, the apparatus on board a warship should be capable of picking up the tune of any of the enemy's ships. Yet, again, means will have to be found for overcoming the possibility of a message being rendered a mere "jumble" by the intervention of a third party, or of the elements. Having dealt with the conditions under which it is contended ætheric telegraphy cannot at present be said to compare at all favourably with telegraphy by cable, Mr. Bright goes on to discuss the question of speed. The working speed attained on "wireless" coherer circuits is low as against that on cables where the conditions are the same. On the average, he puts the relation at about 1 to 10. Twelve words a minute has been given by the United States navy as the maximum speed for sending wireless messages with skilled operators. As regards the sending of several simultaneous messages on the same circuit by syntonic methods, the writer doubts its practicability. Coming, now, to the second point—*i.e.*, as to the possibilities of wireless telegraphy in its present state—Mr. Bright, while denying that it is likely to serve as a successful competitor to cable telegraphy, recommends the cable companies to adopt the ætheric system as a ready "handmaid." It should prove especially applicable, he thinks, to inter-island communication, as well as between islands and the mainland, on account of the more or less constant cable breakdowns due to stress of weather. Then, again, as "feeders" to a trunk line, the wireless method should have a useful sphere. From a strategic point of view, as well as from a general maritime and life-saving standpoint, wireless telegraphy would also be preferable for providing Great Britain and Ireland with a complete system of telegraphic communication round the entire coast. Mr. Bright further details a number of other uses to which the wireless method could well be put, such as for lightship and lighthouse communication, to assist navigation in time of fog, etc. Concluding, he admits that wireless telegraphy has come to stay, but what its possibilities may reach cannot at present be foretold. At the same time, he sees no occasion as yet for alarm on the part of the cable companies in view of the reasons given above.

Tramways in Paris.—Giant strides in the matter of electric street traction have been made in Paris in the last three or four years, with the result that to-day there are close upon 200 miles of electric tramways operating in the city and its environs. From the point of view of the travelling public, little fault is to be found with the electric services provided by the various companies controlling the lines, but, financially, the results are anything but satisfactory. It will, perhaps, not be out of place here to quote a few figures published in the *Journal Officiel* relating to the operation of the Parisian tramways in 1901, which afford much food for reflection. For example, the South Paris Company has over 56 miles of lines in operation, the capital outlay on which amounted to more than a million and a half sterling. The net receipts of this undertaking in 1901 amounted to £34,000, the ratio of receipts to cost being 2·27 per cent., and the proportion of working expenses to traffic receipts 88 per cent. Again, the East Parisian Company has a system comprising about 48 miles of line. The capital outlay was £1,836,000, and the net receipts in 1901 amounted to £4,000. The ratio of receipts to cost was 0·26 per cent., and the proportion of working expenses to traffic receipts 97 per cent. The North-West Parisian Company, with nearly 19 miles of line and a capital outlay on construction of £895,000, made a net profit in that year of £6,000, the ratio of receipts to cost being 0·06 per cent., and the proportion of working expenses to traffic receipts 99 per cent. These figures, which are based on returns to the Minister of Public Works, show how small is the proportion of net revenue to cost of construction, and thus enable one to gauge to a certain extent the earning power of each company. But to look to the causes of these very indifferent results. They are of several kinds, chief among them being the heavy additional cost of constructing the lines on the conduit system—overhead wires in Paris are barred by the Municipality—the low fares in vogue, the onerous charges imposed by the Corporation, and the over-staffing and the generally extravagant management. These, at least, are some of the reasons given by the Paris correspondent of the *Financial Times* in an excellent series of articles he is contributing to his paper on the subject. Perhaps the greatest bugbear to the Parisian tramway companies is the Municipality. Every tramway concession in France is only granted for a determined number of years, and is subject to the conditions of the working agreement imposed on the concessionnaire by the authorities. This document lays down the exact fares to be charged on the tramways, the road repairs that shall be undertaken, the number of cars to be run, the number of hours the employés shall work, the minimum salary the staff shall be paid, and a number of other regulations of the same arbitrary character. One of the most onerous of the stipulations is that no overhead wire system shall be used, and this proscription has, of course, obliged the companies to adopt the more expensive accumulator or conduit system. It will thus be seen that the lot of the tramway companies in Paris is not a particularly happy one. They have now come to an understanding among themselves, and are taking united action with a view to obtaining several modifications of the regulations. Chief among the reforms they are pressing for are a revision of fares, the right to use the overhead system, and the prolongation of the concessions under which they work.

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ELECTRICITY ON RAILWAYS.

To give some information on the question of increased acceleration on electric railways, we may refer to what is being done on the Liverpool Overhead Railway by means of a new type of equipment supplied by Messrs. Dick, Kerr, and Co. It will be remembered that the Liverpool Overhead Railway was the first elevated line in the world operated by electricity, and was equipped some 10 years ago. The total length of the line is a little over 6½ miles, with double track and a third-rail feed and a special rail return operated by 500 volts direct current The trains are made up of two or three carriages, the larger trains weighing about 55 tons. With the old equipment the entire distance was run in 32 minutes, including 16 stops, or practically at a scheduled speed of 12½ miles per hour. This requires a minimum of 14 trains running at five-minute intervals to cope with traffic.

Some 12 months ago, however, it was decided to experiment with a new equipment in order to ascertain what acceleration could be obtained, and Messrs. Dick, Kerr, and Co. entered into a guarantee to run the whole distance—including 16 stops of 12 seconds—in 20·9 minutes; in other words, to improve the scheduled speed from 12½ to nearly 19 miles per hour. The weight of the train, including 154 passengers, was 55 tons. A most careful series of elaborate tests and trial runs were made by Mr. Cotterell, the engineer-in-chief of the Liverpool Railway, assisted by Mr. Mallock, and it was clearly demonstrated that the new train would make the journey easily under 20½ minutes. The accelerated curves obtained from these trials are shown in Fig. 1. From these it will be seen that the acceleration reached

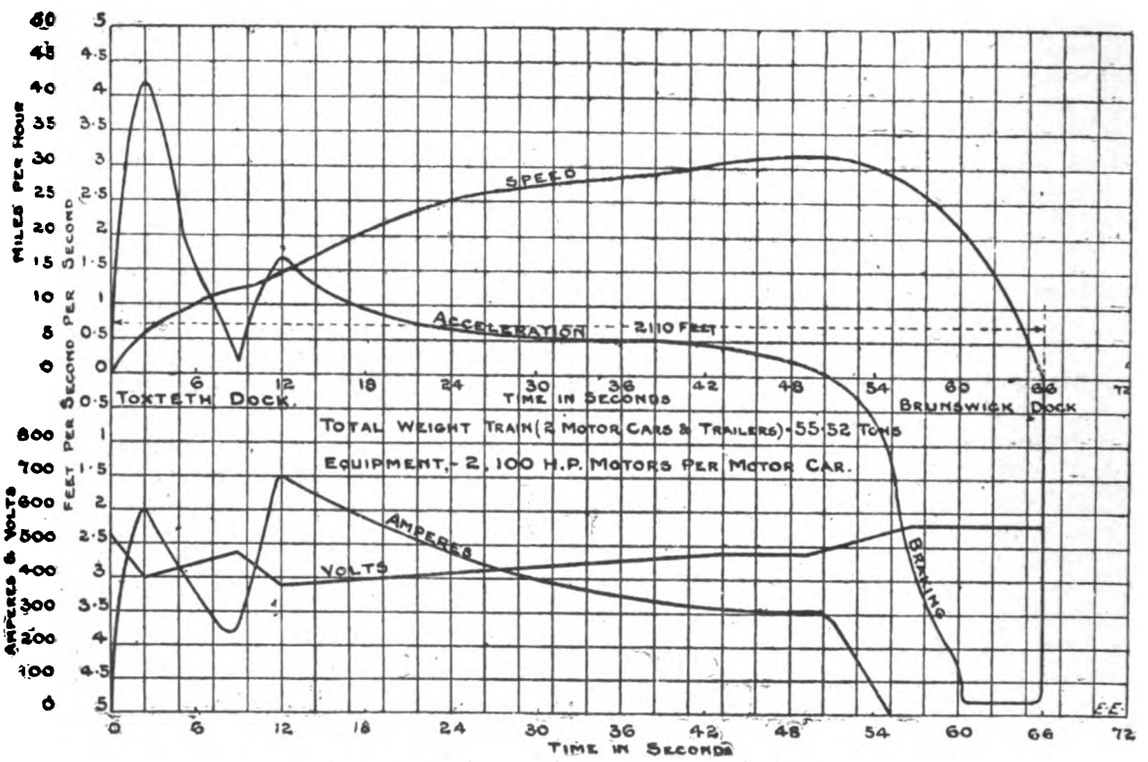

FIG. 1.—Acceleration Curves of the New Liverpool Overhead Trains.

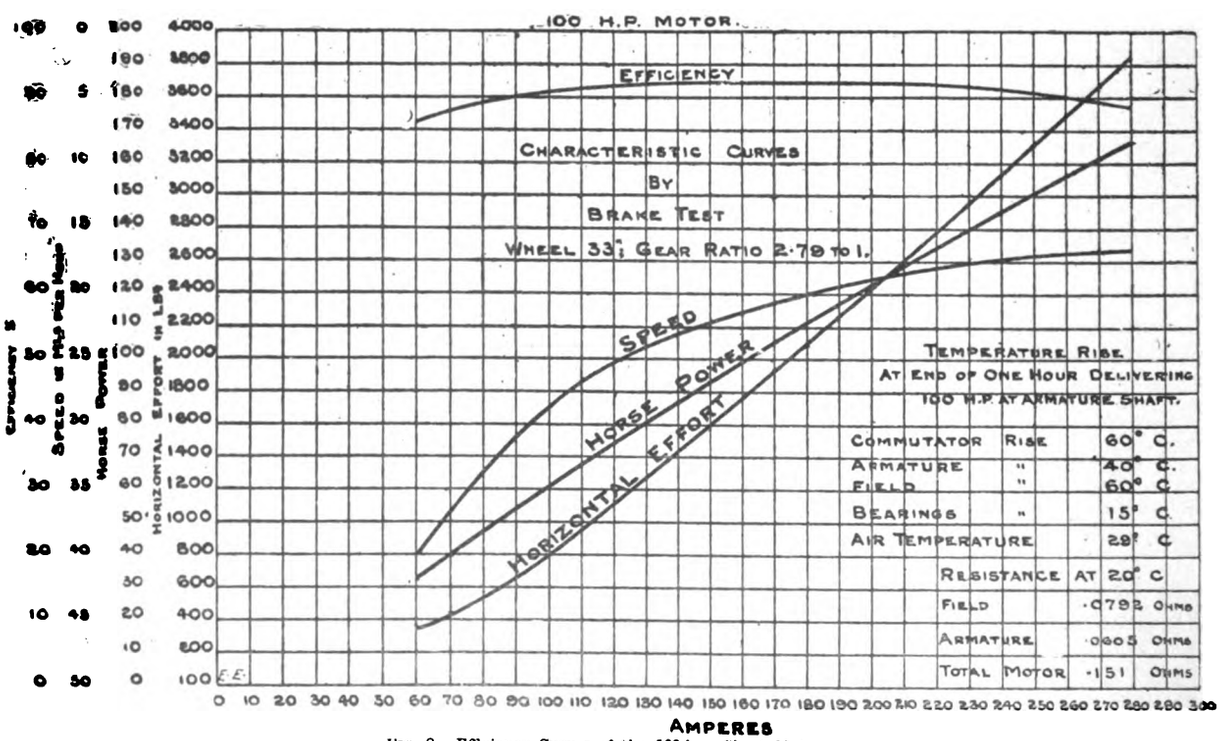

FIG. 2.—Efficiency Curves of the 100-h.p. Short Motors.

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4·2ft. per second per second, or nearly three miles per hour per second, the average acceleration being well over one mile per hour per second, thus enabling the train to cover the 2,110ft. between the stations in little over one minute, including starting and stopping. This rapid acceleration is possible owing to the excellent commutation of the motors, which will not spark when carrying 300 or 400 amperes—that is, three or four times their normal current. During the acceleration of the train in the series position of the controller each motor is carrying 300 amperes of current, as shown by the curve. The curves also show the perfect action of the brakes during the retardation of the train. The negative acceleration recorded reached 4·75ft. per second per second, which is probably near the practical limit in actual service. The diagrams of current in pressure at the motors are recorded, and are of interest in determining the power consumption at different parts of the run.

The frequent stopping of trains running at high-schedule speed will consume from 120 to 150 watts per ton-mile. If, however, the stops are far apart, the watts required are from 90 to 100 per ton-mile. In the experiments recorded, the watts consumed were 137 per ton-mile, or about 6·35 kw. per train mile run. The results of the new accelerated service are shown in the accompanying table. In consequence of the successful issue of these tests, the Liverpool Overhead Railway have instructed Messrs. Dick, Kerr, and Co. to re-equip the whole of the rolling-stock. Each of the new trains is to be fitted with four 100 h.p. railway motors, which are designed by Mr. S. H. Short, and built at the works of the English Electric Manufacturing Company, Preston.

The performance of these motors is shown in the efficiency curves (Fig. 2), these having been made from actual measurements taken from one of the motors during the experimental run. The efficiency is unusually high, being practically 93 per cent. at the full load of 75 kw. Their weight is 4,200lb., or only 42lb. per horse-power, which is a point of considerable importance in keeping down the dead-weight of the train.

Table showing Results on the Liverpool Overhead Railway.

	Old system.	Accelerated service.
Mean speed	12½ miles (20 km.)	19½ miles (32 km.)
Number of stops	16	16
Mean time at stations	11 seconds	11 seconds
Mean distance between stations	729 yards (666m.)	729 yards
Watts per ton-mile	110	137
Acceleration	1·6ft. (0·44m.) per sec. per sec.	3ft. (0·91m.) per second per second
Retardation	3ft. (0·91m.) per sec. per sec.	4·8ft. (1·26m.) per second per second

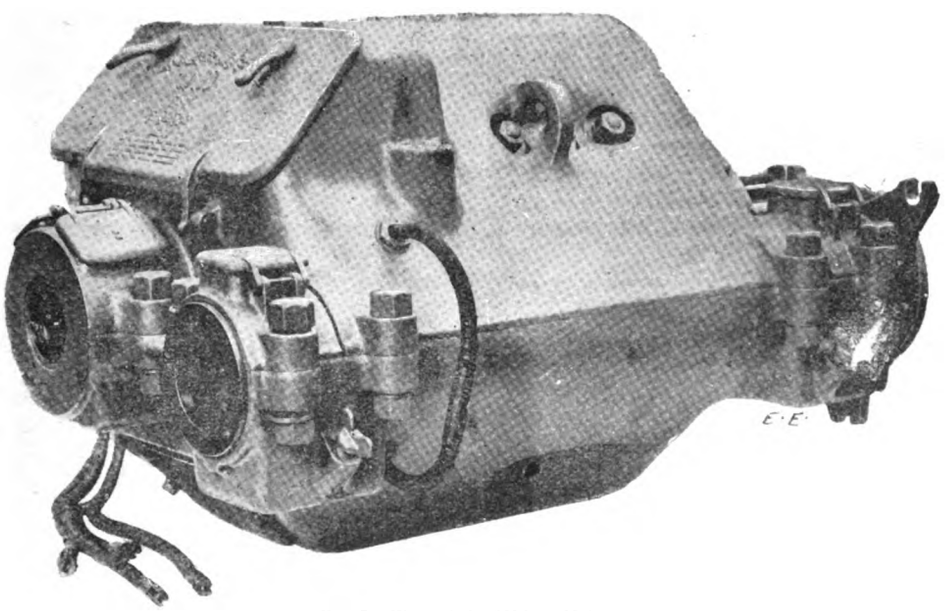

FIG. 3.—View of the 100-h.p. Motor.

The new motors in use on the Liverpool Overhead Railway are completely enclosed in a cast-steel shell, forming a fire and water proof casing; this shell also serves to form the magnetic circuit of the fields and to support the armature and axle bearings. The only opening in the motor casing is over the commutator and brushes; this is, however, securely closed by a hinged lid fitted with fastenings. The motor frame is divided on the horizontal plane, the upper half being removable, leaving the lower half supported on the car axles and the nose suspension In this way the armature and fields can be easily uncovered for inspection and repair without entirely dismantling the motor. This method of opening the motor is just the reverse of the tramcar motor, where the lower half of the frame is let down into a pit for inspection of the interior, which would not be practical with motors of such great size. The interior of the motor frame is provided with four laminated steel pole pieces, each with its own field spool, held in place by large bolts passing through the outer shell. The field spools are made of copper ribbon, about 2in. wide, wound with asbestos and mica strip between layers, and insulated outside with mica and asbestos combination boxes, held in position by means of heavy braided tape. The complete coils are treated with a waterproofing insulating compound and thoroughly baked.

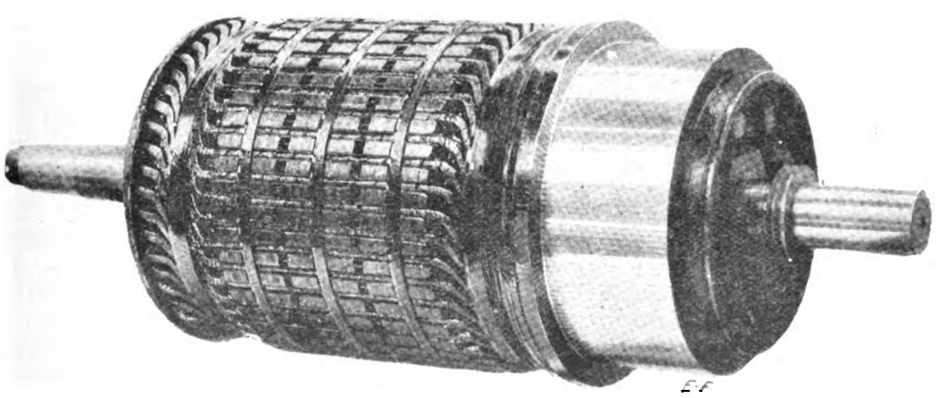

FIG. 4.—Armature of the 100-h.p. Short Motor.

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The same number of turns of copper ribbon is put on each pole, so that a perfectly symmetrical field is produced, in which the armature revolves. The armature is iron-clad, the copper bars with which it is wound being let into deep slots. Each coil in the armature is made with only one turn, and without joints, except at the commutator. The insulation of these coils is also composed largely of mica and asbestos, treated with a special insulating varnish, taped, and baked. The coils are all alike and interchangeable, so that injured ones may be replaced with ease. Ample ventilation is provided for the interior of the armature core, and air ducts leading to the surface aid in keeping up a good circulation. The high-grade steel from which these cores are made ensures low hysteresis losses, and the thorough insulating of the laminæ from each other prevents the formation of eddy currents. The commutator is very large and has many bars, rendering the commutation perfect, even with double the normal load on the motor. The brushes are in two sets at the top of the commutator, with two brushes in each set. No sliding contacts are permitted to carry current, each brush being fitted with a brass clamp which moves with it, and a flexible braided ribbon of copper, connecting it directly with the brush-holder supports and main cables from the controllers.

The efficiency of the motor is well over 90 per cent., as shown by the characteristic curves of the machine. The temperature rise, after one hour's run at full load, is far below the standard of 75deg. C., being as follows: commutator, 55deg. C.; armature, 39deg. C.; fields, 57deg. C.; pinion bearing, 14deg. C.; commutator bearing, 9deg. C. The bearings are all made of the best bronze, and provided with both oil and grease lubrication. Special provision is made to catch all the oil from the ends of the bearings and to return it to the wells, so that it will not be dropping on the permanent way. The gears are of cast steel, with the teeth cut out of the solid casting. The pinion is of hammered machine steel. The gear housing is of malleable iron, made oiltight. The complete motor weighs as follows: motor, 3,945lb.; gear, 260lb.; housing, 140lb.; links, 40lb; key, 2lb.—total, 4,387lb.; or, including gears, gear housing, etc., complete, only 43·8lb. per horse-power. The motors are journalled at one end to the driving axle and spring supported on the bogie frame at the other side. The method of suspension relieves the permanent way of severe shocks at the rear joints and cross-overs. The motors are carried on each of the two end cars of the train. The controlling mechanism is in many respects similar to the series-parallel method of control adopted by Dick, Kerr, and Co., Limited, and is fitted with a new blow-out device which renders it perfectly proof against fire. It is interesting to observe what effect this improved equipment will have upon the service of the Liverpool Overhead Railway. The 12 trains of the new type will replace 14 of the old, and it is a matter of interest that these new trains will accommodate exactly the same number of passengers as the old ones.

With the previous equipment the trains ran 144 train miles per hour, while in the new method they will run 216 train miles per hour. There was a five-minute headway between the old trains, but under the new *régime* this will be reduced to 3½ minutes. In other words, the journey from one end of the line to the other will be made in two-thirds of the time taken on the old method, and, what is of supreme importance, the load on the power station will be more uniform, and, as a consequence, the machinery will be running under more efficient conditions. As a comparison the following table is of interest, as showing the scheduled speeds with the new Liverpool equipments and those obtaining on other lines:

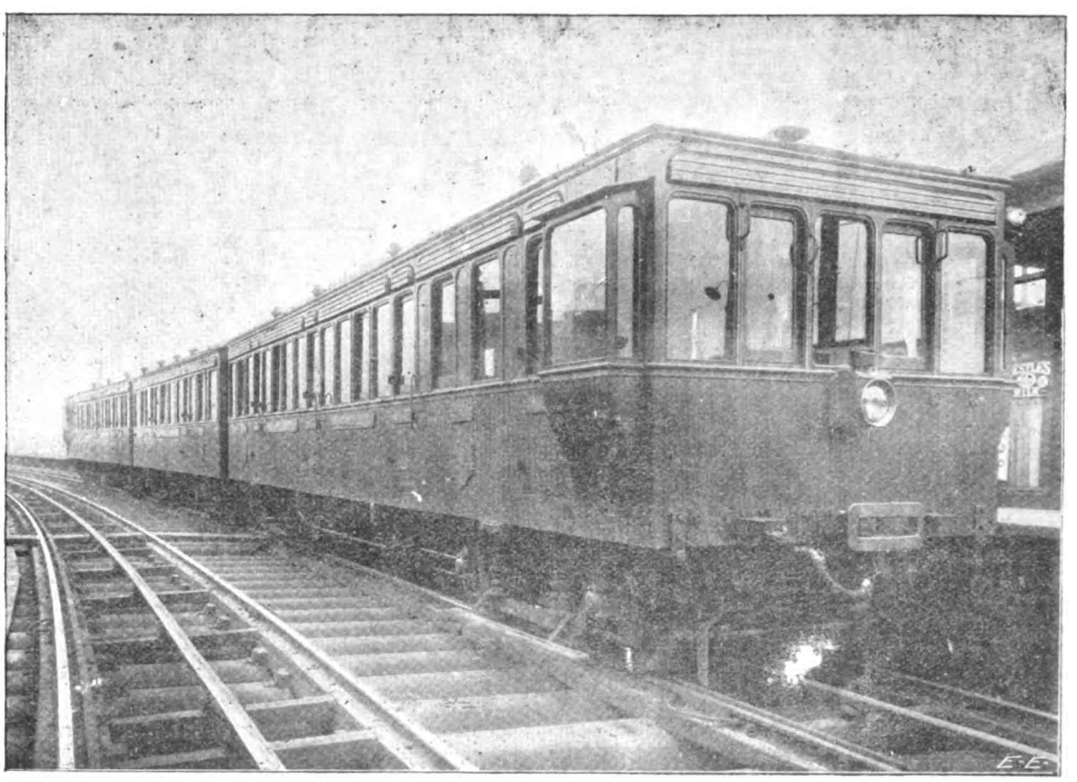

FIG. 5.—The New Train for the Liverpool Overhead Railway, with which a mean speed of 19½ miles per hour is obtained.

	Miles per hour, including stops.
Liverpool Overhead Railway	19
Manhattan Elevated Railway	13½
Metropolitan Elevated Railway	14·1
South Side Elevated Railway (Chicago)	14·6
Lake Street Elevated Railway Chicago)	12½
City and South London	12½
Central London	14

STAMFORD ELECTRICITY WORKS.

The supply of electricity in Stamford was commenced in March this year, and the progress of the undertaking reflects great credit on the local staff of the Urban Electric Supply Company. The population of Stamford is only slightly over 8,000, and already the equivalent of 3,000 8-c p. lamps have been connected to the system. The resident engineer (Mr. W. E. Milns) informs us that 4,000 additional lamps have been applied for. When these have been connected, the density of lamps per head of population will not be far behind that of towns which have had electric lighting undertakings at work for years.

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The electric lighting order for Stamford was obtained in 1900, and was taken over by the Urban Electric Supply Company, who obtained an excellent site for their works in the Wharf-road. The position selected is a central one, and is near the Great Northern Railway Company's station; it is also on the river, so that the plant can eventually work condensing. The following photographs show typical views of these works. Thus, Fig. 1 is an outside view of the station, the buildings for which were erected by Messrs. Hinson and Co., contractors, of Stamford. It will be seen that a stayed iron chimney shaft is used, and that the heating room and boiler-house are galvanised iron structures. The inside of the engine room is illustrated in Fig. 2. This contains two Belliss-Parker steam dynamos, each of 90 kw. output. These machines supply across the outside wire of a three-wire network at 480 volts. The balancing of the system is effected in the usual way by means of rotary balancers and boosters supplied by the same firm. The construction of the switchboard, which was made by Messrs. Kelvin and White, of Glasgow, can also be well seen in the illustration. The connections to the accumulator switches are brought through the wall of the battery-room to switches which are mounted on the walls behind the switchboard. The handles of the regulating switch on the board are then provided with long shafts extending back to their switches. The only objection to this arrangement is that it interferes with the free access behind the switchboard otherwise obtainable. The accumulators, supplied

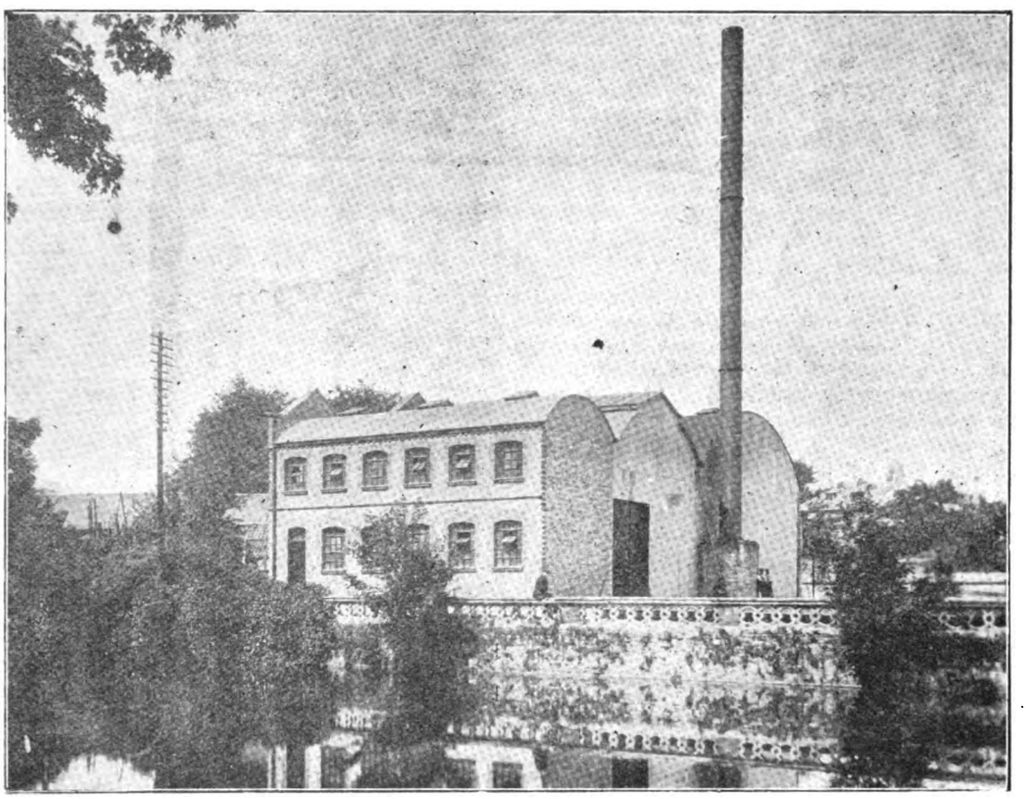

FIG. 1.—The Stamford Electricity Works.

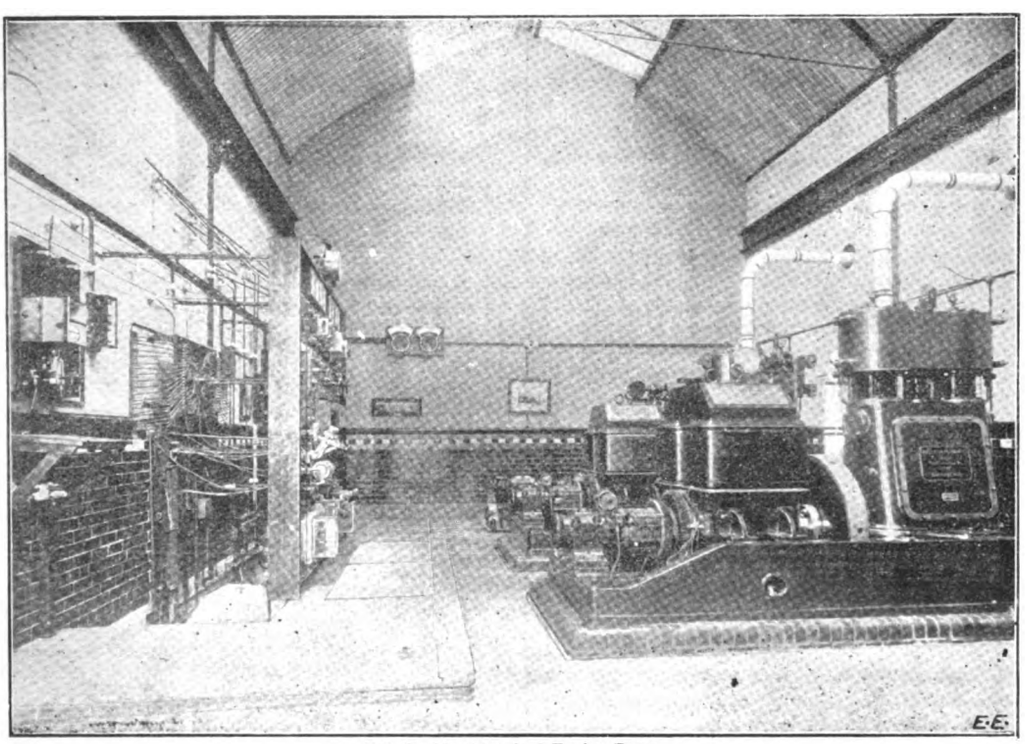

FIG. 2.—The Stamford Engine Room.

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by the D.P. Battery Company, are of 350 ampere-hours capacity, and 260 cells have been provided. These form an effective stand-by at the present time. The boiler-house plant (Fig. 3) consists of Babcock-Wilcox boilers equipped with chain-grate stokers and superheaters.

The whole of the mains have been supplied and laid by the Callender Cable and Construction Company. The cables are all of the single-core type, insulated with vulcanised bitumen, and are laid in wooden troughing filled in with bitumen. The troughs are closed after being filled in with tile covers, which gives a certain amount of mechanical protection to the cable system. Multiple-core cables are used for the pilot wires and services, and these are also laid on the solid system.

With the exception of the boilers, all the plant was erected by the resident engineer, Mr. W. E. Milns, with his own staff. Mr. R. Hill is responsible for the energetic canvassing resulting in such a large number of lamps being quickly connected to the system. The scale of charges by the company for energy to be used for lighting is 7d. and 3d. per unit on the maximum demand system. Power consumers are supplied on the same system at 4d. and 1½d. a unit respectively. The company has to compete with a gas supply at 3s. 6d. per thousand, and the figures

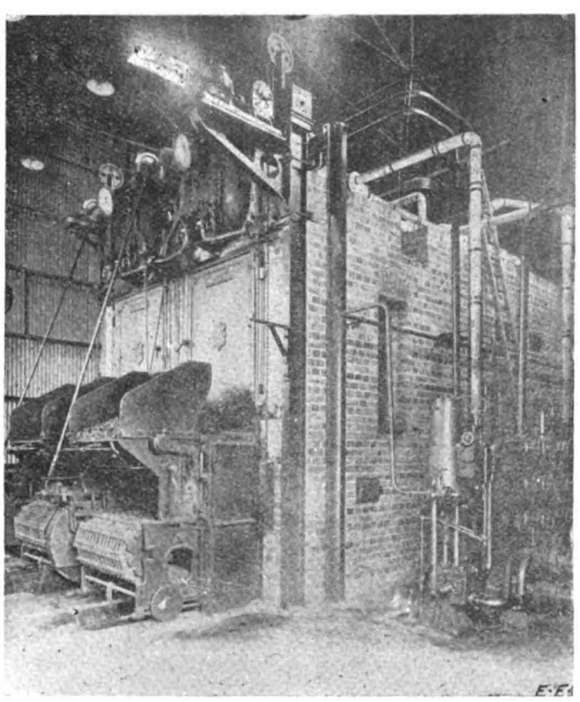

FIG. 3.—Babcock-Wilcox Boilers and Stokers at Stamford.

for lamps connected and applied for show how successful their competition has been.

SOME NOVELTIES IN ELECTRICAL APPARATUS.*

BY M. B. FIELD, M.I.E.E.

I have the honour of calling your attention to a few electrical instruments which possess, I believe, some novel features. I do not propose to occupy your time by a lengthy explanation of the working of these instruments, but will content myself with stating as briefly as possible what objects they are intended to serve. Detailed explanations may be found elsewhere by anyone who may happen to be specially interested.

Compensated Voltmeter.—This particular instrument is designed for indicating the voltage between either the positive or negative and the neutral main at the far end of a three-wire feeder—that is to say, the voltmeter, although connected to the feeder at the station end, indicates the voltage existing at the network end, being compensated for the feeder drop, no matter how much or how little the network may be out of balance. This instrument is compensated for the drop in a triple-concentric cable one mile long, the outers having a cross-section of 0·5 square inch, the neutral 0·25 square inch. No pilot wires are employed. The connections are shown in Fig. 1. It will be noticed the two views are identical as regards connections. R_1, R_2 are series resistances inserted in the mains. Two others, shunt resistances, are connected across the mains, the measuring instrument being connected to these shunts so as to divide them up into the four resistances I have marked 1, 2, 3, 4. The measuring instrument is merely a delicate milli-voltmeter calibrated to read

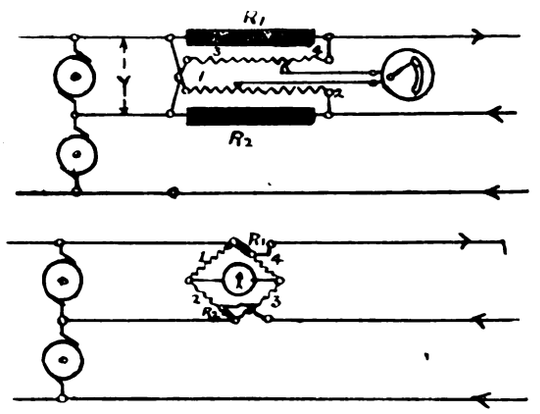

FIG. 1.

the actual volts at the far end of the feeder. It will be seen that the arrangement corresponds to an unbalanced Wheatstone bridge, where potential differences are introduced into two of the arms proportional to the drop of volts in the outer and neutral mains respectively. A little consideration will then show that the current through the measuring instrument will be proportional to the voltage of the circuit minus a certain multiple of the current in R_1, minus a certain multiple of the current in R_2, assuming the currents are flowing in the directions indicated by the arrows. It is merely a matter of adjusting the ratio arms 1, 2, 3, 4 suitably, in order to get true compensation for the feeder drop of voltage.

In this instrument the resistances are as follows:

Ratio arm 1.— 10 × 5·6 = 56 ohms.
„ 2.— 99 × 5·6 = 554·4 „
„ 3.—100 × 5·6 = 560 „
„ 4.— 9 × 5·6 = 50·4 „
R_1 = ·000888 ohm.
R_2 = ·0195 „

Hot-Wire Wattmeter.—I have here a hot-wire instrument which, when connected to an electric circuit, will read

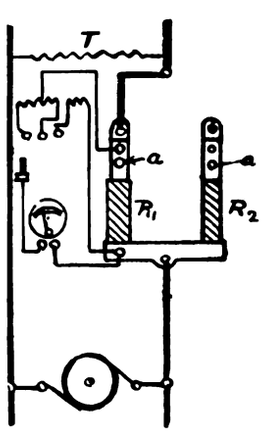

FIG. 2.

amperes, volts, true watts, hence power factor, giving readings *consistent* with one another. The drop of voltage across the instrument does not exceed 0·5 volt, so that measurements can be made by it on motors or other apparatus while connected to their normal circuits—*i.e.*, no special provision of higher voltages is necessary when making such tests. The instrument is essentially for workshop and testing-room purposes, *not* for switchboard work. The connections of this particular instruments are those shown in Fig. 2. R_1 and R_2 are two alternative non-inductive resistances of

* Paper read at the Belfast meeting of the British Association.

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different carrying capacities, either of which can be inserted in the main cirtuit. T is a potential transformer with three secondary windings giving equal voltages. A plug arrangement is attached to the instrument. The first two plug holes (from the left-hand side) give the necessary connections for the determination of watts; the third converts the instrument into a voltmeter; and the fourth and fifth, marked *a* in figure, into an ammeter, special calibration tables being employed. This instrument is really an outcome of the one previously described; for with the plug inserted in hole 1 we have practically the same arrangement as the compensated voltmeter modified for a two-wire circuit. Position No. 2 is the same, but with the secondary E.M.F. of the transformer reversed. If the instrument is calibrated to read the square of the voltage at its terminals in each case, the difference of the two readings is a measure of the watts. These instruments may be made up with two pointers moving over the same scale, and with a special attachment for taking both the power readings simultaneously.

Fault Indicator.—This instrument has been designed specially with reference to tramway circuits. As a general rule all feeders for electric tramways are protected by automatic circuit breakers. These not infrequently open from unknown causes. The general practice in tramway systems after a breaker has come out, is to close it again without taking any special precautions. If the breaker comes out three times in succession, the line is reckoned to be short-circuited, and the fault must be searched for.

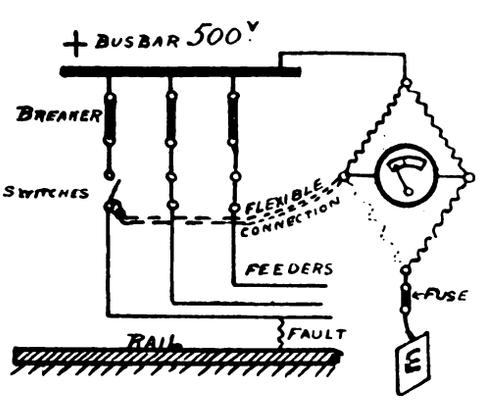

FIG. 3.

Such a fault may be due to a short-circuit on a car, an earthed guard wire touching the trolley wire, a fallen trolley wire, an insulating bolt supporting trolley wire broken down, etc. The above described method is, of course, crude in the extreme, and the practice of closing a circuit on a "dead short" is often fraught with considerable damage—damage which may only come to light some time afterwards. Now, the resistance of the feeder to earth should be a sufficient guide as to whether the feeder is "shorted" or not. If it be "shorted," the resistance will be well under one ohm; if, however, the "short" or overload disappear, the resistance will be fairly high. When the power is cut off any section, the motormen have instructions to at once turn off their controllers, switch on the lights, and wait for these to glow. The resistance to earth will, therefore, be merely the resistance of the lamp circuits. The fault indicator, then, is merely a Wheatstone's bridge where the feeder circuit forms the unknown resistance, the voltmeter on galvanometer and ratio arms being so proportioned that if the unknown resistance is less than one ohm, the needle goes hard over to the left, pointing to "Line blocked," and if over 20 ohms hard over to the right, pointing to "Line clear." The general arrangement is shown in Fig. 3. A relay may be fitted to the indicator to call attention to the fact that a line is "cleared" as soon as the fault is removed. The instrument may be kept permanently in connection with the positive 'bus bar, and plugged on at a moment's notice to any feeder, the breaker of which has opened. To a large tramway system, blocks and interruptions of traffic are most costly, and any instrument which will in any way minimise the duration of these is, I think, worth the consideration of all tramway engineers.

Synchronising Gear.—Some engineers prefer synchronising with voltmeters, some with lamps—for myself, I vastly prefer a dead-beat voltmeter. I am, however, very much in favour of installing a set of pilot lamps near the stop valve of each engine, so that the driver can watch the process himself, and open or close the stop valve intelligently as is required, till paralleling is accomplished. It is, of course, further necessary to adjust the voltage of the incoming machine to equal that of the 'bus bars to which it is about to be switched. The object of this synchronising switch is by a *single* setting to establish all the connections necessary for these indications—viz.: it (1) puts into circuit the pilot lamps on the incoming engine; (2) puts into circuit the synchronising lamps on panel controlling the incoming generator; (3) puts into circuit the synchronising voltmeter; (4) puts in circuit a special voltmeter which shows at a glance whether the voltage of the incoming alternator is equal to greater or less than that of the 'bus bars (Fig. 4).

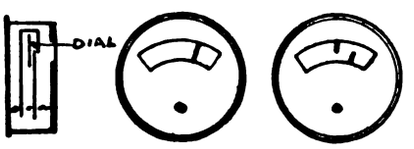

FIG. 4.

Operation No. 2 may, of course, be dispensed with, for with a synchronising voltmeter these lamps are not essential. They are, however, always useful as a reserve method of synchronising. The special voltmeter mentioned in operation (4) is in reality a double one, with two pointers moving over the same dial. One pointer comes up the back of the dial (which is illuminated) and over the top; the other swings in front of the dial. There are no markings on the dial. The one voltmeter is connected to the incoming machine, the other to the 'bus bars. If the voltage of each is the same, the two pointers form a radial line across the dial. If the voltages be unequal, the line is broken. The synchronising voltmeter and the above double voltmeter are both mounted on a swinging bracket attached to the switchboard, so that both are in view simultaneously (Fig. 5). The synchronising switch itself has some novel features. This one I have here is designed for four alternators. With this switch only four synchronising transformers are needed, one connected to each alternator—that is, the usual auxiliary transformer connected to the 'bus bars may be dispensed with. Again, if the dial of the double voltmeter be calibrated, it is really superfluous to supply each generator panel with a separate voltmeter. A synchronising bracket may be fixed at either end of the board, so that in case one instrument breaks down there is

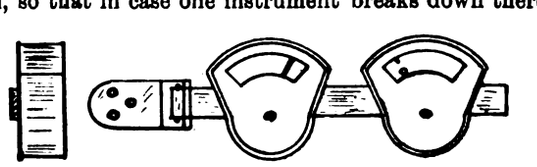

FIG. 5.

always a reserve one. A considerable simplification of the generator panels is thus effected.

ON THE SPECIFIC UTILISATION OF MATERIALS IN DYNAMO DESIGN.*

BY PROF. SILVANUS P. THOMPSON, F.R.S.

In comparing together different dynamos designed by different engineers, one finds very considerable differences between them with respect to the specific utilisation of the materials employed. This remark applies even to machines of kindred type and magnitude, and intended to work under similar conditions. One designer will so design his machine that the iron cores or the iron teeth are subjected to a much higher degree of magnetic saturation than those in the design of a different engineer. One engineer will employ a higher density of current in his copper conductors than another employs. Another will

* Paper read at the Belfast meeting of the British Association.

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contrive by choice of insulating material to get more copper into an equal space in the slots. Even between machines of identical type, output, and efficiency there may be differences; for, though the net efficiency may be alike, the inevitable losses of energy may be differently allocated, one machine having greater heat losses in the copper, another greater heat losses in the iron.

In the present note the specific utilisation of the materials is considered solely in relation to the armature; but the armature in which the material is utilised to the greatest advantage will be the one requiring least material in proportion to its output, and, therefore, in general the smallest. Hence it will require also in general the smallest size of field magnet.

In a paper read before the Electrical Section of the Engineering Congress at Glasgow in 1901, Mr. Mavor introduced the conception of the "active belt," meaning by this term the entire mass of the peripheral structure of the armature down to the roots of the armature teeth, and consisting of iron, copper, and insulation. It is in this active belt that the whole inductive generation of E.M.F.'s takes place, and it is also on this active belt that the whole of the mechanical forces as between armature and field are exerted. Mr. Mavor discussed the energy spent in this active belt, and in order to obtain figures that could be compared with one another for different machines, he calculated down the relation between the output of the machine and the volume of the active belt, not under the actual conditions of use, but on the supposition that in all machines the field was equally strong and the peripheral speed alike. In other words, he ascertained for a number of different machines, the number of ergs per second per cubic centimetre of active belt at unit velocity in unit field. He found the number, though varying from one machine to another, to be about five. Now, the work done per magnetic line in moving a current across a field is simply proportional to that current, so that Mr. Mavor's coefficient is simply a measure of the current density (or a number of C.G.S. units of current per square centimetre) in the *gross* section of the active belt As 10 amperes equal one C.G.S. unit, his result is equivalent to 50 amperes per square centimetre, or 322 amperes per square inch of the gross section. Consider the copper conductors that run through the active belt parallel to the shaft. In their net section the current density at full load may vary in different machines. In modern ventilated armatures designers work with current densities of from 1,200 to 1,800 amperes per square inch. But the copper occupies only from 0·4 to 0·5 of the slot, and as the slots are about of equal width with the teeth, or often slightly wider, one may take it that the gross section (transverse to the direction of flow of the current) of the active belt will be roughly about four times as great as the net copper section. Hence, on this view, the gross density should be from 300 to 450 amperes per square inch, or from 46·5 to 70 amperes per square centimetre, equivalent to 4·65 to 7 ergs per cubic centimetre at unit speed in unit field. Mr. Mavor's figure of 5 is nearer the lower of these limits.

Now, we may extend still further this conception of the active belt, and may consider, not only the mean number of amperes that traverse each square inch of it parallel to the shaft, but also the mean number of magnetic lines that traverse each square inch of it radially; and at the same time we may consider the speed with which it moves forward tangentially. There are here three items that enter severally into the expression for the power per cubic inch. They are in three different directions mutually at right angles to one another—the speed tangential, the magnetic flux radial, the current axial. To deal with these quantities we resort to symbols as follows:

E = E.M.F. (volts) generated by armature;
C = current (amperes) flowing through armature;
N = magnetic flux (lines) per pole;
Z = total number of armature conductors;
p = number of poles;
c = number of circuits in parallel through armature;
d = diameter of armature (in inches);
l = length of core body (in inches);
s = length of tooth or depth of slot (in inches);
n = number of revolutions (per second);
v = peripheral velocity (in inches per second).

Now, the armature periphery is $\pi d l$; and the volume of the active belt is $\pi d l s$. The output of the machine in watts is $E \times C$. Hence:

$$\text{Watts per cubic inch} = \frac{E C}{\pi d l s} \quad . \quad . \quad . \quad (1)$$

Now we may write for the E.M.F. of the machine:

$$E = \frac{n p N Z}{c \times 10^8} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Further,

$$n = v \div \pi d. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Inserting the values of (2) and (3) into (1), we get

$$\text{Watts per cubic inch} = \frac{Z C N p v}{c \pi^2 d^2 l s . 10^8} \quad . \quad . \quad (4)$$

This expression we may decompose into three factors, thus:

$$\text{Watts per cubic inch} = \frac{Z C}{\pi c d s} . \frac{N p}{\pi d l} . \frac{v}{10^8} \quad (4A)$$

These three factors we may severally write:

$Z C \div \pi c d s = \alpha$ = gross current density per square inch axially in active belt.

$N p \div \pi d l = \beta$ = gross magnetic density per square inch radially in active belt.

$v \div 10^8 = \gamma$ = a quantity proportional to the peripheral velocity.

If, then, we take out these three factors, α, β, and γ, for any particular machine, we have at once a means of comparison between its design and that of other machines, in respect of the specific utilisation of materials. Some makers manage to crowd many amperes through the copper, or to have much copper in the belt: in their machines α will be large. Other makers contrive to have a high mean magnetic flux density in the belt: in their machines β will be large. Others drive their machines with a high surface speed, and thus manage to increase the specific output of a given quantity of active material. Now, owing to the conditions that are necessitated by sparkless commutation, α cannot be very high unless β is high also; though β may be high without α being so. But γ may be high or low quite independently of α or β.

The author has made a detailed analysis of some 50 modern generators to ascertain the values of these factors of specific utilisation. He did not include any smooth-core machines nor arc-lighting dynamos, nor any very small designs. In fact, the figures considered relate only to continuous-current generators of modern type, and of sizes above 50 kw., with slotted armature cores, as used for lighting or traction. In such machines the values of the constant α lie mostly between 300 and 460 amperes per square inch, a few being outside these limits. The values of β lie mostly between 30,000 and 45,000, the extreme values being 22,000 and 58,000 lines per square inch. The values of γ lie mostly between 0·000004 and 0·000009; or the peripheral speeds lie mostly between 400in. and 900in. per second, or between 2,000ft and 4,500ft. per minute. In a few cases an even higher speed is used.

Multiplying together the three factors for any machine we get its specific output in watts per cubic inch of active belt. In the machines considered, the value of this varies between 45 and 120 watts per cubic inch. But in one case the value runs down to 15 watts per cubic inch, though the machine is by a first-class maker; and in one case the figure rises to the value of 192 watts per cubic inch. This machine is the 1,600-kw. generator described by Mr. Hobart before the Engineering Congress last year at Glasgow. A high peripheral speed and a high degree of saturation of the iron teeth conspire to give this machine a remarkably great output in proportion to its size and weight.

It is, of course, possible to obtain an apparently high specific utilisation value by a sacrifice of efficiency, or by admitting a higher temperature rise than is usually allowed

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to the manufacturers of machines. There is no doubt that British manufacturers have been hampered in the latter respect by ridiculous restrictions imposed by consulting engineers. A temperature rise not exceeding 20deg. C. has been specified as the limit, in cases where a temperature rise of 40deg. C. or even 50deg. C. would have been perfectly safe. If the final efficiency is satisfactory, and the insulation adequate and honest, it is absurd to tie down a manufacturer to such a restriction as that in no part the temperature rise shall exceed 20deg. C. It handicaps him in attaining the highest specific utilisation of his materials, and forces him so to construct his machines that they are both heavier and more costly than otherwise they would be.

WATER POWER IN IRELAND.*

BY F. J. DICK, M.I.C.E.

There are general conditions of similarity in the water-power sites between Castleconnell and Limerick, Belleek and Ballyshannon, Lough Neagh and Coleraine. The available fall may in each case be taken at 30ft. In the case of the Bann that fall is concentrated artificially already at three points—viz., Portna, 14ft.; Movanagher, 11ft.; Carnroe, 5ft.--total, 30ft. There is more than 40ft. fall below Castleconnell, but the cost of rendering it all available would probably be prohibitive. Below Belleek there is more than 100ft. fall, but the same remark applies.

The catchment areas at the outlets of Lough Derg, Lower Lough Erne, and Lough Neagh are $2\frac{1}{2}$, 1, and $1\frac{1}{5}$ million acres respectively. The rainfall of the three districts is very similar in amount. Auxiliary steam power is not supposed to be contemplated, and the capacity of each site to produce a continuous power is, therefore, limited by the minimum flow of the rivers, and other considerations resulting from legislation. The dry-weather minimum flows at these sites are: Castleconnell, 37,000 cubic feet per minute; Belleek, 25,000 cubic feet per minute; Toome (Lough Neagh), 30,000 cubic feet per minute. But these are exceptionally low minima, and inspection of the diagrams exhibited of the daily flow of the River Shannon at Killaloe for the seven consecutive years from 1893 to 1899 inclusive showed that it would for most purposes be safe to put the summer minimum at about 25 per cent. higher values, or in round numbers: Castleconnell, 50,000 cubic feet per minute; Belleek, 30,000 cubic feet per minute; Toome, 37,000 cubic feet per minute. These quantities would produce an available horse-power at each of these places, taking a turbine efficiency of 70 per cent., of: 30ft. fall below Castleconnell, 2,000 h.p.; 30ft. fall below Eelleek, 1,200 h.p.; 30ft. fall below Toome, 1,470 h.p. It should be noted, however, that these would by no means be the actual powers available in summer having regard to legislation connected with the fishing industry.

In the case of the Shannon a recent Act provided that no water whatever for power purposes could be diverted from the Shannon during the summer months until 90 000 cubic feet per minute was passing down the river between the points of abstraction and return. In the case of the Lower Bann an Act fixed the quantity available for water power at 20,000 cubic feet per minute, and in the case of the Erne it may be assumed that a preferential quantity of at least 20,000 cubic feet per minute would be required for fishing purposes.

Having regard to these facts, the water power available in summer at these places would therefore stand thus: Shannon, 30ft. fall below Castleconnell, none; Erne, 30ft. fall below Belleek, 400 h.p.; Lower Bann, 30ft. fall below Toome, 800 h.p. Storage to augment these is practically out of the question having regard to the enormous sums which have been expended for the purpose of keeping the Shannon, Erne, and Bann lakes at or near their summer level in connection with the requirements of arterial drainage and navigation. It is noteworthy that the range of level secured in these cases (as well as at Lough Corrib, in Galway, whose power is already practically fully utilised) is about 2ft. as between the winter and summer, except at Lough Neagh, which varies 4ft.

Longitudinal sections of the Shannon showing the variation of level at Castleconnell corresponding to different quantities of water discharged were thrown on the screen.

The foregoing results appear to show that there has been much misconception as to the amount of *continuous* water power available in the more important Irish rivers. For example, Sir Robert Kane, in his book, "The Industrial Resources of Ireland," estimated the power of the Shannon between Killaloe and Limerick as 33,950 h.p. in continuous action day and night throughout the year!

* "Water Power in Ireland: Note on the Shannon, Erne, and Lower Bann Rivers." Paper read at the Belfast meeting of the British Association.

THE RAINFALL OF IRELAND.*

BY DR. HUGH ROBERT MILL, D.SC.

The author showed that in order to determine the true mean annual rainfall of any region it was necessary to have uniform, continuous, and prolonged observations at a large number of well-distributed stations. It was now possible for the first time to give a fairly satisfactory account of Irish rainfall, though the observing stations at work were only one for every 170 square miles, as compared with one for every 20 square miles in England. The number of stations in Ireland had increased from 83 in 1874 to 190 in 1901, an increase of 140 per cent.; while the number of stations in England and Wales increased only by 120 per cent., and in Scotland only by 32 per cent. in the same period. In 1874 there was not a single record of rainfall from the counties of Clare, Kildare, Leitrim, Limerick, Longford, or Monaghan; now there was at least one rain record for every country. The number of stations was still far too small, especially in Connaught, and after the stimulus of the British Association in Belfast produced its effect in 1875 the number in Ulster had ceased to grow. While 1,400 additional stations would be necessary to place Ireland on the same footing as an equal area of England, only 185 additional observers were required to give the same number of rain gauges per thousand of population. Perfect records for the 10 years 1890-99 existed for 108 stations in Ireland, and by computation 31 additional records could be made available. Of these 21 records were perfect for the 30 years 1870-99, and 56 records of somewhat shorter duration could be computed with reasonable accuracy. The distribution was not satisfactory, the western half of the country and all the mountainous districts being very poorly represented. The maps for the 30 years, 1870-99, might be taken as showing the true mean fall as far as the limited number of stations made it possible to do so. There were only three small areas with a fall exceeding 50in. per annum in the west of Kerry, of Mayo, and Donegal respectively. Possibly some parts of the eastern mountains might also have a fall exceeding 50in. More than 40in. fell over the whole of Ireland west of the Foyle and the Shannon, and to the west and south of a line drawn from Limerick through Mallow to Clonmel, whence a narrow belt, equally wet, ran north-eastward through the counties of Waterford, Wexford, and Wicklow. Two small areas with more than 40in. occurred in the south-east of county Down and the east of county Antrim. All the rest of Ireland had between 30in. and 40in. of rain, except parts of county Dublin and county Meath, where the fall averaged less than 30in. The variations of rainfall in Ireland were less than those in England. Thus for the 10 years, 1890-1899, the rainfall over Ireland was only 2 per cent. below the 30 years' average; that over England and Wales showed a deficiency of 7 per cent. The average rainfall of the 10 years was practically the same as that of the 30 years in central Ireland, a trifle above the average in the north-west, and a little below the average round the north, east, and south coasts. The average rainfall per annum of Ireland was about 42in., as against 32in. in England, and

* Abstract of paper read before the Belfast meeting of the British Association.

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from 45in. to 47in. in Scotland. He would be glad to give any assistance in the power of the British Rainfall Organisation to civil engineers requiring rainfall statistics.

THE FUTURE OF THE TELEPHONE IN THE UNITED KINGDOM.*

BY J. E. KINGSBURY.

To the members of the British Association the telephone and its applications cannot fail to be of interest, for they must ever recall with pride that it was at the Glasgow meeting of the association in 1876 that Alexander Graham Bell's invention was first introduced into this country by the Sir William Thomson of that time, and the Lord Kelvin of this. The telephone then was a scientific marvel, and attention was centred on its improvement as a talking instrument. Some of its possibilities were foreshadowed, but its principal application was not foreseen. At the meeeting of the association at Sheffield in 1879 an exchange was shown in operation coincident with the opening in London of public telephone exchanges. From that time the science of the telephone has been the science of telephonic intercommunication.

Like all the more recent practical applications of scientific principles, it is in itself a composite art calling to its aid not only acoustics and electricity, but, of late years more particularly, the heavier branches of mechanics and engineering, since the modern telephone exchange has anticipated the power schemes by producing at one centre the electrical energy required to signal and to talk between thousands of stations over lines mostly placed underground at a considerable cost, and requiring much engineering skill. Any one of the elements of this composite art would afford interesting subjects for discussion. But they have been and will be dealt with elsewhere and at other times, and will be only very casually touched upon in this paper. The future progress of the telephone in the United Kingdom does not depend upon scientific developments, but upon common sense. In this it does not differ from most engineering questions, for I take it that engineering is a means to an end; that an engineer would derive little satisfaction from the construction of a bridge, however beautiful its proportions, if the approaches rendered it of no utility.

There are at the present time some impediments on the approaches which need removal. They are of a political, economical, and social nature, and they exist, as I think, largely on account of the lack of public recognition of the peculiarities which differentiate a telephone exchange system from other works of practical utility. It is my object in this paper to attempt to remove some of the popular misunderstandings which undoubtedly exist, and by placing before you some of the features upon which telephone service depends, draw some conclusions as to its future. You will, of course, be prepared for a considerable dip into the past and some reference to the present before the future is reached.

It is necessary to bear in mind that in 1870 various companies undertaking the transmission of telegrams were acquired by the State, and the work which they undertook was combined with that of the Post Office. The Act of 1869 extinguished competition in telegraphs, and conferred on the Postmaster-General the exclusive privilege of transmitting telegrams. The Post Office had been carrying on this business for six years when the telephone was invented. Its development and application to purposes of profit in the United Kingdom took another three years, so that telephone exchange companies began operations in London in 1879. The Post Office claimed that the service rendered by the telephone companies was an infringement of the powers conferred on the State by the Telegraph Act of 1869. The telephone companies contested this claim, but it was decided in favour of the Post Office in the suit of the Attorney General *v.* the Edison Telephone Company of London, Limited, tried before Mr. Baron Pollock and Mr. Justice Stephen in 1880. The reasonableness of the decision is even now sometimes questioned, mainly because the Act was passed in 1869 and the telephone invented only in 1876. But distinction needs to be drawn between (1) a service which the State reserved to itself the sole right of undertaking and (2) improvements in apparatus for, or in the means of carrying out, that service.

The service reserved by the State was the transmission of telegrams, and in Mr. Justice Stephens's very careful judgment he shows that within the definition of the Act of 1869, "Any apparatus for transmitting messages by electric signals is a telegraph whether a wire is used or not, and that any apparatus of which a wire used for telegraphic communication is an essential part is a telegraph, whether the communication is made by electricity or not." Thus the telephone was only an improvement in, or an accessory to, the service of which the State held a monopoly.

Counsel for the company gave notice of appeal, and the Attorney-General, on behalf of the Crown, stated "that, of course, the Postmaster-General is fully alive to the advantages derived by the public from telephonic communication, and whatever result this litigation may lead to, care will be taken in the interests of the revenue, and also in the interest of the public, that nothing shall be done to stop telephonic communication so far as it is required by the public" This statement foreshadowed the policy which the Government had considered it advisable to pursue—viz., to work the telephone industry through the medium of private organisations or public companies acting under license. Licenses were issued for a period of 31 years conditional on payment of 10 per cent. of the gross receipts. An indication of the Government's intention to resume the working of the system at some period is given by a condition of the license that the Government were to have the right to purchase the licensee's business at septennial periods upon giving six months' notice, and subject to arbitration in event of disagreement on price.

The first licenses limited communication to four or five miles from a defined centre, the State providing trunk lines between the areas. The limitation was found to be inconvenient. It was removed in 1884 and trunk wires between towns were erected by the companies. In 1896 the trunk wires were purchased by the Post Office and the companies' work limited to "telephone areas" based on the requirements of localities. Efforts have been made to obtain a reduction in the Post Office royalty, which has been denounced at various times, and has been complained of as a tax on communication, as the newspaper stamp was denounced as a tax on knowledge. But even the sufferers by it did not universally condemn that objectionable tax, for Addison, in the *Spectator* of the day preceding the application of the stamp, intimated that he would glory in contributing his utmost to the public weal, and remarked that "It is a received maxim that no honest man should enrich himself by methods that are prejudicial to the community in which he lives, and by the same rule I think we may pronounce the person to deserve well of his countrymen whose labours bring more into the public coffers than into his own pocket." In this mildly ironical way did Addison convey the information that of the price paid by the purchaser one-half went into the public coffers. The telephone royalty is more moderate, and it cannot be said that the labours of the Telephone Company put more into the Treasury than is distributed amongst their shareholders, but the amount is a substantial one, for during the last 10 years the company has paid in Post Office royalty £916,000 in round figures. For the past year the royalty was about £150,000. The royalty is a part of that protection of the revenues of the State to which the Attorney-General referred, and so far as the companies are concerned it may be regarded as a payment by means of which they are enabled to earn dividends, since without a license it would not be possible for them to undertake the business at all. The Post Office not only reserved the right to compete, but in some places actually did compete, and in others granted licenses freely to competing companies. The inference to be drawn from their attitude is that they were careful not to create a monopoly outside themselves, regarded freedom of action as tending to the public benefit, and were satisfied to let ordinary laws work out the solution of the problem so long as their

* Paper read at the Belfast meeting of the British Association.

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sovereign rights were maintained and their tribute paid. The service was a new one, there had been no previous experience of its working and no reasonable forecast could be made.

The competition which existed between the Bell Company and the Edison Company in 1879 ended by the amalgamation of the two into the United Telephone Company in 1880 before any considerable work had been done; and resulted rather from the advantage of combining patent rights than extinguishing any extensive business competition. But as a subscriber to the Edison Company, I am able to bear witness to the advantage of the increased capacity of communication which resulted from the amalgamation, small as that would seem now. Shortly after the amalgamation a company called the London and Globe Telephone Company established an exchange in London, proposing to charge a reduced rental of £12 per annum, instead of £20, the rate then ruling. The company discontinued its operations after a few hundred subscribers had been connected, because it was unable to obtain instruments free of the Edison patent. As a subscriber to the London and Globe Company, I can also speak from experience of the advantage of the reduction in telephone subscriptions which resulted from the cessation of a duplicate service. The other principal competitive exchanges during the patent era were at Dundee and Sheffield, and in anticipation of the expiry of the patents, an exchange was started in Manchester by the Mutual Company. The Dundee Company was purchased by the National Telephone Company at an early stage in its career; the Sheffield Company was eventually absorbed, and the Mutual Company lived but a comparatively short period.

The popular view of these amalgamations is well known. The real reason has been overlooked. Before formulating it, I will ask you to consider what a telephonic conversation is, and how it is obtained? Let me make a comparison between telephone exchange service with which we have been familiar for a little more than 20 years and other services which have existed for much longer periods. There are no longer any competing telegraphs in England, but let us suppose there are. I desire to send a telegram to any town. I can take my choice of lines. There is no restriction whatever on the delivery of my message to any inhabitant of that town I may desire to communicate with. In the same way, I may take advantage of railway competition by choosing the cheapest or quickest route, or I may prefer to take the longest or most expensive route on account of its natural beauties. What would be thought of the advantages of a railway competition from London to Liverpool if the latter city were divided into two portions, and it were ordained that for a destination on one side of St. George's Hall it would be necessary to travel by the North-Western, and for a destination on the other side by the Midland Railway? Let us suppose the issue of season tickets. With one season ticket a passenger would be able to reach one half of Liverpool. If he desired to reach the other half as well he would require two season tickets, and would need to take a different route for either destination. By the division, I do not mean a policeman outside the station to direct your cabman by a given street, which order he can evade at the next turning. You must please to imagine an impenetrable barrier. You regard this undoubtedly as a preposterous proposition, but it is exactly analogous to the conditions prevailing under competition in telephony. There are a restricted number of possible correspondents for distinct services, or double season tickets, if you wish to enlarge your area of communication to the fullest possible extent.

The reason why competing services have ceased in the past is because the absurdity of such a situation becomes obvious when put in practice. Let us see how the subscribers of the lapsed companies fared in the combinations which have been made. The Dundee Company, at the time of the amalgamation, had 332 subscribers; 152 of these subscribers belonged to both companies, and thus had two season tickets. Each subscriber to the local company paid £5. 10s. per annum. He thus paid 3·975d. per annum each for the opportunity of communicating with 332 subscribers. On amalgamation the subscriptions of the 152 were slightly reduced and of the 180 largely increased, but the annual cost of the right to speak with each other subscriber was reduced from 3·975d. to 2·919d., and with the increase in subscribers this reduction was continually growing in favour of the original subscribers. In addition to the larger number of possible correspondents in their own locality, the amalgamation gave the subscribers to the local company access to other localities, thus adding considerably to the value of the telephone to them. The influence of a widespread "telephone net"—to adopt a Continental expression—may be compared with the force of gravity. Sooner or later the smaller local body, if it do not evaporate altogether, must be attracted to the larger body. And if the repellant force natural to competitors should retard unduly the operation of this attractive force, then the latter will inevitably be assisted by some superior power in the interest of the public weal, for it must be remembered that the proprietors of exchanges and the subscribers thereto are not the only people concerned. The general public experience some of the drawbacks of this competition. As an example, I may cite an instance from Scandinavia—a part of the world frequently referred to in connection with the advantages of competition in telephony. About the time of the competitive service in Dundee, rival companies were giving the citizens of Christiania the same advantages, when (Aug. 20, 1884) "the Municipal Council resolved, in accordance with the proposal of the Executive Committee, to notify the International Bell Telephone Company and the Christiania Telephone Association that after two weeks they shall not be allowed to run new telephone lines over the public streets, squares, etc., and the Council appointed Messrs. Birch, Reichenwald, Anderson, and Christopherson to aid the Executive Committee in negotiating with the telephone companies an amalgamation into a single company." The round-table conference succeeded in its efforts, the competition ceased, the number of subscribers grew rapidly, and the exchange has since been acquired by the Government.

The experience of Dundee was not repeated in the United Kingdom for a number of years, because the National Telephone Company were protected by patent rights. On the expiry of the patents a number of public-spirited citizens of Manchester combined to remove from their town the stigma of being dependent on a telephonic monopoly, and to demonstrate to their predecessors of Dundee the iniquity of being bought up at a profit. They formed the Mutual Telephone Company, of Manchester. The Mutual Company was in due course acquired by the National Company. At the time of the amalgamation 492 of the 1,349 subscribers of the Mutual Company also subscribed to the other company. The ratio of subscription to number of subscribers—that is, the cost of the opportunity to communicate—was 1·320d. per subscriber per annum. On amalgamation it was reduced to ·567d.

In the Parliamentary Committee Report of 1895 it is shown that the average payments of the Mutual subscribers were £7. 8s. 6d. per annum. The average rate of the other company is not given. The normal rate was £10. The average would probably be slightly higher. The total payments by the people of Manchester before and after amalgamation were approximately as follows:

Before amalgamation	National	3,374	at £10	0	0	£33,740
	Mutual	1,349	at 7	8	6	10,016
		4,723				£43,756
After amalgamation	Combined subscribers	4,723				
	Less duplicates	492				
		4,231	at £10	0	0	£42,310

Whilst the latter total is lower, yet in the absence of definite information as to the National Company's average the figures must not be taken as more than an indication that, to the then existing subscribers, there was no very material change in the total cost of the service. But this, even if admitted, does not go far with the advocates of competition. The contention is that the lower rate

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was a paying rate, and that all subsequent subcribers have been overcharged by reason of the absence of competition. The claim that the lower rate was a paying rate is based on the assertion that during the existence of the competing companies they were able to make both ends meet. I neither confirm nor combat the assertion, but I wish to correct an impression which is very natural to the mercantile mind. It is that on the fixed subscription plan every additional subscriber is a monetary gain. A new subscriber adds to the working expenses, in that he not only makes calls himself, but increases the calls of other subscribers. With the growth of the exchange there is an increase in the apparatus or plant used in common, such as junction wires and switchboards, as well as in the number of operators. Hence, with the same class of equipment, the increase in subscribers leads to a disproportionate increase in cost of plant and working expenses.

The reason why the working costs at the present time are not considerably higher than in earlier years is bocause the class of equipment is not the same. Improved appliances have been introduced, additional plant has been erected or old plant reorganised, enabling the work to be done more economically. But these improvements have cost money, and it will at once be seen that upon these early exchanges, which are so often referred to, further expenditure would need to have been made without an increase in revenue, and from this may be seen the importance of making an allowance for depreciation before arriving at the cost of the service. Depreciation in telephone plant must not be confounded simply with the wear and tear of ordinary machinery. Certain portions may be claimed to be practically indestructible in themselves, and yet require considerable depreciation allowance. This arises from the changes caused by growth, whereby plant is displaced even though capable of continued use. No rule can be laid down for universal application. There are instances of 5 per cent. and of 15 per cent. being allowed, but the medium figure is more general.

As I have said, the real lesson of the amalgamation was never learned. The apparently profitable nature of telephone enterprise, the invariable maintenance of the rates at the higher level, conveyed an impression which has been sedulously fostered that the absorbing telephone companies were simply seeking, in Addison's words, "to enrich themselves by methods that were prejudicial to the community," and Parliament determined by the Act of 1899 to develop, by the aid of the ratepayers, that competition which had so far failed under private enterprise. Two municipalities, Glasgow and Tunbridge Wells, have taken advantage of the permission, and history is repeating itself in its usual way. The first annual report of the Telephone Committee of the Glasgow Corporation shows that £192,693. 14s. 3d. has been spent in equipping an exchange for 5,494 stations. "The stations are subscribed for by 4,697 persons and firms; of these 2,059 have never been telephone subscribers before." This may be taken to mean that all the other subscribers to the municipal exchange are also subscribers to the company's exchange. The average capital expenditure per person or firm (not per station) is £41, but the total expenditure includes work which is very properly undertaken in advance of requirements, and it is a reasonable inference that with a comparatively small additional expenditure sufficient subscribers could be added to reduce materially the above average. It is futile to take only the cost of the useable lines, because there always will be considerable excess. I want only to make a comparison between the useful and the useless expenditure. At a capital outlay of £35 each, 2,059 new subscribers give a useful expenditure of £72,065, and 2,638 a useless expenditure of £92,330. It is not necessary for me to suggest how very much more useful that useful expenditure would have been if it had widened the field of the new subscribers. In Tunbridge Wells the same results of duplicate subscribers and duplicate subscriptions are found, as was inevitable.

The necessity of anticipating demand and the supply of plant largely in excess of that actually used is inherent in telephone service. Conduits in anticipation of cables, cable in anticipation of subscribers, switchboard equipment in excess of immediate requirements: all these necessarily exist in any well-planned exchange. Every subscriber must bear his proportion of the excess, since of the revenue obtained from the subscribers a portion must be devoted to interest on capital. Duplicate the system, and, if they are equally well planned, you double the surplus plant, the capital expenditure therefore, and the subscribers' burden thereon. Compare the action of these municipalities with the admirable arrangement concluded by the Postmaster-General in London, where every subscriber to the Post Office system is in communication with all the 40,000 subscribers to the previously existing system, so that duplicates are unnecessary and no expenditure is wasted. Competition is a check—a means of preventing undue profit being made by the producer of a commodity or the supplier of a service, and the maintenance of the check requires the continuance of the competition. Technical advocates of competitive telephony realise its temporary character, as will be seen from the published report of the Glasgow engineer recommending another English municipality to undertake competitive service. Dealing with the question of intercommunication between the rival exchanges, he says, "Intercommunication locally from the beginning would render the development of the Corporation exchange difficult. . . . But when the Corporation's exchange has become larger the conditions will be reversed. . . . On reaching that point, intercommunication might be insisted upon by the Corporation with every advantage, for the effect would be to complete the ruin of the opposition system."

It might be argued that it is not in the province of a municipality to complete the ruin of an enterprise rendering a useful service to any of its ratepayers. It might be suggested that the attempt to destroy sometimes results in being destroyed, but I prefer rather to approach the consideration of municipal telephones in a spirit of sympathy with the municipal ideal, and a realisation of the advantages which may sometimes be obtained by collective effort. It is not surprising that, in the absence of an accurate conception of the nature of telephone exchange work, a municipality should be regarded as a suitable body to undertake it. The first idea that occurs to one is that the municipality is the local authority, and yet, as applied to a telephone area, a municipality is only one of several authorities, for whilst the business centres throughout the kingdom have grown, the municipalities remain to a very large extent simply extensions of the old parochial system, and the extensions have not been carried far enough. The telephone area is the whole district over which the business and social relations of the locality naturally flows, but in its flow it covers numerous ownerships. There is no rivalry equal to the rivalry of neighbouring municipalities. There is not a common interest, and in the absence of identical interests there is difficulty in obtaining agreement in policy, or on the details of carrying out a policy.

Agreement may sometimes be obtained as the result of an enthusiasm against what is regarded, rightly or wrongly, as a common foe. It may be continued while the contest lasts. Assume that the ruin of the opposition is completed, will the cohesion continue? Localities change their condition. The fashionable quarter to-day is the business quarter to-morrow. It is the interest of the outlying district to develop its resources. It is the interest of the older and larger municipality—the predominant partner in the telephone area—to retain its prestige, to prevent the development of its rivals. The telephone will be an important factor in such rivalries. Unless it be in independent hands, it is easy to foresee a splitting up into smaller units, adding to the confusion, increasing the cost, and generally working to the detriment of the service. The successful supply of electric light, for example, by municipalities must not be regarded as any criterion of a similar result in the case of telephone exchanges. An electric light station contains a producing plant, the streets carry distributing mains, the service is from the centre outwards, and the entire plant from centre to extremities is under one control. A policy may be initiated and enforced without regard to outside considerations. Telephone exchange service, on the other hand, requires that the system should work in with other systems. Traffic between two places

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calls for provision for outgoing calls at one exchange and provision for incoming calls at another exchange. Independent views at either exchange are incompatible with successful working. Neighbouring municipalities running tramway services might so arrange that there could be no through communication, but the inconvenience occasioned to the passenger would be only that of stepping out of one car into another. The equivalent in telephonic service would be the stoppage of communication altogether.

One of the arguments urged for local control is that a large percentage of conversations are local. But compare the value of a local conversation with a long-distance conversation, and it will be seen how important it is that no impediment, either of an engineering or administrative nature, should be placed in the way of such communications. Experience shows an almost inevitable tendency to local or individual preferences, both in the way of engineering and management; and experience shows also not only the practical difficulties arising from such preferences, but also the greater difficulty of applying a remedy. It is sometimes assumed that competition is necessary in order to increase the number of subscribers. I will give an example of phenomenal increase without competition. On Jan. 1, 1894, there were about 10,000 stations in New York. On Jan. 1, 1902, there were 72,189 stations in only a portion of the area which was included in the 1894 figures. This considerable increase over the previous progress is attributed to the adoption of a rational system of charging. Up to 1894 there was a "flat rate," the same subscription for large user and small user. In 1894 the message-rate system was applied, with the result that the telephone service has become available to the small user, and enormously increased in value to all subscribers by widening the field of communication. This method has also been adopted for the Post Office system in London. It was proposed for adoption some years ago by the National Company, in Sheffield, but the subscribers rebelled against it.

I have remarked on the extent to which the future has to be anticipated by present expenditure. Each new subscriber involves capital outlay, and new present work invariably includes some margin for future use The amounts expended during the past five years in adding to to the exchange construction and equipment of existing services by similar organisations in the United Kingdom and the United States compare as follows:

	National Telephone Company.	Licensees of American Bell Telephone Company.
1897	£460,937	£973,063
1898	682,506	1,489,499
1899	742,151	3,189,892
1900	834,772	4,382,908
1901	536,793	4,400,000
	£3,257,159	£14,435,362

In making these comparisons, I wish rather to draw attention to the yearly growth than to compare the totals. In the United States there is considerable growth in new expenditure from year to year. In the United Kingdom there is a fairly gradual increase to 1900, and a decrease for 1901. The difference suggests some reason. I think it will be found in the fact that in the United States the companies supplying the service have no limit to their existence. In the United Kingdom, the company supplying the service dies in 1911, or, to put it more accurately, its right to continue the business dies then. To the Parliamentary Committee of 1898 Mr. Forbes stated that it would be the policy of the company not to embark on new expenditure after 1904, but to maintain their existing system in the best condition till the expiry of the license in 1911. By the Telegraph Act of 1899 it is provided that the license of the National Company shall be extended in those areas in which competitive services are started, the restrictive barrier against intercommunication being gradually broken down. With longer life, the hesitation to undertake further expenditure disappears, for the longer period in which returns may be obtained warrants new investment by the company.

Corporations can borrow easily and cheaply. We thus have financially a most anomalous situation. Money can be spent on competitive systems, which are the most wasteful, which give the maximum of inconvenience with the minimum of public benefit; but money cannot be spent on developing the existing system, to which additions can be made at a minimum of cost with a maximum of benefit. The future of the telephone depends very much on the present, for equipment for present subscribers includes some provision for future subscribers, and present starvation means future weakness.

The engineering and construction work should be on a scale that provides for considerable growth, and of a kind that will give reasonable expectation of satisfactory results when that growth is attained. On sound financial principles work on such a scale cannot be undertaken on the terms of existing licenses. The best that could be expected with a sole tenant is a reasonable surplus on present requirements. The best that can be expected from competitive services with unremunerative rates and short tenure is hand-to-mouth construction work and speedy dilapidations.

The existence of duplicate services designed and operated without regard to one another necessarily means that on the expiry of the licenses it may be found better and cheaper for the State to lay down a new system than to attempt to combine the existing ones. I regard it, however, as extremely doubtful that competitive systems will continue to the end of the license. It seems to me that the result of the competitions now in progress may be easily foretold. I venture the suggestion that competition by municipalities was provided for under a misapprehension of the nature of telephone exchange service, and a misconception of the results, direct or indirect, which might be expected I venture, further, the suggestion that those municipalities which have undertaken such competition have done so under a mistaken view of the benefits to be obtained and the cost of obtaining them. But I have too great a faith in public opinion to doubt that as the lessons are brought home, the result of existing competition will be the same as previous competitions. Duality will give way to unity as the only reasonable method of conducting the work. Unfortunately, these disadvantages must be apparent and realised before they are regarded, and probably much expenditure will be incurred before the mistake is recognised. In the meantime the future progress in the practical use of the most beautiful and most useful application of science which the past century produced will be seriously impeded.

The "removal of any disadvantages of a public kind which impedes the progress of science" is one of the objects of the British Association. The impediment is so much of a public kind as to be fraught with peculiar difficulties, and to involve important considerations of imperial and local politics, which are out of our province. I can only hope that the subject may be considered solely from the point of view of the "public weal," and that scientific enquiry may have some share in reaching conclusions. If that be the case, I do not hesitate to express my own belief that the future of the telephone in the United Kingdom will be free from competition, free from the expense and waste of war, developed by the certainty of permanent utility, and cheapened by the economy which unity of control and permanent work will attain.

FORTHCOMING EVENTS.

The following fixtures for meetings have been made:

Sanitary Institute.—Sept. 9-27, health exhibition.

Municipal and County Engineers.—District meetings. Midland: Sept. 27, West Bromwich. Eastern: Oct. 25, King's Lynn. Home: October 11, Aldershot.

Municipal Officers' Association.—District meetings at Birmingham, Liverpool, and Newcastle are being arranged.

Institution of Heating and Ventilating Engineers.—Sept. 23, autumn meeting, Birmingham. Sept. 24, excursion to Warwick and Stratford-on-Avon.

Franklin Institute.—This institute has now issued its *Journal* for September. It contains the concluding parts of several papers which have been presented to the institute at different meetings; also a number of notes and comments, among which we notice two, on "Some Recent Electric Furnace Products" and on "Aluminium as a Substitute for Copper" respectively.

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CONTENTS.

Notes	397	The British Association	416
Electricity on Railways	402	Trade Notices and Novelties	420
Stamford Electricity Works	404	Appointments Vacant	420
Some Novelties in Electrical Apparatus	406	New Companies Registered	420
On the Specific Utilisation of Materials in Dynamo Designs	407	Questions and Answers	421
Water Power in Ireland	409, 414	Legal Intelligence	424
The Rainfall of Ireland	409	Companies' Meetings and Reports	424
The Future of the Telephone in the United Kingdom	410	Contracts for Electrical Supplies	425
Forthcoming Events	413	Traction Notes	426
Suburban Traffic	415	Lighting Notes	428
Reviews	415	Provisional Patents, 1902	430
Magnetic Detectors in Space Telegraphy	415	Specifications Accepted	431
		Companies' Stock and Share List	431
		Traffic Returns	432

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WATER POWER IN IRELAND.

It is to the interest of a country that its natural gifts should be utilised to the utmost. This is not the case at present with the water power of Ireland, and there are several reasons to account for this lack of development. At the meeting of the British Association last week two papers connected with this subject were read and discussed. The first of these, by Dr. R. H. Mill, dealt with the rainfall of the country, and showed, from careful records of rain gauges extending over a large number of years, the average rainfall was about ten inches more per annum than that of England. The maps used by Dr. Mill to illustrate the distribution of the rainfall for Ireland showed that the average fall was, as is usual, much more dense in the mountainous districts. The other paper, by Mr. F. G. Dick, who is the chief engineer of the Irish Board of Works, also contained information which is of enormous value to those engineers who have to organise power distribution schemes in Ireland utilising water power from large rivers. The conclusions from reading Mr. Dick's paper do not seem particularly hopeful for such undertakings unless auxiliary steam plant is used in dry summers. It is the old question of vested interest coupled with the need of adequate drainage for the land. Taking the Bann River, for instance, which is the outlet from Lough Neagh to the sea, the difference between the average winter flow and the dry summer flow of water is excessive. Lough Neagh is the largest fresh-water lough in the United Kingdom, and if the water power only were to be considered would provide ample storage to supply a regular flow during the dry summer months. Unfortunately, the lake cannot be used for this purpose, owing to the large areas of agricultural lands which would be flooded if the level of the lake were raised—in fact, the usual increased level of the water in this lake in the winter time has caused an outcry against the weirs and locks introduced into the Bann River for navigation purposes. The other vested interest besides the agricultural one above referred to, is that connected with the fishery rights on the Irish rivers. It was brought out in the discussion that even where water powers have been utilised for a number of years attempts are made by the owners of fishing rights to interfere with the same, while all suggested extensions are most vigorously opposed. Mr. Dick clearly showed that the minimum quantities of water secured to these fishery rights on certain of the large rivers would prevent any water power being used at all in very dry seasons. It would seem, therefore, that the pioneering work in developing water-power schemes of any magnitude is beset by enormous difficulties. Prof. Unwin, however, in the discussion following on the reading of the above two papers, pointed out the lines on which the difficult problem should be attacked. He said that the water power of a country was of national importance, and that in Switzerland the Government had surveyed and registered available waterfalls in order to ensure that the same should be utilised for the public good. Now that it is no longer necessary to use water power at the site of the fall, there is a distinct future for its employment in Ireland, as the power can be transmitted electrically from the agricultural districts, where little is required, to industrial centres, like that round Belfast. It is distinctly a question which the Government should investigate as to how far improved drainage of the country cannot be associated with such power schemes, which could, perhaps, obtain in the mountainous districts the storage to enable them to give a continuous supply in dry seasons. Even if the Government will not follow the example set them in Switzerland, they should

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see that this class of obstruction, which has ruined agricultural Ireland, shall not prevent growth of the new industries which can be fostered by cheap power.

SUBURBAN TRAFFIC.

The Glasgow railway authorities, finding a large diminution in their suburban traffic owing to the competition of the tramways, have decided to curtail the train service. That is the information to be found in various paragraphs in the daily papers, and it ought not to come as a surprise to anybody who has read the signs of the times aright. There are many things which determine the growth of a suburb, one of which is the facility with which the workers can get to and from their work, assuming the site of that work to be in the town to which the suburb comes as an addition. Hitherto suburbs have frequently grown around railway stations, and the building of a local station has assisted in the development of many a "ripe building plot." If, however, the railway station initiates and bears the brunt of the loss and trouble during development, the tramway comes along when the population to be accommodated is assured, and if the conveniences offered by the tramway are more and greater than those of the railway, the working of the railway traffic, so far as a particular district is concerned, may become a constant loss, which, of course, the authorities will cut as quickly as possible. The only remedy is that the population to be accommodated increases in proportion to the accommodation offered. Unless this is the case, the passengers merely change over from one set of vehicles to another. That this would be the case was shown in these columns years ago, and the railway authorities were urged to consider whether prevention would not be better than cure, and that their interests would be better served by promoting the increased facilities themselves. As yet the only real move in this direction comes from Tyneside, but unless other railways quickly follow they will find to their detriment that it is too late.

REVIEWS.

Exercises in Electrical Engineering: together with Tables of Useful Data and Constants. By MAGNUS MACLEAN, D.Sc., F.R.S.E., M.I.E.E., professor of electrical engineering in the Glasgow and West of Scotland Technical College. Biggs and Co., London. Price, 1s. 6d.

This collection of questions is of more than ordinary interest, in that it deals more with practice than with theory. Prof. Maclean has classified his questions in seven chapters, and, further, has divided each chapter into sections, each section dealing with a particular subject. Thus the first chapter contains five sections, the whole consisting of questions relating to the generation of electricity. The sections deal respectively with (1) working of plant; (2) continuous-current machines; (3) alternators; (4) prime movers; (5) primary batteries. At the end of the 75 pages of questions we have useful data concerning the equivalent values of various units in the English and in the metric systems, followed by a series of extremely useful tables. The concluding part of this little book ought in these days, when everything relating to electric traction must be studied, to be particularly useful. It deals with horse-power, input, etc., required to take electric cars up different gradients at different speeds. With the tables attached, many of the problems relating to traction can be solved at a glance. For example, nearly 44 h.p. is required for a car weighing 10 tons on a 6 per cent. gradient to go at 10 miles per hour. There are seven of these tables, besides a diagram relating to traction, and each table gives a variety of information. The second of these, for example, gives for per cent. gradients 0, 1, 2, 3, 4, 5, 6, the total tractive force, the tractive force per motor, the current input with motors in series, with motors in parallel, the horse-power input with motors in series or in parallel, and the maximum speeds with motors in series or in parallel; so that it will be seen here is a concentration of practical information which cannot but prove of great service. It is almost needless to add that Prof. Maclean's great experience in teaching and his extensive knowledge of the subject, have resulted in a selection of questions the correct solution of which will compel the student to be exact and to study practical work with the greatest care.

MAGNETIC DETECTORS IN SPACE TELEGRAPHY.*

BY ERNEST WILSON.

1. So far as I am aware, Rutherford was the first to make a scientific investigation into the effect which high-frequency electric currents have upon the magnetism of a bundle of wires previously magnetised. He wound an insulated conductor upon the wires and connected it to a receiver, and found that a magnetometer was affected when electric impulses were received from a distant transmitter. The effect was to demagnetise the bundle of wires. Experiments were made in the Siemens Laboratory, King's College, London, in 1897, the only published note in connection with which is in British specification 30,846, 1897, in which

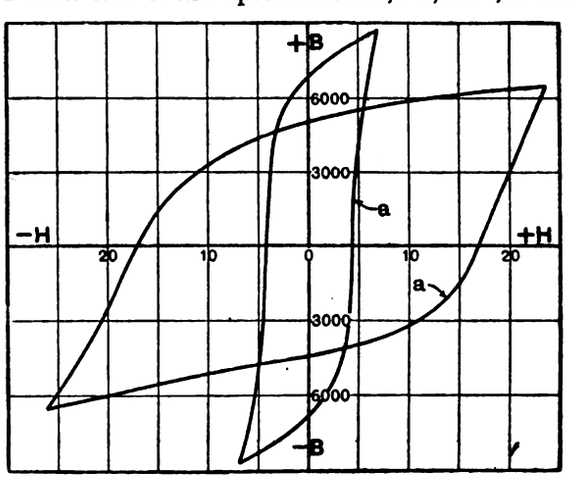

FIG. 1.

a local varying magnetising force is used during the reception of the electric impulses received from a distant transmitter. It is well known that if iron is taken through a magnetic cycle, it is very sensitive to change in the magnetising force when on the steep part of the cyclical curve. This effect is very marked in pure iron; so much so, that if the magnetising force be varied to a point at which the magnetism is on the steep part of the curve and be then kept constant, a tap will cause it to settle down still further, giving a considerable kick with a ballistic galvanometer placed in a secondary circuit linked with the specimen. To test the effect of high-frequency currents upon magnetism, two experiments may be mentioned—one on hard-steel wire 0·025cm. diameter, the other on iron wire 0·256cm. diameter, as received from the draw-plate. Each specimen was wound into a ring having 40 turns 3cm. diameter, and supplied with a primary and secondary coil for ballistic galvanometer tests. In addition, each was wound with three turns of stranded copper wire for connecting to a receiver. The latter consisted of a condenser and nine turns of copper wire 4ft. in diameter in the case of electromagnetic impulses, and two hard-drawn brass wires in the case of Hertzian waves. The distance between transmitter and receiver was 36ft. The magnetising force was varied by means of a liquid reverser, and kept steady when on the steep part of the cylical curve of induction. Fig. 1 gives the cyclical curves for the iron and steel, and the force was varied to the points marked *a* in each case before application of the electric impulses. An apparent acquire-

* Paper read at the Belfast meeting of the British Association.

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ment of 14 and 6 per cent. of the maximum intensity of magnetic induction was observed in the steel and iron specimens respectively—that is to say, the kick observed when the magnetising force was finally changed to its maximum value was less after the waves had been applied than it would have been without the application of waves. It is difficult to differentiate between true Hertzian wave effect and that due to electromagnetic induction, as both were present in the latter case. Probably all the wires attached to the rings helped to receive the impulses. It may be mentioned that the resonating circuit was tuned to the primary, and had a frequency of about $1{\cdot}5 \times 10^6$ periods per second. The values of maximum H in the steel and iron rings were 25 and 6·8, and the maximum values of B were 6,540 and 9,020 respectively.

2. A telephone of 139 ohms resistance was placed in circuit with a coil of 840 turns, and resistance 23 ohms, wound on the steel ring above mentioned. It gave sounds in keeping with the sparks at the transmitter very markedly, when, by means of the liquid reverser, the magnetism was changing along the steep part of the cyclical curve. A diagram of connections is given in Fig. 2, in which A is the liquid reverser having copper plates in dilute copper sulphate solution; B is a battery of storage cells with an adjustable resistance, C, in circuit; D is the magnetising coil wound on the experimental ring; E is the coil attached to the receiver; and F is a coil connected to a telephone, G. In order that the effects of the variations due to the local magnetising force might be stopped in the telephone, two similar rings had their telephone circuits opposed so far as the changes due to the local magnetising forces are concerned, but helping as regards the magnetising force due to the high-frequency

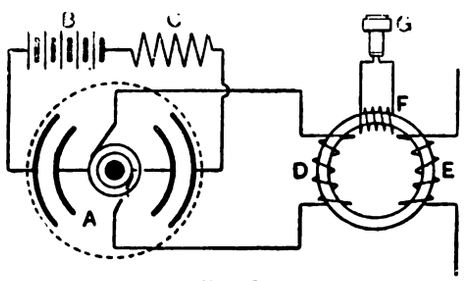

FIG. 2.

currents. Different values of the maximum intensity of magnetic induction were tried, but it was difficult to say if an intermediate force was better than a larger one. The impression was that iron gave better results than steel.

3. A comparison was made between reversing by aid of an electric current in a magnetising coil and a permanent magnet. Here it must be noted that there may be a difference in the effects obtained by reversing the magnetism in the manner above described, and reversing by rotating a permanent magnet in front of a bundle of iron wires. In the one case the magnetism is reversed by passing through zero, and in the other it is reversed by turning round in a rotating magnetic field. So far as could be judged, there appeared to be equally good results whether the current in a magnetising coil wound on a bundle of iron wires bent into the form of a horseshoe was reversed, or whether the magnet was brought up to the bundle of iron wires, moved away, reversed, and again brought up, or simply rotated in front of the bundle of wires.

4. To try the effect of submitting the specimen to mechanical stress, a bundle of 50 wires of iron 0·0265cm. diameter each was suspended from a wooden frame and wound with a magnetising coil having 22 turns per centimetre in which currents of 1 and ·5 ampere were reversed. A telephone circuit was placed over this. When the wires were stressed to the extent of 7·37 kg. per square millimetre, and at the same time subjected to torsion the effects in the telephone were increased. Results were obtained with soft nickel wire 1·6mm. diameter when loaded to 9·76 kg. per square millimetre. It is well known that by submitting nickel to a pull and twist stress the cyclic curve of magnetic induction is rendered very steep, so much so that the sounds in the telephone due to the local variation of the magnetising force, which were small when not twisted, became very pronounced with a twist of 2 leg or 3deg. per centimetre of length.

5. To try the effect of heating, a bundle of 40 wires of iron, 0·0265cm. diameter each, was supported horizontally and connected to a battery of storage cells. The wires were first covered with a layer of asbestos, and wound thereon was an asbestos-covered wire used for the local magnetising current. A telephone circuit was wound above this on another layer of asbestos. The effects in the telephone were very pronounced when the iron had a temperature just below the critical temperature at which it loses its magnetism, and much less pronounced when at atmospheric temperature.

6. All the above experiments were confined to short distances. Mr. Marconi has already achieved wonderful success with rotating magnetic fields in signalling to great distances.

THE BRITISH ASSOCIATION.

The following is part of the presidential address delivered by Prof. James Dewar, M.A., LL.D., D.S.c., F.R.S., before the Belfast meeting of the British Association last week. In the first portion of the address the president gave an exhaustive history of the artificial production of cold and of the endeavour to get down to temperatures nearer the absolute zero. The results obtained by means of liquid hydrogen having been fully described, Prof. Dewar proceeded as follows:

The Upper Air and Auroras.

The present liquid ocean, neglecting everything for the moment but the water, was at a previous period of the earth's history part of the atmosphere, and its condensation has been brought about by the gradual cooling of the earth's surface. This resulting ocean is subjected to the pressure of the remaining uncondensed gases, and as these are slightly soluble they dissolve to some extent in the fluid. The gases in solution can be taken out by distillation or by exhausting the water, and if we compare their volume with the volume of the water as steam we should find about one volume of air in 60,000 volumes of steam. This would then be about the rough proportion of the relatively permanent gas to condensable gas which existed in the case of the vaporised ocean. Now let us assume the surface of the earth gradually cooled to some 200deg. below the freezing point. Then, after all the present ocean was frozen, and the climate became three times more intense than any Arctic frost, a new ocean of liquid air would appear, covering the entire surface of the frozen globe about 35ft. deep. We may now apply the same reasoning to the liquid air ocean that we formerly did to the water one, and this would lead us to anticipate that it might contain in solution some gases that may be far less condensable than the chief constituents of the fluid. In order to separate them we must imitate the method of taking the gases out of water. Assume a sample of liquid air cooled to the low temperature that can be reached by its own evaporation, connected by a pipe to a condenser cooled in liquid hydrogen; that any volatile gases present in solution will distil over with the first portions of the air, and can be pumped off, being uncondensable at the temperature of the condenser. In this way, a gas mixture, containing, of the known gases, free hydrogen, helium, and neon, has been separated from liquid air. It is interesting to note in passing that the relative volatilities of water and oxygen are in the same ratio as those of liquid air and hydrogen, so that the analogy between the ocean of water and that of liquid air has another suggestive parallel. The total uncondensable gas separated in this way amounts to about one fifty-thousandth of the volume of the air, which is about the same proportion as the air dissolved in water. That free hydrogen exists in air in small amount is conclusively proved, but the actual proportion found by the process is very much smaller than Gautier has estimated by the combustion method. The recent experiments of Lord Rayleigh show that Gautier, who estimated the hydrogen present as one five-thousandth, has in some way produced more hydrogen than he can manage to extract from pure air by a repetition of the same process. The spectroscopic examination of these gases throws new light upon the question of the aurora and the nature of the upper air. On passing electric discharges through the tubes containing the most volatile of the atmospheric gases, they glow with a bright orange light, which is especially marked at the negative pole. The spectroscope shows that this light consists, in the visible part of the spectrum, chiefly of a succession of strong rays in the red, orange, and yellow,

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attributed to hydrogen, helium, and neon. Besides these, a vast number of rays, generally less brilliant, are distributed through the whole length of the visible spectrum. The greater part of these rays are of, as yet, unknown origin. The violet and ultra-violet part of the spectrum rivals in strength that of the red and yellow rays. As these gases probably include some of the gases that pervade interplanetary space, search was made for the prominent nebular, coronal, and auroral lines. No definite lines agreeing with the nebular spectrum could be found, but many lines occurred closely coincident with the coronal and auroral spectrum. But before discussing the spectroscopic problem it will be necessary to consider the nature and condition of the upper air.

According to the old law of Dalton, supported by the modern dynamical theory of gases, each constituent of the atmosphere while acted upon by the force of gravity forms a separate atmosphere, completely independent, except as to temperature, of the others, and the relations between the common temperature and the pressure and altitude for each specific atmosphere can be definitely expressed. If we assume the altitude and temperature known, then the pressure can be ascertained for the same height in the case of each of the gaseous constituents, and in this way the percentage composition of the atmosphere at that place may be deduced. Suppose we start with a surface atmosphere having the composition of our air, only containing two ten-thousandths of hydrogen, then at 37 miles, if a sample could be procured for analysis, we believe that it would be found to contain 12 per cent. of hydrogen and only 10 per cent. of oxygen. The carbonic acid practically disappears; and by the time we reach 47 miles, where the temperature is minus 132deg., assuming a gradient of 3·2deg. per mile, the nitrogen and oxygen have so thinned out that the only constituent of the upper air which is left is hydrogen. If the gradient of temperature were doubled, the elimination of the nitrogen and oxygen would take place by the time 37 miles was reached, with a temperature of minus 220deg. The permanence of the composition of the air at the highest altitudes, as deduced from the basis of the dynamical theory of gases, has been discussed by Stoney, Bryan, and others. It would appear that there is a consensus of opinion that the rate at which gases like hydrogen and helium could escape from the earth's atmosphere would be excessively slow. Considering that to compensate any such loss the same gases are being supplied by actions taking place in the crust of the earth, we may safely regard them as necessarily permanent constituents of the upper air. The temperature at the elevations we have been discussing would not be sufficient to cause any liquefaction of the nitrogen and oxygen, the pressure being so low. If we assume the mean temperature as about the boiling point of oxygen at atmospheric pressure, then a considerable amount of the carbonic acid must solidify as a mist if the air from a lower level be cooled to this temperature; and the same result might take place with other gases of relatively small volatility which occur in air. This would explain the clouds that have been seen at an elevation of 50 miles without assuming the possibility of water vapour being carried up so high. The temperature of the upper air must be above that on the vapour pressure curve corresponding to the barometric pressure at the locality, otherwise liquid condensation must take place. In other words, the temperature must be above the dew-point of air at that place. At higher elevations, on any reasonable assumption of temperature distribution, we inevitably reach a temperature where the air would condense, just as Fourier and Poisson supposed it would, unless the temperature is arrested in some way from approaching the zero. Both ultra-violet absorption and the prevalence of electric storms may have something to do with the maintenance of a higher mean temperature. The whole mass of the air above 40 miles is not more than one seven-hundredth part of the total mass of the atmosphere, so that any rain or snow of liquid or solid air, if it did occur, would necessarily be of a very tenuous description. In any case, the dense gases tend to accumulate in the lower strata, and the lighter ones to predominate at the higher altitudes, always assuming that a steady state of equilibrium has been reached. It must be observed, however, that a sample of air taken at an elevation of nine miles has shown no difference in composition from that at the ground, whereas, according to our hypothesis, the oxygen ought to have been diminished to 17 per cent., and the carbonic acid should also have become much less. This can only be explained by assuming that a large intermixture of different layers of the atmosphere is still taking place at this elevation. This is confirmed by a study of the motions of clouds about six miles high, which reveals an average velocity of the air currents of some 70 miles an hour; such violent winds must be the means of causing the intermingling of different atmospheric strata. Some clouds, however, during hot and thundery weather have been seen to reach an elevation of 17 miles, so that we have direct proof that on occasion the lower layers of atmosphere are carried to a great elevation. The existence of an atmosphere at more than 100 miles above the surface of the earth is revealed to us by the appearance of meteors and fireballs, and when we can take photographs of the spectrum of such apparitions we shall learn a great deal about the composition of the upper air. In the meantime Pickering's solitary spectrum of a meteor reveals an atmosphere of hydrogen and helium, and so far this is corroborative of the doctrine we have been discussing. It has long been recognised that the aurora is the result of electric discharges within the limits of the earth's atmosphere, but it was difficult to understand why its spectrum should be so entirely different from anything which could be produced artificially by electric discharges through rarefied air at the surface of the earth. Writing in 1879, Rand Capron, after collecting all the recorded observations, was able to enumerate no more than nine auroral rays, of which but one could with any probability be identified with rays emitted by atmospheric air under an electric discharge. Vogel attributed this want of agreement between nature and experiment, in a vague way, to difference of temperature and pressure; and Zollner thought the auroral spectrum to be one of a different order, in the sense in which the line and band spectra of nitrogen are said to be of different orders. Such statements were merely confessions of ignorance. But since that time observations of the spectra of auroras have been greatly multiplied, chiefly through the Swedish and Danish Polar Expeditions, and the length of spectrum recorded on the ultra-violet side has been greatly extended by the use of photography, so that, in a recent discussion of the results, M. Henri Stassano is able to enumerate upwards of 100 auroral rays, of which the wave-length is more or less approximately known, some of them far in the ultra-violet. Of this large number of rays he is able to identify, within the probable limits of errors of observation, about two-thirds as rays, which Prof. Liveing and myself have observed to be emitted by the most volatile gases of atmospheric air unliquefiable at the temperature of liquid hydrogen. Most of the remainder he ascribes to argon, and some he might, with more probability, have identified with krypton or xenon rays if he had been aware of the publication of wave-lengths of the spectra of those gases and the identification of one of the highest rays of krypton with that most characteristic of auroras. The rosy tint often seen in auroras, particularly in the streamers, appears to be due mainly to neon, of which the spectrum is remarkably rich in red and orange rays. One or two neon rays are amongst those most frequently observed, while the red ray of hydrogen and one red ray of krypton have been noticed only once. The predominance of neon is not surprising, seeing that from its relatively greater proportion in air and its low density it must tend to concentrate at higher elevations. So large a number of probable identifications warrants the belief that we may yet be able to reproduce in our laboratories the auroral spectrum in its entirety. It is true that we have still to account for the appearance of some, and the absence of other, rays of the newly-discovered gases, which in the way in which we stimulate them appear to be equally brilliant, and for the absence, with one doubtful exception, of all the rays of nitrogen. If we cannot give the reason of this, it is because we do not know the mechanism of luminescence—nor even whether the particles which carry the electricity are themselves luminous, or whether they only produce stresses causing other particles which encounter them to vibrate; yet we are certain that an electric discharge in a highly rarefied mixture of gases lights one element and not another in a way which, to our ignorance, seems capricious. The Swedish North Polar Expedition concluded from a great number of trigonometrical measurements that the average above the ground of the base of the aurora was 50 km. (34 miles) at Cape Thorsden, Spitzbergen; at this height the pressure of the nitrogen of the atmosphere would be only about one-tenth of a millimetre, and Moissan and Deslandres have found that in atmospheric air at pressures less than 1mm. the rays of nitrogen and oxygen fade and are replaced by those of argon and by five new rays which Stassano identifies with rays of the more volatile gases measured by us. Also Collie and Ramsay's observations on the distance to which electrical discharges of equal potential traverse different gases explosively throw much light on the question; for they find that while for helium and neon this distance is from 250mm. to 300mm., for argon it is 45½mm., for hydrogen it is 39mm., and for air and oxygen still less. This indicates that a good deal depends on the very constitution of the gases themselves, and certainly helps us to understand why neon and argon, which exist in the atmosphere in larger proportions than helium, krypton, or xenon, should make their appearance in the spectrum of auroras almost to the exclusion of nitrogen and oxygen. How much depends not only on the constitution and it may be the temperature of the gases, but also on the character of the electric discharge, is evident from the difference between the spectra at the cathode and anode in different gases, notably in nitrogen and argon, and not less remarkably in the more volatile compounds of the atmosphere. Paulsen thinks the auroral spectrum wholly due to cathodic rays. Without stopping to discuss that question, it is certain that changes in the character of the electric discharge produce definite changes in the spectra excited by them. It has long been known that in many

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spectra the rays which are inconspicuous with an uncondensed electric discharge become very pronounced when a Leyden jar is in the circuit. This used to be ascribed to a higher temperature in this condensed spark, though measurements of that temperature have not borne out the explanation. Schuster and Hemsalech have shown that these changes of spectra are in part due to the oscillatory character of the condenser discharge which may be enhanced by self-induction, and the corresponding change of spectrum thereby made more pronounced. Lightning we should expect to resemble condensed discharge much more than aurora, but this is not borne out by the spectrum. Pickering's recent analysis of the spectrum of a flash obtained by photography shows, out of 19 lines measured by him, only two which can be assigned with probability to nitrogen and oxygen, while three hydrogen rays most likely due to water are very conspicuous, and 11 may be reasonably ascribed to argon, krypton, and xenon, one to more volatile gas of the neon class, and the brightest ray of all is but a very little less refrangible than the characteristic auroral ray, and coincides with a strong ray of calcium, but also lies between, and close to, an argon and a neon ray, neither of them weak rays.

There may be some doubt about the identification of the spectral rays of auroras because of the wide limits of the probable errors in measuring wave-lengths so faint as most of them are, but there is no such doubt about the wave-lengths of the rays in solar protuberances measured by Deslandres and Hale. Stassano found that these rays, 44 in number, lying between the Fraunhofer line F and 3,148 in the ultra-violet agree very closely with rays which Prof. Liveing and myself measured in the spectra of the most volatile atmospheric gases. It will be remembered that one of the earliest suggestions as to the nature of solar prominences was that they were solar auroras. This supposition helped to explain the marvellous rapidity of their changes, and the apparent suspension of brilliant self-luminous clouds at enormous heights above the sun's surface. Now the identification of the rays of their spectra with those of the most volatile gases, which also furnish many of the auroral rays, certainly supports that suggestion. A stronger support, however, seems to be given to it by the results obtained at the total eclipse of May, 1901, by the American expedition to Sumatra. In the *Astrophysical Journal* for June last is a list of 339 lines in the spectrum of the corona photographed by Humphreys, during totality, with a very large concave grating. Of these no fewer than 209 do not differ from lines we have measured in the most volatile gases of the atmosphere, or in krypton or xenon, by more than one unit of wave-length on Armstrong's scale, a quantity within the limit of probable error. Of the remainder, a good many agree to a like degree with argon lines, a very few with oxygen lines, and still fewer with nitrogen lines; the characteristic green auroral ray, which is not in the range of Humphrey's photographs, also agrees within a small fraction of a unit of wave-length with one of the rays emitted by the most volatile atmospheric gas. Taking into account the Fraunhofer lines H, K, and G, usually ascribed to calcium, there remain only 55 lines of the 339 unaccounted for to the degree of probability indicated. Of these, considerably more than half are very weak lines which have not depicted themselves on more than one of the six films exposed, and extend but a very short distance into the sun's atmosphere.

There are, however, seven which are stronger lines, and reach to a considerable height above the sun's rim, and all have depicted themselves on at least four of the six films. If there be no considerable error in the wave-lengths assigned (and such is not likely to be the case), these lines may perhaps be due to some volatile element which may yet be discovered in our atmosphere. However that may be, the very great number of close coincidences between the auroral rays and those which are emitted under electric excitement by gases of our atmosphere almost constrains us to believe, what is indeed most probable on other grounds, that the sun's coronal atmosphere is composed of the same substances as the earth's, and that it is rendered luminous in the same way—namely, by electric discharges. This conclusion has plainly an important bearing on the explanation which should be given of the outburst of new stars and of the extraordinary and rapid changes in their spectra. Moreover, leaving on one side the question whether gases ever become luminous by the direct action of heat, apart from such transfers of energy as occur in chemical change and electric disturbance, it demands a revision of the theories which attribute more permanent differences between the spectra of different stars to differences of temperature, and a fuller consideration of the question whether they cannot with better reason be explained by differences in the electric conditions which prevail in the stellar atmosphere.

If we turn to the question, what is the cause of the electric discharges which are generally believed to occasion auroras, but of which little more has hitherto been known that they are connected with sun-spots and solar eruptions, recent studies of electric discharges in high vacua, with which the names of Crookes, Röntgen, Lenard, and J. J. Thomson will always be associated, have opened the way for Arrhenius to suggest a definite and rational answer. He points out that the frequent disturbances which we know to occur in the sun must cause electric discharges in the sun's atmosphere far exceeding any that occur in that of the earth. These will be attended with an ionisation of the gases, and the negative ions will stream away through the outer atmosphere of the sun into the interplanetary space, becoming, as Wilson has shown, nuclei of aggregation of condensable vapours and cosmic dust. The liquid and solid particles thus formed will be of various sizes; the larger will gravitate back to the sun, while those with diameters less than one and a half thousandths of a millilimetre, but nevertheless greater than a wave-length of light, will, in accordance with Clerk-Maxwell's electromagnetic theory, be driven away from the sun by the incidence of the solar rays upon them, with velocities which may become enormous, until they meet other celestial bodies, or increase their dimensions by picking up more cosmic dust or diminish them by evaporation. The earth will catch its share of such particles on the side which is turned towards the sun, and its upper atmosphere will thereby become negatively electrified until the potential of the charge reaches such a point that a discharge occurs, which will be repeated as more charged particles reach the earth. This theory not only accounts for the auroral discharges and the coincidence of their times of greatest frequency with those of the maxima of sunspots, but also for the minor maxima and minima. The vernal and autumnal maxima occur when the line through the earth and sun has its greatest inclination to the solar equator, so that the earth is more directly exposed to the region of maximum of sunspots, while the 26 days' period corresponds closely with the period of rotation of that part of the solar surface where faculæ are most abundant. J. J. Thomson has pointed out, as a consequence of the Richardson observations, that negative ions will be constantly streaming from the sun merely regarded as a hot body, but this is not inconsistent with the supposition that there will be an excess of this emission in eruptions, and from the regions of faculæ. Arrhenius's theory accounts also, in a way which seems the most satisfactory hitherto enunciated, for the appearances presented by comets. The solid parts of these objects absorb the sun's rays, and as they approach the sun become heated on the side turned towards him until the volatile substances frozen in or upon them are evaporated and diffused in the gaseous state in surrounding space, where they get cooled to the temperature of liquefaction and aggregated in drops about the negative ions. The larger of these drops gravitate towards the sun and form clouds of the coma about the head, while the smaller are driven by the incidence of the sun's light upon them away from the sun and form the tail. The curvature of the tail depends, as Bredichin has shown, on the rate at which the particles are driven, which in turn depends on the size and specific gravity of the particles, and these will vary with the density of the vapour from which they are formed and the frequency of the negative ions which collect them. In any case, Arrhenius's theory is a most suggestive one, not only with reference to auroras and comets and the solar corona and chromosphere, but also as to the constitution of the photosphere itself.

Various Low-Temperature Researches.

We may now summarise some of the results which have already been attained by low-temperature studies. In the first place, the great majority of chemical interactions are entirely suspended, but an element of such exceptional powers of combination as fluorine is still active at the temperature of liquid air. Whether solid fluorine and liquid hydrogen would interact no one can at present say. Bodies naturally become denser, but even a highly-expansive substance like ice does not appear to reach the density of water at the lowest temperature. This is confirmatory of the view that the particles of matter under such conditions are not packed in the closest possible way. The force of cohesion is greatly increased at low temperatures, as is shown by the additional stress required to rupture metallic wires. This fact is of interest in connection with two conflicting theories of matter. Lord Kelvin's view is that the forces that hold together the particles of bodies may be accounted for without assuming any other agency than gravitation or any other law than the Newtonian. An opposite view is that the phenomena of the aggregation of molecules depend upon the molecular vibration as a physical cause. Hence, at the zero of absolute temperature, this vibrating energy being in complete abeyance, the phenomena of cohesion should cease to exist, and matter generally be reduced to an incoherent heap of cosmic dust. This second view receives no support from experiment.

The photographic action of light is diminished at the temperature of liquid air to about 20 per cent. of its ordinary efficiency, and at the still lower temperature of liquid hydrogen only about 10 per cent. of the original sensitivity remains. At the temperature of liquid air or liquid hydrogen a large range of organic bodies and many inorganic ones acquire under exposure to violet light the property of phosphorescence. Such bodies

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glow faintly so long as they are kept cold, but become exceedingly brilliant during the period when the temperature is rising.

Even solid air is a phosphorescent body. All the alkaline earth sulphides which phosphoresce brilliantly at the ordinary temperature lose this property when cooled, to be revived on heating, but such bodies, in the first instance, may be stimulated through the absorption of light at the lowest temperatures. Radio-active bodies, on the other hand, like radium, which are naturally self-luminous, maintain this luminosity unimpaired at the very lowest temperatures, and are still capable of inducing phosphorescence in bodies like the platino-cyanides. Some crystals become for a time self-luminous when cooled in liquid air or hydrogen, owing to the induced electric stimulation causing discharges between the crystal molecules. This phenomenon is very pronounced with nitrate of uranium and some platino-cyanides.

In conjunction with Prof. Fleming, a long series of experiments was made on the electric and magnetic properties of bodies at low temperatures. The subjects that have been under investigation may be classified as follows: "The Thermo-Electric Powers of Pure Metals"; "The Magnetic Properties of Iron and Steel"; "Dielectric Constants"; "The Magnetic and Electric Constants of Liquid Oxygen"; "Magnetic Susceptibility."

The investigations have shown that electric conductivity in pure metals varies almost inversely as the absolute temperature down to minus 200deg., but that this law is greatly affected by the presence of the most minute amount of impurity. Hence the results amount to a proof that electric resistance in pure metals is closely dependent upon the molecular or atomic motion which gives rise to temperature, and that the process by which the energy constituting what is called an electric current is dissipated essentially depends upon non-homogeneity of structure and upon the absolute temperature of the material. It might be inferred that at the zero of absolute temperature resistance would vanish altogether, and all pure metals become perfect conductors of electricity. This conclusion, however, has been rendered very doubtful by subsequent observations made at still lower temperatures, which appear to point to an ultimate finite resistance. Thus the temperature at which copper was assumed to have no resistance was minus 223deg., but that metal has been cooled to minus 253deg. without getting rid of all resistance. The reduction in resistance of some of the metals at the boiling point of hydrogen is very remarkable. Thus copper has only 1 per cent., gold and platinum 3 per cent., and silver 4 per cent. of the resistance they possessed at zero Centigrade, but iron still retains 12 per cent. of its initial resistance. In the case of alloys and impure metals, cold brings about a much smaller decrease in resistivity, and in the case of carbons and insulators like guttapercha, glass, ebonite, etc., their resistivity steadily increases. The enormous increase in resistance of bismuth when transversely magnetised and cooled was also discovered in the course of these experiments. The study of dielectric constants at low temperatures has resulted in the discovery of some interesting facts. A fundamental deduction from Maxwell's theory is that the square of the refractive index of a body should be the same number as its dielectric constant. So far, however, from this being the case generally, the exceptions are far more numerous than the coincidences. It has been shown in the case of many substances, such as ice and glass, that an increase in the frequency of the alternating E.M.F. results in a reduction of the dielectric constant to a value more consistent with Maxwell's law. By experiments upon many substances, it is shown that even a moderate increase of frequency brings the large dielectric constant to values quite near to that required by Maxwell's law. It was thus shown that low temperature has the same effect as high frequency in annulling the abnormal dielectric values. The exact measurement of the dielectric constant of liquid oxygen, as well as its magnetic permeability, combined with the optical determination of the refractive index, showed that liquid oxygen strictly obeys Maxwell's electro-optic law even at very low electric frequencies. In magnetic work the result of greatest value is the proof that magnetic susceptibility varies inversely as the absolute temperature. This shows that the magnetisation of paramagnetic bodies is an affair of orientation of molecules, and it suggests that at the absolute zero all the feebly paramagnetic bodies will be strongly magnetic. The diamagnetism of bismuth was found to be increased at low temperatures. The magnetic moment of a steel magnet is temporarily increased by cooling in liquid air, but the increase seems to have reached a limit, because on further cooling to the temperature of liquid hydrogen hardly any further change was observed. The study of the thermo-electric relations of the metals at low temperatures resulted in a great extension of the well-known Tait theremo-electric diagram. Tait found that the thermo-electric power of the metals could be expressed by a linear function of the absolute temperature, but at the extreme range of temperature now under consideration this law was found not to hold generally; and further, it appeared that many abrupt electric changes take place, which originate probably from specific molecular changes occurring in the metal. The thermo-electric neutral points of certain metals, such as lead and gold, which are located about or below the boiling point of hydrogen, have been found to be a convenient means of defining specific temperatures in this exceptional part of the scale.

The effect of cold upon the life of living organisms is a matter of great intrinsic interest, as well as of wide theoretical importance. Experiment indicates that moderately high temperatures are much more fatal, at least to the lower forms of life, than are exceedingly low ones. Prof. McKendrick froze for an hour at a temperature of 182deg. C. samples of meat, milk, etc., in sealed tubes; when these were opened after being kept at blood heat for a few days, their contents were found to be quite putrid. More recently some more elaborate tests were carried out at the Jenner Institute of Preventive Medicine on a series of typical bacteria. These were exposed to the temperature of liquid air for 20 hours, but their vitality was not affected, their functional activities remained unimpaired, and the cultures which they yielded were normal in every respect. The same result was obtained when liquid hydrogen was substituted for air. A similar persistence of life in seeds has been demonstrated even at the lowest temperatures; they were frozen for over 100 hours in liquid air, at the instance of Messrs. Brown and Escombe, with no other result that to affect their protoplasm with a certain inertness, from which it recovered with warmth. Subsequently commercial samples of barley, pea, vegetable marrow, and mustard seeds were literally steeped for six hours in liquid hydrogen at the Royal Institution, yet when they were sown by Sir W. T. Thiselton Dyer at Kew in the ordinary way, the proportion in which germination occurred was no less than in the other batches of the same seeds which had suffered no abnormal treatment. Bacteria are minute vegetable cells, the standard of measurement for which is the "mikron." Yet it has been found possible to completely triturate these microscopic cells, when the operation is carried out at the temperature of liquid air, the cells then being frozen into hard breakable masses. The typhoid organism has been treated in this way, and the cell plasma obtained for the purpose of studying its toxic and immunising properties. It would hardly have been anticipated that liquid air should find such immediate application in biological research. A research by Prof. Macfadyen, just concluded, has shown that many varieties of micro-organisms can be exposed to the temperature of liquid air for a period of six months without any appreciable loss of vitality, although at such a temperature the ordinary chemical processes of the cell must cease. At such a temperature the cells cannot be said to be either alive or dead, in the ordinary acceptation of these words. It is a new and hitherto unobtained condition of living matter—a third state.

A final instance of the application of the above methods may be given. Certain species of bacteria during the course of their vital processes are capable of emitting light. If, however, the cells be broken up at the temperature of liquid air, and the crushed contents brought to the ordinary temperature, the luminosity function is found to have disappeared. This points to the luminosity not being due to the action of a ferment—a "Luciferase"—but as being essentially bound up with the vital processes of the cells, and dependent for its production on the intact organisation of the cell. These attempts to study by frigorific methods the physiology of the cell have already yielded valuable and encouraging results, and it is to be hoped that this line of investigation will continue to be vigorously prosecuted at the Jenner Institute.

And now, to conclude an address which must have sorely taxed your patience, I may remind you that I commenced by referring to the plaint of Elizabethan science, that cold was not a natural available product. In the course of a long struggle with Nature, man, by the application of intelligent and steady industry, has acquired a control over this agency which enables him to produce it at will, and with almost any degree of intensity short of a limit defined by the very nature of things. But the success in working what appears at first sight to be a quarry of research that would soon suffer exhaustion, has only brought him to the threshold of new labyrinths, the entanglements of which frustrate, with a seemingly invulnerable complexity, the hopes of further progress. In a legitimate sense all genuine scientific workers feel that they are "the inheritors of unfulfilled renown." The battlefields of science are the centres of a perpetual warfare, in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of Nature. To serve in the scientific army, to have shown some initiative, and to be rewarded by the consciousness that in the eyes of his comrades he bears the accredited accolade of successful endeavour, is enough to satisfy the legitimate ambition of every earnest

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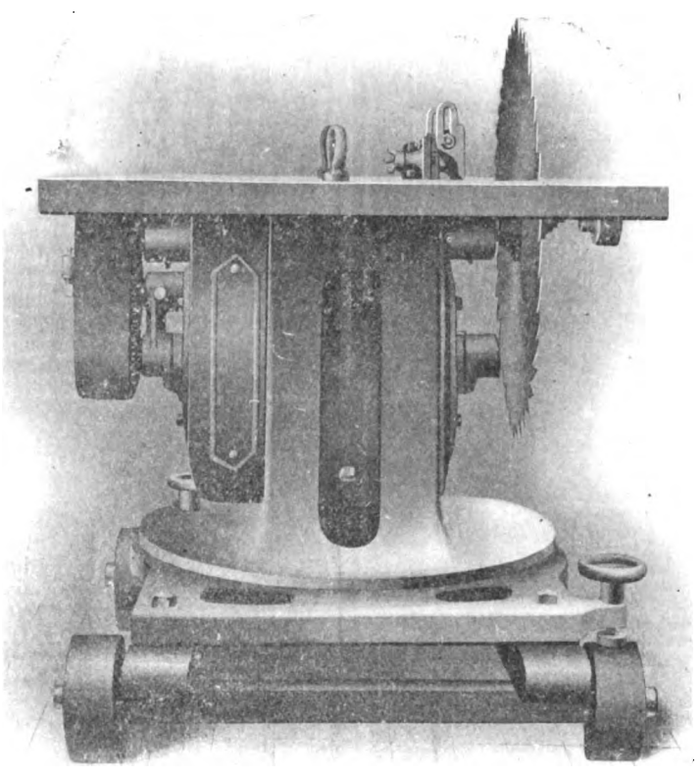
student of Nature. The real warranty that the march of progress in the future will be as glorious as in the past lies in the perpetual reinforcement of the scientific ranks by recruits animated by such a spirit, and proud to obtain such a reward.

TRADE NOTICES AND NOVELTIES.

Portable Electrical Saw Bench.

We illustrate herewith a tool which should be found exceedingly useful by shipbuilders, colliery owners, engineers, timber merchants, and others. This is an electrical circular-saw bench. Portability being one of its special features, every part is of the lightest possible construction consistent with stability and strength. Being mounted on wheels, as shown, it can be readily run along to any place where it may be required and where electric power is available. A most important feature is the introduction of a turntable on the framing, by



Portable Electric Saw Bench.

means of which the top part of the machine can be swung round to any desired angle without changing the position of the base of the bench. This allows of the bench being used for cross-cutting and other purposes in confined places, where otherwise want of space would prevent long pieces being handled. The bench owes its introduction to the enterprise of the Sunderland Forge and Engineering Company, Limited, Pallion, Sunderland, the electric motor which drives the saw being of their "Pallion" multipolar continuous-current enclosed type. The motor is hung on the underside of the table of the bench, and thus is quite out of the way for cross cutting. It embodies all the makers' recent improvements, and is built with a view of standing the shocks and frequent heavy loads incident to cutting timber. The starting switch is fitted under the table, being protected by means of an iron casing having a hinged door. The case and starter are hidden from view by the motor in the illustration herewith. The starter itself is fitted with no-voltage release and automatic overload cut-out as an extra protection to the motor. The above firm supply six sizes of their portable electrical circular-saw bench. It should be mentioned that the benches themselves are being made by Messrs. John McDowall and Sons, of Johnstone, N.B., while the swivel arrangement is Cameron's patent.

Catalogues, etc., Received.

Electric Bells and Accessories.—From Messrs. Baxendale and Co., Miller-street Works, Manchester, we have received a copy of their new catalogue of electric bells and accessories.

The Nernst Lamp.—The Nernst Electric Light, Limited, 82, Victoria-street, London, S.W., who are introducing the Nernst lamp into the territories for which they hold the sole rights, including the whole of Asia, Africa, Central and South America, and all British Colonies, have just issued a new catalogue and price-list, wherein are described the two types of lamps which the company are prepared to sell. This catalogue is well illustrated and the descriptions given are very full.

Collector Grinding and Polishing Apparatus.—Mr. A. S rauss-Collin, Bush-lane House, Connon-street, E.C., sends us a leaflet illustrating and describing a patent rapid collector grinding and polishing apparatus for polishing direct-current collectors and collecting rings. From the illustrations given the action of the apparatus seems very simple.

The "Ark" Lamp.—From Messrs. Johnson and Phillips, Victoria Works, Old Charlton, Kent, we have received a large picture postcard illustrating the numerous forms of their "Ark" lamp. Several artistic fittings are shown on the same card. We understand that the firm have a large stock of these lamps and fittings ready for immediate delivery.

Switchboards.—We have received from the Electrical Company, Limited, 122-4, Charing Cross-road, London, W.C., a copy of their price-list No. 14, dealing with switchboards. Illustrations and descriptions of various large switchboards are given, also of standard switchboards, and accessories for switchboards.

APPOINTMENTS VACANT.

Switchboard Attendant, Eccles Corporation Electricity Works, £62 per annum, Sept. 31. Particulars may be obtained from the Town Clerk, Town Hall, Eccles.

Various, Tonbridge Urban District Council, Sept. 22. Full particulars can be obtained from Mr. J. A. B. Horsley, engineer, Electricity Works, Tonbridge.

Surveyors of Electrical Plant, the National Boiler and General Insurance Company, Limited, £120 per annum. See advertisement.

Meter Tester and Inspector, experience in calibrating and testing prepayment meters desirable. See advertisement.

NEW COMPANIES REGISTERED.

London Motor Omnibus Syndicate, Limited.—Capital, £3,020. Objects: to carry on business as builders of and dealers in vehicles of every description, launches, steamboats, propelled by either steam, oil, or electricity, etc

Whitley Motor and Engineering Company, Limited —Capital, £500. Objects: to carry on the business of manufacturers of and dealers in cycles, motorcars, carriages, etc.

W. T. Skelding and Co., Limited.—Capital, £10,000. Objects: to carry on the business of electrical, electrical installation and general engineers, mechanical engineers, manufacturers of electrical fittings, apparatus and machinery, etc.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

517. A company holds powers for electric tramways and electric lighting in three villages through which the tramways pass. The tramways radiate in three directions, the centre being a convenient spot for a power station, being close to canal and colliery. On each leg of the tramways one of the three villages is situate, the distance from the power station to the villages varying between 1½ to 4 miles, the arms of the tramways being four, five, and six miles in length from the radiating point or power station. The radiating point is practically the electrical centre of gravity. A good demand for power may be expected, and a fair demand for lighting current. The power station will therefore be a combined lighting and traction station. Consider the all-round advantages of the following systems of generation and distribution for such a scheme: (*a*) high-tension continuous and rotatory transformers; (*b*) low-tension with reversible boosters and battery sub-stations; (*c*) three-phase and rotatory transformers (motor-generators); (*d*) three-phase and converters; *e*) three-phase and static transformers The effect of lightning and inductive disruptive charges in the high-tension continuous system should be borne in mind.—C. J.

[NOTE.—A special award of £3 will be given for the best answer to the above question.—ED. *E. E.*]

518. Describe fully the circumstances under which boosters are used in connection with rail-return cables in tramway work, and give diagram of all connections.—J. A. MORTON.

ANSWERS.

Question No. 510.—Describe the most simple and satisfactory method of testing the efficiency of a lightning conductor.

Answer to No. 510 (*awarded* 7*s.* 6*d.*).—In testing a lightning conductor, perhaps the most important thing is to test the conductor's "earth." It is most necessary that tests or inspections of earth connections should be made at the driest time of the year. In wet weather they must always be unreliable. First of all, though, we must

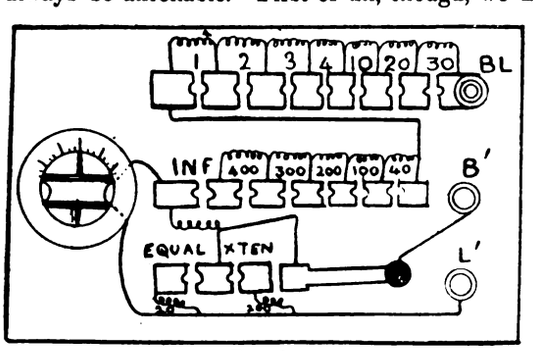

FIG. 1.

test for continuity. For this purpose a detector and cell can be used. To test the conductor's earth the following instrument can be used, and has a range up to 1,110 ohms when testing direct by steps of one ohm, and to 11,100 ohms by steps of 10 ohms when using the multiplying hole marked "× ten." The method of using it is as follows (see sketch): The wire to the conductor is taken to terminal L^1, one pole of the battery and the wire to the test earth-plate to terminal B L, and the other pole of the battery to terminal B^1. The plugs on the upper row of brasses would then be moved about until no deflection is produced upon the galvanoscope on the battery key being pressed down, the bottom plug being placed in the "equal" hole. If however, the resistance to be found is more than 1,110 (shown by above trial), the bottom plug is moved to the "× ten" hole, and a balance obtained and recorded. As regards the earth connection, simple inspection may frequently be the easiest and most satisfactory test. Should it be difficult to inspect, then the electrical test should be used, and I think the Wheatstone balance test is the best. It might happen that the connection between the conductor and the plate, or tube, or mass of metal forming "the earth," was imperfect owing to oxidation. In such a case the resistance would appear considerable, yet in reality the connections might be practically good as regards lightning. The resistance of the conductor is, however, of little or no consequence when opposed to E M.F. of such high tension as a lightning discharge. It is quite erroneous to suppose that lightning always passes to earth by those paths which "to the ordinary voltaic current test lowest." It, however, does pass to earth by those paths which to a current of its own potential would test lowest. The best system of testing lightning conductors is to balance the resistance of each of the earths of the building against the remainder of the system, from which the state of the earths may be inferred with sufficient accuracy for all practical purposes. As regards the earth connections, it is most important that the electrical resistance which they offer should be very far less than that offered by any alternative route in the line of probable discharge, such as the rain-water or gas pipes outside a building. The test by simple inspection seems to be the best for the conductors above ground. A resistance test could only be applied with advantage where there were no slip joints, and where the conductors were difficult of access.—H. R. H.

Answer to No. 510 (*awarded* 7*s.* 6*d.*).—If the conductor referred to in this question is the ordinary type used for the protection of buildings, then the only proper test of its efficiency is time and experience, together with the maintenance of a good earth. Much reliance cannot be placed on the test with Wheatstone bridge and galvanometer; these are powerless to answer many important points in respect to efficiency. Considering that a flash of lightning may strike one corner of a building and apparently rush part way down, the conductor then flashes off sideways to a roof gutter, etc. Yet at the same time, when tested with Wheatstone bridge and galvanometer, the resistance between conductor and earth may be only about 100 ohms, whilst the path along which the flash actually travelled would offer a resistance of about 1,000,000 ω. Even a break in the conductor itself is not sufficient reason for the flash striking probably yards instead of across the fracture.

It is, however, essential to know both the resistance and conductivity of the conductor and earth, but as regards the conductor's efficiency in a storm these quantities tell practically nothing Conductivity is not what is required; the electric inertia or "self-induction" must be reduced by increasing the conductor's capacity. A flash of lightning is the spark through the dielectric of a Leyden jar, so to say, whose coatings are either two clouds, or else cloud and earth, and has been proved to be oscillatory. Therefore the efficiency would be influenced by the material of the conductor. For instance, a rising current has to magnetise the space all round it, and the production of this magnetisation delays and impedes the rise of the current to its maximum value, and a falling current permits the magnetisation of the space to decay, and this dying out of the magnetisation impedes the fall of the current to its minimum.

Now, the total magnetisation produced by the current is proportional to the current strength, C, and equal to this multiplied by a constant, L, or $P = L\,C$, where L is a coefficient characteristic of the circuit, and is defined as the coefficient of self-induction. If the current goes through $\frac{\rho}{2\pi}$ complete alternations in a second, then the impedance it meets with due to the reversals of its own magnetic field $= \rho L$. This is not the whole obstruction it meets with, but it is the only part which does not dissipate energy, and may be called the inertia part of the impedance, the remaining part of which is R; thus the coefficient of

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the dissipation of energy = $C^2 R$. The total impedance, P, is the resultant of these two as if they acted at right angles to each other, or $P = (\rho L)^2 + R^2$. In respect to the resistance, iron would be worse than copper, but for rapid alternations the value of R is insignificant compared with (ρ L). Now, this (ρ L) term depends on the material which the conductor is made in so far as the conductor gets magnetised itself. To see that the conductor offers a minimum resistance the following connections are made, where E_2 and E_3 (Fig. 1) are two separate and independent

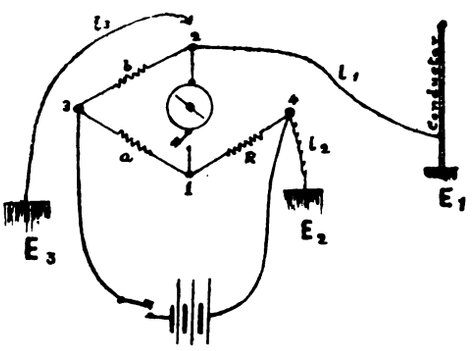

FIG. 1.

earths situated 10ft. from E_1. Let l_1 = the resistance of the leading wire to E_1, and E_1 = the resistance of the earth to be determined.

Let E_2 and E_3 = the resistances of the two other earths, including their leads, l_2 and l_3. Let R_1, R_2, and R_3 = the resistances unplugged in the adjustable arm of the bridge $\times \frac{a}{b}$ in each case when measuring the resistances of E_1, E_2, E_3.

Then,
$$R_1 = l_1 + E_1 + E_2,$$
$$R_2 = l_1 + E_1 + E_3,$$
$$R_3 = E_2 + E_3.$$

Hence,
$$E_2 = R_1 - l_1 - E_1,$$
$$E_3 = R_2 - l_1 - E_1.$$

Therefore,
$$R_3 = E_2 + E_3,$$
$$R_3 = R_1 - l_1 - E_1 + R_2 - l_1 - E_1,$$
$$R_3 = R_1 + R_2 - 2\,E_1 - 2\,l_1.$$

Hence,
$$E_1 = \frac{R_1 + R_2 - R_3 - 2\,l_1}{2},$$

or,
$$E_1 = \frac{R_1 + R_2 - R_3}{2} - l_1.$$

For further information on this subject, see *Proceedings* of the Institution of Electrical Engineers for Dr. Lodge's paper on "Lightning Conductors."—K.

Question No. 511.—I recently saw a rotary converter with a device for steadying and controlling speed within certain limits. This was designated a "teazer," but I can find no account of it. Can any reader please explain?

Answer to No. 511 (*awarded 7s* 6d.).—It is a well-known fact that many large machines, such as rotary printing presses, turrets, etc., are required to move along continuously at a low and even rate of speed, frequently at one-twentieth of the maximum speed. Having a large moment of rest, they require an unusually large amount of torque to start them, sometimes as much as three or four times that torque which the motor is called upon to produce at full speed. A system, known as the "teazer" system, has been designed to meet these conditions. As the current required to produce normal running torque in these large motors was already of considerable volume, it was an embarrassing question how the large volume of current was to be obtained for producing a torque sufficient to start them. It will be easily understood that in order to obtain the necessary current through the motor to start up against the load when current was taken from public supply, a large amount of energy had to be dissipated in resistance to reduce the voltage on motor armature to that required to overcome the static resistance of the machine. This would mean that the line would be called upon for current at full line voltage three or four times that required to run the motor at normal load. Take, for instance, an 80-h.p. motor in the case of a new machine, which always takes more power to run than one which has been in daily operation for a few months; this would mean probably 400 h.p. would instantaneously be thrown on the line. As a matter of fact, the actual energy required to start is much less than that required to run the motor at full speed, as the voltage required to overcome the resistance of motor and the back E.M.F. at a slow speed is only a fraction of that

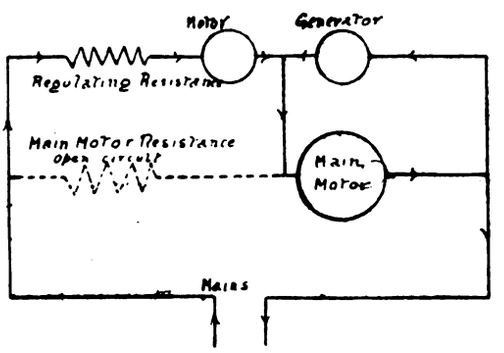

FIG. 1.

required at full speed. A motor-generator is, therefore, supplied to transform the line current into this lower voltage. These transformers are usually wound for a ratio of about 4 to 1. A rheostat is provided in the motor current of the motor-generator, so that the voltage on the generator side may be varied from zero to a maximum of one-fourth the line voltage. The connections, which are all brought to a controller operated by a single handle, are as shown in the sketch (Fig. 1). The direction of current is shown by arrows. When in its first position to start, the main current passes through the small regulating resistance of the motor-generator to its primary or motor, and which is wound for the full line voltage. From these it divides into two parts on its way to the return circuit—one through the secondary or generator end of the motor-generator, and from then out to the line, and the other through the main motor armature and out to the line. This current which passes through the main motor armature is quite sufficient to move the armature slightly, and so take up any back lash, etc., in the gears. This current also gets the motor-generator under way, and as its speed rises the dynamo end begins to generate current at a low voltage but of large capacity.

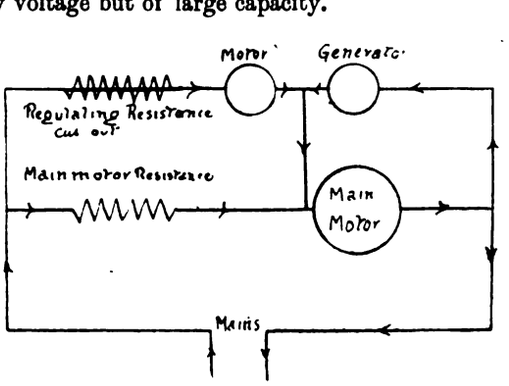

FIG. 2.

This secondary current, as shown by the arrow marks, is the current that produces the starting torque, and as it rises with the increased speed of the motor-generator it gives the main motor an easy start, raising it to a "slow motion" speed, and that without the slightest jar to the machine it operates. After the motor has performed its "slow motion" work, the controller passes on to the next step, which brings it in circuit with the main line current, through the speed-controlling resistance shown in dotted lines (Fig. 2). This resistance is so proportioned that the drop in volts equals the maximum volts given by the generator side of motor-generator, thus introducing the main line current without the slightest jar. By moving the controller forward again, main line resistance is cut out, and

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as the pressure rises the main line assumes more and more of the load, until the motor-generator is supplying no current, whereupon the automatic switch in the motor-generator circuit opens and the motor-generator shuts down (Fig. 3). More resistance is cut out until motor is supplied with full-line voltage, when it will run at its normal speed. Most of these motors are compound-wound, but provided with a resistance in the shunt circuit which will raise the speed of motor about 15 to 25 per cent. above normal by reducing the strength of fields.

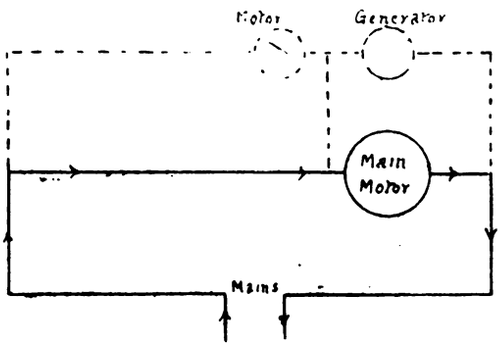
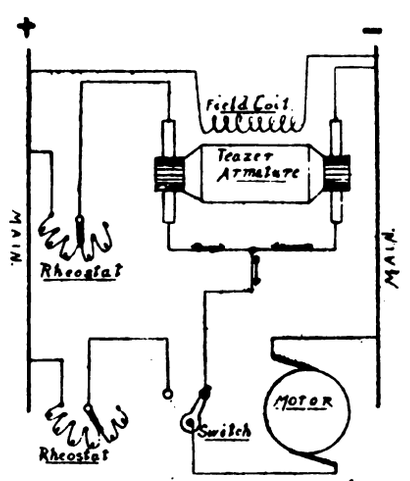


FIG. 3.

The introduction of, first, the main-line current through the motor-generator to take up the back lash, then starting up the main motor by speeding up the motor-generator, and following with the introduction of the main-line current, which can be made to run the motor at any desired speed; the automatic shutting down of the motor-generator when not in service, and the automatic release stops placed in convenient positions surround the press, make a most ingenious system for operating large machines whose running conditions are of such an exacting nature.—R. A. M.

Answer to No. 511 (*awarded* 7*s.* 6d.).—The teazer system of motor control is sometimes adopted for controlling large motors, especially those that drive machines that possess very large moments of inertia, which require a very large starting torque. The torque exerted by a motor depends upon the strength of the current flowing through its armature; and since the current which is required to produce the normal running torque of these motors is already of considerable magnitude, it is desirable that a continuous-current transformation, by means of a dynamotor, be



Connections for Teazer System of Motor Control.

FIG. 1

employed to avoid drawing the excessive starting current from the mains The dynamotor used for this purpose is designed so that its motor side may be supplied by the line voltage, while its generator side is usually wound for a voltage of about one fifth that of the line. By this arrangement the excessive current for starting a motor is derived without necessitating an increase of the supply current above the normal amount. The two teazer armature windings are connected in series with a rheostat across the supply mains; the dynamotor field winding is excited directly from the line; the negative brush of the motor side is connected with the positive brush of the dynamo side See diagram (Fig. 1.) At starting, the main motor armature is supplied from the generator end of the dynamotor with a voltage somewhat less than one-fifth of the line voltage, depending upon the magnitude of the regulating resistance; thus, the current which passes through the motor is about five times as great as that taken from the supply mains, so that the required amount of starting torque is produced with the normal supply current. Since the speed of the motor is dependent upon the E.M.F. impressed upon it, the starting speed is only about one-fifth of the normal running speed. The E M.F. of the motor, and with it its speed, is raised by manipulating the dynamo-regulating resistance, and when the proper speed is attained the motor connections are switched to the supply mains through a second series-regulating resistance, thus establishing the required conditions for running under working load. Regulation of the resistances and changes of the connections are accomplished by the aid of a controller, and thus the motor may be operated by the manipulation of a single hand-wheel.—W. F. S.

Answer to No. 511 (*awarded* 5*s.*).—"F. P. S." evidently refers to an "inverted" rotary converter—*i.e.*, one which transforms from direct to alternating current. For when transforming from alternating to direct the speed is, of

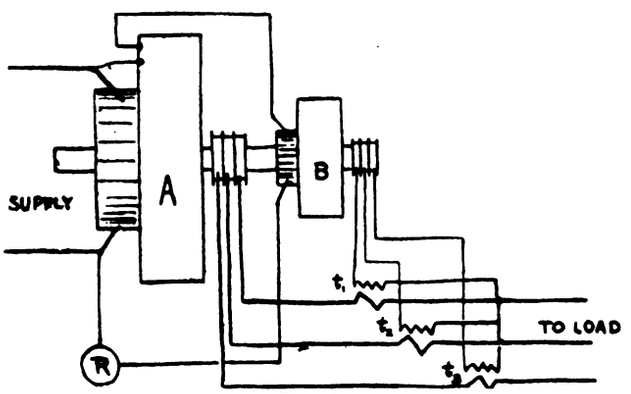


FIG. 1.

course, fixed by the frequency of supply. When a rotary is used in the opposite sense, however, it is running (as regards speed) as a direct-current shunt motor, and its speed is a function of the field strength. Anything tending to weaken the field will increase the speed, while strengthening the field will reduce the speed. Now, if a lagging current be drawn from the alternating side, the armature reaction will reduce the flux and the speed will increase. More than one bad accident has occurred in this way, the speed having increased till the machine flew to pieces. On the other hand, if a leading current be drawn from the machine (as might be taken by other rotaries on the system), the armature reaction will increase the flux, thus reducing the speed. In using rotaries in this way, it is therefore necessary to have some device which will automatically regulate the speed with varying load.

The device which "F. P. S." saw was probably that described and illustrated in Fig 1. In the sketch A is the main rotary, supplied with direct current at its commutator. On the same shaft is a small rotary, B, with no field winding, and the field frame so mounted that it may be turned round (concentrically with the armature) by hand to any position. Its collector rings are fed from the secondaries of three star-connected series transformers, t_1, t_2, t_3, placed in the three-phase leads between the main rotary and the load. The brushes of the "teazer" rotary are connected in series with the shunt field current of the main machine. R is the field rheostat. Now, considering B alone, suppose a three-phase current is circulating in the armature, with the machine running at normal (synchronous) speed. The pole-pieces are magnetised by the armature current, and by shifting the frame round the neutral axis on the commutator may be shifted also, so that the voltage across the brushes will vary according to the position of the poles. Supposing, now, that the

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whole combination is running under load, and that the power factor of the load is unity—*i.e.*, there is no lag or lead of the load current. The poles of B may be set so that the neutral axis lies at right angles to the line joining the two brushes (supposing there are only two), and there will be no voltage between them. If, now, a lagging current be drawn from the main machine, the phase of the current in B will also lag, the neutral points will shift back, and voltage will appear at the brushes. This voltage is arranged to increase the field current of A, so tending to reduce the speed and counteracting the effect of the lagging current. On the other hand, a leading current drawn from A causes B to insert an opposing voltage into the field circuit, weakening the field of A and keeping up the speed. By this means the strength of the main field is regulated according to the power factor of the load, and the speed kept fairly constant.—R. C.

Best Answer to No. 511 (*awarded* 5*s.*).—The monocyclic system was designed to replace the old-type single-phase system of alternate-current distribution, by affording the

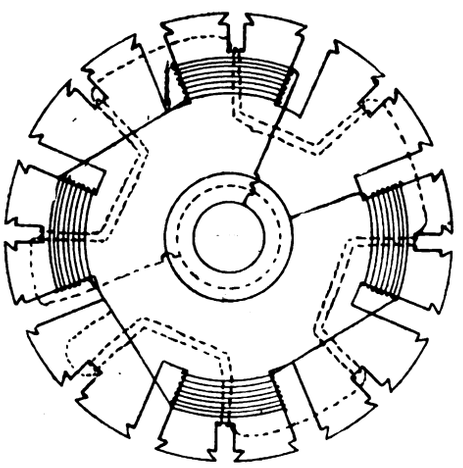

FIG. 1.

advantage of being able to supply power to alternate-current motors that shall be self-starting under full load without affecting the steady working of the lighting system. The monocyclic generators differ from the old single-phasers only by having midway between the main slots that receive the windings on the armature a second set of small and shallow slots (as shown in Fig. 1), which contain a supplementary or "teazer" winding, shown in dotted lines. The "teazer" coils have only one quarter of the number of turns of the main coils, and, therefore, give only one-quarter as much E.M.F. The teazer

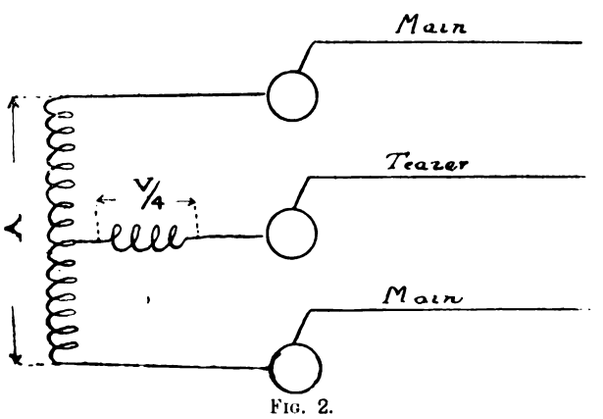

FIG. 2.

winding is connected with one end to a third or middle collector ring, and with the other end to the middle of the main winding, as shown diagrammatically in Fig. 2. It will be evident that the current in the teazer winding will be out of phase with the main current, also as the current going out from the teaser coil has to return through one or the other half of the main winding, it meets with a considerable self-induction. This feature, causing a relatively higher impedance in the teazer circuit, limits the flow of current in that circuit by causing the voltage in this part of the coil to drop as current is taken through it, so that the power put forth by the alternator is practically all conveyed by the current of the other winding in the same way as in the old single-phase system. That is, the teazer current is almost entirely a wattless current, useful for giving a starting torque to motors which are connected up with a third wire to the teazer line, but not really contributing anything to the driving power when the motor has got up speed. Thus it is seen that the teazer winding has some effect in steadying and controlling the speed within certain limits. The teazer voltage of the generator cannot be measured directly, since only one terminal is accessible when the armature is rotating. The potential difference between the two mains or outside collector rings is simply due to the main coil. The difference of potential between the middle or teazer collector ring and either of the two main collector rings, is the resultant of the teazer voltage and half the main voltage.

Since the teazer voltage at open circuit is one quarter of the main voltage, and the difference of phase between them is 90deg., the relative voltage will be

$$= \sqrt{(\tfrac{1}{4})^2 + (\tfrac{1}{2})^2} = \sqrt{\tfrac{1}{16} + \tfrac{1}{4}} = \sqrt{\tfrac{5}{16}} = 0{\cdot}57;$$

or, if the whole voltage across the outer mains is 2,000 volts, and that of the teazer coil 500 volts, then each half of the main coil will generate 1,000 volts, while the measured difference of potential between the teazer line and either main will be about 1,140 volts.—A. J. M.

LEGAL INTELLIGENCE.

MAZARRON ELECTRIC LIGHT COMPANY.

Mr. Justice Swinfen Eady in the Vacation Court on Wednesday had before him the matter of the Mazarron Electric Light Company, Limited, on a motion by the plaintiff, Richard, for the appointment of a receiver and manager.

Mr. Robertson said that the plaintiff was the holder of five £20 debentures in the company, which was incorporated in 1893 for the purpose of establishing a system of electric lighting for the town of Mazarron, in Spain, under a concession dated September, 1892, for a term of 50 years, and the company was now working that concession. A term of the debentures was that the company should redeem the debentures at par in an aggregate amount of at least £200 on Jan. 1, 1899, and a like amount in every succeeding January till the whole amount of the issue was paid off. The principal moneys became payable if this condition was broken, and also if default was made in payment of interest for the period of six months, or if an order was made for the winding-up of the company. The ground for the application was that the company had committed a breach of the conditions in that it did not redeem in 1902, or at all.

Mr. Tyrrell, on behalf of the company, submitted that there was no ground for the appointment.

His Lordship granted the application, and appointed Mr. Hussey as receiver and manager.

BRITISH POWER, TRACTION, AND LIGHTING COMPANY.

In the Vacation Court on Wednesday Mr. Justice Swinfen Eady had before him a petition by Mr. L. Hannen, a judgment creditor for £250, for the compulsory winding-up of the above company.

Mr. Kenyon Parker, for the company, asked that the petition be allowed to stand over for two months. He said that meetings of the shareholders and of the creditors had been held, and it had been pointed out to the creditors that unless fresh capital could be procured the company must stop, and then the unsecured creditors would probably get nothing.

In the result it was arranged that the petition should stand over till the first petition day after Nov. 17.

COMPANIES' MEETINGS AND REPORTS.

DIRECT WEST INDIA CABLE.

The report of the directors for the year ended June 30 last states that the net result of the year's working is a profit of £4,789, as compared with £5,236 for the previous year. An interim dividend of 3 per cent. has already been paid, and it is now proposed to make a further equal payment, which will leave £2,989 to be carried forward. This will increase the amount to the credit of revenue account to £30,982. The shareholders are asked to approve the establishment of a staff provident fund in accordance with the details of the scheme to be submitted to the meeting. The Company's cables continue to work with complete efficiency. Offers for the sale of debentures to the trustees were invited in December and June last, and £7,999 was paid for £8,000 of debentures, which amount has been written off capital expenditure.

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ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS.

The directors in their report for the year ended June 30 state that the works have been fully maintained as regards buildings and machinery, the cost of which has been charged against revenue. After allowing £4,041. 2s. 4d. for depreciation, the profit for the year is £14,854. 1s. 1d., to which must be added £2,578. 2s. 7d. brought from last year (£3,778. 2s. 7d., less £1,200, special allowances to directors), making a total of £17,432. 3s. 8d., which the directors recommend be dealt with as follows: to carry to general reserve fund £2,000; to pay a dividend of 8 per cent., less income tax, £12,000; to carry forward to next year £3,432. 3s. 8d.

GLASGOW DISTRICT SUBWAY.

The half-yearly meeting of the above Company was held in Glasgow on Wednesday.

Mr. A. Simpson (the chairman), in moving the adoption of the report, said that despite the competition of the Glasgow electric cars the Company was able to pay 1½ per cent., or ½ per cent. increase. The question of conversion of the present cable haulage into electric traction was under consideration, but the directors did not see the substitution would be of any advantage to the shareholders.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Huddersfield.—The Corporation invite tenders for high and low tension cable. Tenders by Sept. 30. See advertisement.

Swansea.—The Corporation invite tenders for the supply of one 40-kw. continuous-current motor-balancer. Tenders by Sept. 26. See advertisement.

Belfast.—The Gas and Electric Committee invite tenders for the supply of electric motors for a period of 12 months. Tenders by Oct. 10. See advertisement.

Grimsby.—The Corporation invite tenders for the supply of continuous-current motors for letting on the hire system. Tenders by Sept. 20. See advertisement.

Dundee.—The Gas Commissioners invite tenders for the supply of carbons for public lamps, delivered at the Electrical Power Station, Dundee. Tenders by Sept. 24. See advertisement.

Tientsin (China).—Mr. A. W. Harvey Pellingham, secretary of the British Colony at Tientsin, China, invite tenders for installation and working of electricity works. Tenders by Nov. 30.

Burton-upon-Trent.—The Corporation invite tenders for the supply and laying of electric mains, conduits, junction boxes, etc., in connection with the tramways. Tenders by Sept. 30. See advertisement.

Blackburn.—The Town Council invite tenders for the supply, delivery, and erection, at the electricity works, Blackburn, of one electrically-driven travelling crane. Tenders by Sept. 22. See advertisement.

Dundee.—The Gas Commissioners invite tenders for the supply and erection, at the Electrical Power Station, Dundee, of water-tube boilers, with mechanical stokers and superheaters, and induced-draught apparatus. Tenders by Sept. 24. See advertisement.

Orence.—The Municipal Authorities invite tenders for the installation and working for 20 years of electric lighting the above. One hundred 16-c.p. lamps will be paid for at the rate of 3,500 pesetas per annum. Tenders to the above authorities, province Celanova, by Sept. 23.

Southampton.—The Corporation invite tenders for the supply of 110 tons of rolled-steel rails and the fishplates therefor. Full particulars to be obtained upon application to Mr. J. A. Crowther, borough engineer, Municipal Offices, Southampton. Tenders by Sept. 26.

Colchester.—The Churchwardens of St. Botolph's Church invite tenders for a complete installation of electric light at the church. Specifications, etc., can be obtained from Mr. A. R. Sillar, A.M.I.E.E., borough electrical engineer, Corporation Offices, 36, Stanwell-street. Tenders by 22nd inst.

Peterborough.—The Corporation invite tenders for the construction and seating of a Lancashire boiler, 28ft. by 7ft, at their electricity works. Specifications, etc., may be obtained at the office of Mr. John C. Gill, A.M.I.C.E., engineer, Municipal Offices, Peterborough. Tenders by Sept. 30.

Blackpool.—The Tramways Committee invite tenders for the supply of steel rails, fishplates, bolts and nuts, tiebars, crucible cast-steel points, and crossings. Specifications, etc., can be obtained from Mr. John S. Brodie, A.M.I.C.E., borough engineer, Town Hall, Blackpool. Tenders by Sept. 23.

Leicester.—The Tramways Committee invite tenders for the erection of an octagonal brick chimney shaft, 180ft. high, on the site of the new generating station, The Lero. Specification, etc., can be obtained at the office of Mr. E. George Mawbey, M.I.C.E., Town Hall, Leicester. Tenders by Sept. 30.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for Lancashire boilers, economisers, surface condenser, and pumps, etc., steam, feed, blow-off, and drain pipes, etc., and travelling crane. Specifications, etc., can be obtained from Mr. F. Schofield, clerk to the Board, Town Hall, Stalybridge. Tenders by Oct. 13.

Shanghai.—Messrs. Preece and Cardew are authorised to receive tenders for the supply and delivery c.i.f. of two 500-kw. steam alternators (the engines to be enclosed double-acting type and alternators to have stationary armatures, pressure 2,100 volts, periodicity 100), switchboards, and two condensers and circulating water pumps. Tenders by Oct. 30. See advertisement.

Bexleyheath (Kent).—The Electric Lighting and Traction Committee of the Urban District Council invite tenders for transformers and transformer pillars; condenser, air-pump, and water softener; feed pumps and pipework; and travelling crane. Specification, etc., may be obtained from the engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders by Sept. 30.

Bury (Lancs.).—The Tramways Committee invite tenders for the work required in the construction of the permanent way in several parts of the borough—viz.: Fairfield section, Bolton-road section, Heywood-street section, and Knowsley-street section. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by 24th inst.

Ilford.—The Urban District Council invite tenders for the supply and erection of dry-back, semi-marine type boiler (15,000lb evaporation per hour), superheater and accessories, and motor feed pump; steam, feed, and blow-off pipes, and feed filter; surface condenser, cooling tower, motor pumps, hot-well, grease extractor, exhaust, steam, and water pipes. Tenders by Oct. 6. See advertisement.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Swindon, Wilts, of all the materials, fittings, and accessories for a complete installation of the electric light and wiring to the motors on the works, and also for the supply and delivery at the electricity works of testing instruments and engine-room accessories. Tenders by Oct. 4. See advertisement.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

Dungannon (Ireland).—The Urban District Council invite tenders for the supply, delivery, and erection of the plant and material, and for the carrying out of the work comprised in the adjoined sections: (Section A) dynamos (two 35 kw.), switchboard; (B) gas plant—(Sub-Section a) engines (two 60 b.h.p.), (b) producer-gas plant; (C) battery; (D) underground feeder and distributing mains; E) public lamps and connections to mains. Specifications, etc., can be obtained from Mr. James M. Hamilton clerk of the Council, Dungannon. Tenders by Sept. 24.

Ashford (Middlesex).—The Managers of the West London School District invite tenders for the following in connection with the electric lighting of their schools at Ashford, Middlesex: (Contract No. 1) dynamos, booster, storage battery, switchboard, etc.; (2) feeders and wiring. Specifications, etc., may be inspected at the offices of the consulting electrical engineer, Mr. T. J. Digby, 32, Shaftesbury-avenue, W., or at the Schools, and obtained from Mr. F. G. Beeching, clerk to the Managers, West London District Schools, Ashford Middlesex. Tenders by 6 p.m. on 25th inst.

Madrid.—The Postal Telegraph Department invite tenders for laying of 71 miles of submarine cable between Santa Isabel (Fernando Po) and King Bell's Town (Cameroons). The maximum subvention will be 8,400 pesetas per mile. A building is to be erected at the landing point; the contractors must furnish trial apparatus and pay 75 pesetas per day to each member of the commission of inspection, which has been appointed by the Government, until acceptance of the cable. A provisional deposit of 30,000 pesetas and a final deposit of 10 per cent. of the value of the contract will be required. Tenders by Sept. 30, which are to be addressed to the above authorities, from whom further information may be obtained.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of land-owners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

London, N.—The Light Railways Committee of the Middlesex County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction bridge work, etc.), of the following light railways—viz.: (Contract No. 1) railway No. 1—a line of double track (with cross-overs, contingent works, etc.) to be laid along Lordship-lane and Bruce-grove, in the districts of Wood Green and Tottenham, in the county of Middlesex, having a length of 1 mile 7 furlongs 6·8 chains or thereabouts; (No. 3) railway No 3—a line of double track (with cross-overs, contingent works, etc.) to be laid along the Archway and Great North roads, from Highgate Archway to Whetstone, in the districts of Hornsey and

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Finchley, in the county of Middlesex, having a length of 4 miles 6 furlongs 1·5 chains or thereabouts; (No. 5) railway No. 5—a line of double track (with cross-overs, contingent works, etc.) to be laid along the Edgware-road, from Cricklewood to Edgware, Hendon, Kingsbury, and Hendon Rural, in the county of Middlesex, having a length of 4 miles 6 furlongs 8 chains or thereabouts. Specification, etc., for each contract may be seen and schedule of quantities obtained on application at the office of Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster, S.W Tenders by Oct. 7.

RESULTS OF TENDERS.

Gateshead.—The tender of Belliss and Morcom has been accepted for one 730-h.p. engine for coupling to a Siemens and Halske dynamo.

Pemberton.—The Council have accepted the tender of Belliss and Morcom for supply of two 540-h.p. engines for coupling to Dick-Kerr dynamos.

Langho Inebriates' Home.—The tender of Belliss and Morcom has been accepted for two 40-h.p. engines for coupling to Laurence-Scott dynamos.

South Africa.—The Municipality of Johannesburg have placed an order with Willans and Robinson, Rugby, for one of their 240-h.p. compound engines.

Southend-on-Sea.—The Corporation have decided to instal a Willans engine of 250 h.p., direct coupled to a Bruce eebles dynamo, for supplying power to their electric tramways.

Wolverhampton.—Woods and Co., Blackburn, have obtained the contract for the electric lighting of the workhouse. The Electric Construction Company will supply the dynamos and Belliss engines.

Swindon.—The Town Council have accepted the tender of the Tudor Accumulator Company for the supply and delivery of a battery of accumulators at £1,102, and at £66 for the maintenance of the same for a period of seven years.

Kingseat Asylum.—The Aberdeen Electrical Engineering Company, Limited, have secured the contract for complete electric lighting plant at Kingseat Asylum, including engines, dynamos, switchboard, main cables, and the wiring of 24 buildings for electric light, telephones, and tell-tales.

West Ham.—The Council have accepted the following tenders: (Section A) steam, exhaust, feed-water, and drain piping, water softener, steam traps and separators, Babcock and Wilcox, Oriel House, Farringdon-street, E.C., £11,133. 16s.; (B) circulating and air pumps, discharge piping, water purifier, and vapour pipes for the electricity works, Sir Hiram Maxim Electrical Engineering Company, 65, Gracechurch-street, E.C., £4,784.

Ipswich.—The Town Council have accepted the following tenders in connection with the plant and buildings required for the electric lighting and tramways: Allgemeine Electricitäts-Gesellschaft. Berlin, own dynamos and Reavell and Co.'s engines, £6,564. 5s.; Tudor Accumulator Company, London, storage battery £1,256, maintenance of same for five years at £83 per annum; Ransomes and Rapier, Ipswich, travelling crane, £350; Johnson and Phillips, Old Charlton, Kent, mains and feeders, £12,901; Dick, Kerr, and Co., permanent way, £41,220; S. A. Kenney, Ipswich, generating station and offices, £26,948; Shillitoe, Bury, chimney shaft, £3,700; S. A. Kenney, Ipswich, car-shed, £6,704; J. Shillitoe and Son, Bury St. Edmunds, destructor buildings, £5,500. Tenders for arc lamps are still under consideration.

Brake Engines.—We are informed that Browett, Lindley, and Co. have in hand the following orders: Two 450 brake engines for Weston-super-Mare to the order of the Electrical Power Distribution Company; one 40-kw. combined set to the order of the Patricroft Workhouse; two 300-h.p. engines for the London, Brighton, and South Coast Railway to the order of Dick, Kerr, and Co.; three 750 brake engines for the Birmingham and Midland Tramways to the order of the Electrical Power Distribution Company; one 500 brake engine for the Bradford Colliery to the order of J. H. Holmes and Co.; two 60 brake engines to the order of Crompton and Co. for abroad; two 90 brake engines for a large mill in Belfast to the order of Mr. Ferguson, consulting engineer; two 80 brake and one 45 brake engines to be coupled to Mavor and Coulson dynamos for Kingseat Asylum.

BUSINESS NOTES.

TRACTION.

Weston-super-Mare.—The Council have decided against the use of trailers on the electric tramways.

East London (S.A.).—The Municipality propose shortly to place orders for additional electric tramcars.

Reddish.—The Stockport Town Council have refused to accede to the request of the workmen at Reddish to issue weekly tickets on the tramcars

Birkdale.—The residents of the township in the west end are agitating for the extension of the tramways from Weld-road to Grosvenor-road.

Hove.—At a special meeting of the Town Council on Monday it was decided to delete the proposed line in Waterloo-street from the tramway scheme.

Ashton-under-Lyne.—The Electricity Committee have fixed the charge for current to the Corporation tramways for running the new cars at 1½d. per unit.

Glasgow.—Owing to the competition of the municipal tramways, the service of small passenger steamers known as the Cluthas is to be withdrawn from the River Clyde.

Withington.—The Board of Trade have approved the system of electric traction proposed to be adopted under the provisions of the Withington Tramways Act, 1899.

Lowestoft.—Several members of the Lowestoft Corporation have this week visited Wolverhampton and inspected the Lorain system of electric traction in operation there.

Bath.—The electric tramways company here are negotiating with the Town Council with a view to obtaining current for the tramways from the Corporation generating station.

Folkestone.—It is proposed to appoint a small deputation to visit such places as Paris, Brussels, and Wolverhampton to inspect the different tramway systems in operation there.

Mottram-in-Longdendale.—The Stalybridge, Hyde, etc., Tramways Board have resolved not to proceed for the present with the proposed electric tramway and lighting scheme for this place.

Norton.—Considerable dissatisfaction is felt here at the delay in extending the tramway service to Woodseats, the powers for which are held by the Sheffield Corporation under their Act of 1900.

Nelson.—It has been decided to proceed at once with the work of constructing the light railways to the borough boundaries at Barrowford and Colne, entailing an estimated outlay of about £18,000.

Devonport.—A sub-committee of the Tramways Committee has been appointed to consider the propriety of still further extending the tramways and the promoting of a Bill or provisional order for that purpose.

Upholland.—The District Council are welcoming the proposal of the Wigan Corporation to apply in the next session of Parliament for powers to construct tramways from the terminus at Leatherhead Green to Upholland.

Nottingham.—The first trial run over the new Lenton-boulevard section of the electric tramways was made last week, when a car traversed the whole route for the purpose of testing the metals and overhead wires.

Eccles.—The Salford Corporation are making efforts to complete the laying of the tramway along Eccles Old-road, Church-street, and Liverpool-road to Peel Green, in order that the cars may begin running early in October

Ramsbottom.—Mr. Chattwood, electrical engineer, of Bolton, has been retained by the District Council to formulate a scheme for a line of tramways in the district from Holcombe Brook to Edenfield, through the centre of Ramsbottom.

Presentation.—Mr. Stirton, electrical engineer, has been presented by the employés of the Greenock and Port Glasgow Tramways Company with a travelling trunk and handbag, on his securing a similar situation with the Middleton Tramways Company.

Pontypridd.—The Council propose to promote a Bill in the next session of Parliament for powers to construct a tramway forming a junction with the existing horse tramway to Porth, and to engage Sir Douglas Fox to report upon the matter.

Mornington (N.Z.).—We understand that the Mornington Tramway Company have agreed to sell their property to the Borough Council upon a valuation basis, said valuation to exclude any goodwill in respect of traffic from Mornington borough.

Knaresborough.—The Harrogate Corporation having decided upon the introduction of electric tramways in their town, the Town Council of Knaresborough are taking steps to secure the advantages of a connecting tramway between the two places.

Teddington.—Negotiations between the District Council and the London United Tramways Company are still proceeding. It is hoped that an agreement with reference to the introduction of electric tramways in the district will soon be come to.

Turkey.—A telegram from Constantinople states that the Sultan has promulgated an irade authorising the admission into Turkey of electric engines for the eastern railway, but up to the present no irade has been issued regarding electrical machinery.

Southend.—The first fatality on the electric tramway system occurred on Wednesday. A boy named Alfred Bantock, 4½ years old, was crossing South Church-road when he was knocked down and run over by a car. The wheels passed over his legs.

Halifax.—At their meeting on Monday the Town Council agreed to the recommendation of the committee to proceed with the construction of the tramway from Stump Cross to Hipperholme at an estimated cost of £6,498 and the extension from Salterhebble to West Vale.

Bolton.—The borough engineer, electrical engineer, and traffic manager have been instructed to report fully upon the subject of running cars by Trinity-street. The engineer has also been requested to arrange for lifeguards being fixed to all the cars as early as possible.

Lancashire and Yorkshire Railway.—A correspondent states that the Lancashire and Yorkshire Railway Company have been conducting electrical experiments in the neighbourhood of their engineering works at Horwich with a view to adopting electricity on portions of their system.

Harrow.—The Light Railway Commissioners will on Oct. 22 open a second enquiry at Harrow into the proposal of the Middlesex County Council to construct a light railway through the parishes of Wembley, Harrow Weald, Harrow, Northolt, Wealdstone, Edgware, Little Stanmore, and Great Stanmore.

Sowerby Bridge.—The Halifax tramway extension from King Cross to Sowerby Bridge, *viâ* Pye Nest-road, is now completed, and traffic will be commenced as soon as the official sanction is obtained. Major Druitt, inspector to the Board of Trade, has already made his official inspection of the line.

Sheffield.—The Tramways Committee are experimenting with a view to securing for their cars a lifeguard which will act satisfactorily

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under all conditions. A new apparatus made by a local firm was tried last week. It is said not to have been a complete success, but it will be tested again at a later date.

Prestwich.—The Salford Corporation have submitted to the District Council the terms on which they would be prepared to supply electricity in bulk for the working of the tramways in the district. The Board of Trade have approved the proposed method of construction of the tramways in Bury New-road.

Birmingham.—A stiff fight has commenced in Birmingham over the tramway municipalisation question. The Council are seeking to carry this through by a Bill intended to be promoted next session, but a large number of interests and trading associations are combining with the object of securing its defeat.

Davyhulme.—The Parochial Committee have decided to give the scheme for a tramway from Patricroft Bridge to Gatley, where it is proposed to join up with the Cheadle and Stockport lines, their general support pending a definite agreement with the Manchester Southern Tramways Company, the promoters of the project.

Whitehaven.—The scheme for a system of electric tramways in this district does not appear to be moving in the right direction. Some time ago it was understood there was a probability of an early start being made to carry out the undertaking, but nothing has been heard lately that the scheme is making any progress.

Bromley (Kent).—The British Electric Traction Company have in view a comprehensive system of electric tramways connecting Bromley with Penge and the existing Croydon system and so on, *viâ* the London County Council's lines to London. The proposed system would also serve a large district to the south and east of Bromley.

Manchester-Salford Dispute.—The negotiations between representatives of the Corporations of Manchester and Salford with respect to the dispute which has arisen in regard to the through running of the tramways have been resumed. It is hoped that the matter may be amicably settled without reference to the Board of Trade.

Perth.—In consequence of there being some uncertainty as to the voting on the resolution declared to be carried at the meeting of the Town Council on Sept. 1 in favour of the compulsory purchase of the tramways company's undertaking, it has been decided to call a special meeting of the Council to consider the matter *de novo*.

Handsworth.—A difficulty is stated to have arisen between the authorities at West Bromwich and Handsworth in connection with the relaying of the tramlines in Holyhead-road for electric traction, and unless an agreement is arrived at it will be impossible to have a through electric route between New Inns and West Bromwich.

Electric Trams v. Railways.—It is announced that the Glasgow and South-Western Railway Company have withdrawn their suburban service to Govan and Springburn, with the exception of workmen's trains. This course has become necessary owing to the competition, at cheaper rates, by the electric trams of the Glasgow Corporation.

Ramsgate.—The Corporation have decided to approach the Board of Trade with a view to obtaining their assistance in compelling the light railway company to carry out the original plan of line No. 1 by the widening of Ellington Park-road and the construction of a terminal station at the main entrance gates of the South-Eastern Railway Station.

Dover Monorail Scheme.—The Town Councils of Rochester and Chatham and the District Council of Gillingham have decided to give a general support to the Southern Counties Monorail Syndicate, who propose to promote a Bill in Parliament applying for powers to construct a monorail from London to Dover, provided that a station be placed in that district.

Cheadle.—The Tramways Committee have decided that the whole scheme of tramways to Gatley shall be proceeded with, and that a formal agreement embodying the terms of the agreement be drawn up between the Council and the Stockport Corporation. It is also decided to write to the Corporation to the effect that the Council will elect to supply its own electric power.

Croydon.—There have been several cases of wilful obstruction of the electric cars during the past week by drivers of horse-drawn vehicles refusing to get off the track when required. We are pleased to see that the local Bench is doing its best to put a stop to this sort of thing. In one case the offender was fined 10s. and 7s. 6d. costs, and another 40s. and 10s. 6d. costs.

Aberdeen.—An increase of £328 in the receipts from the Corporation tramways last week is noted over the receipts for the corresponding week the previous year. The total receipts for the 14 weeks of the financial year are £16,372, against £12,349 last year, showing an increase of £4,023; while as the expenditure for the 14 weeks is £680 less than for the corresponding period, the total advantage is £4,704.

Tramway Profits.—The following interesting little decision of the Tramways Committee shows how the wind is blowing at Sheffield: "That this committee is prepared, out of its accumulated surplus, to provide such a sum as is necessary to defray the expenses to be incurred in connection with the conferring of the freedom of the city on the Right Honourable Viscount Kitchener, such expenses, in the opinion of this committee, being incurred for the public good."

Walsall.—The Tramways Committee visited Manchester on Wednesday and inspected the tramway system there. A difficulty having arisen in reference to the quality of the steel rails as provided in the specification of the borough surveyor, the committee have assented to a slight modification on expert advice, and the Leeds Steel Company have commenced to roll the rails. The contractor hopes to be in a position shortly to commence operations for laying the tramways.

Bradford.—A meeting of the tramway employés of the Corporation have passed a resolution complaining of the arbitrary attitude of the Tramways Committee, and deciding that if a more satisfactory answer be not given the men will before Oct. 2 ballot as to whether they are prepared to tender their notices. Their chief requests are for a guaranteed week of 60 hours worked in six days, and that the present system of checking by waybills be abolished, or a more equitable system substituted.

Southampton.—In the course of a discussion on the tramways at the last meeting of the Town Council, the Mayor observed that the Bitterne Park section, which had recently been opened, had been laid under the supervision of the Corporation's own officers, and was the best length of line they had. The first car ran over the new section without the slightest hitch, and the section had been remarkably successful since. He congratulated the surveyor on the manner in which he had conducted the work.

Aston.—We understand that the points that will be discussed at the forthcoming conference of the local authorities outside Birmingham, of whom the Aston Council are the moving spirits, come under the following three heads: (1) whether it would be wiser for each authority to work its own district; or (2) whether it would be to the advantage of all concerned that Birmingham should municipalise the whole system; or (3) whether it would be better to hand over the entire concern to the British Electric Traction Company.

Airdrie.—It is reported that the application of the Airdrie and Coatbridge Tramways Company for an extension of time to lay the first portion of the line in Coatbridge has been refused by the Board of Trade, but that they have been allowed an extension of time for beginning the work. The Corporations of both burghs had lodged objections to the application. As matters now stand, the tramways will have to be completed by Aug. 9 next, although the company have six months in which to make a start with the work.

Yarmouth.—The general manager of the tramways reports that the total number of passengers carried by the electric trams since they started is 712,887, and the receipts amount to £3,692, and the mileage to 59,850. The total receipts per car mile work out at 14·8d., the average fare per passenger 1·2d, and the average number of passengers carried per mile 11·9. For the last three weeks the passengers have numbered 20,780, 19,183, and 17,460, and the receipts £443. 1s. 7d., £417. 9s. 9d., and £379. 3s. 8d. respectively.

Swansea.—It has already been stated in these columns that the Corporation have decided to adopt the Kingsland system of electric traction on the proposed extensions of the tramways. We now learn that the Kingsland Company have agreed to give a guarantee with regard to the maximum cost of the installation and the satisfactory running of their system for six to twelve months, and they also agree, if at the end of that period it is found to work unsatisfactorily, to substitute the overhead trolley system without additional cost.

Additional Traffic Returns.—Anglo-Argentine, £210 increase; Barcelona Ensanche y Gracia, £66 decrease; Barcelona, £345 increase; Brisbane, £419 increase (month of August, £11,442, increase £2,942); Buenos Ayres and Belgrano Electric, £363 increase; Calcutta, £246 increase; Cape Town (month of August), receipts £15,450, expenditure £7,801; Isle of Thanet Electric, £281 increase; Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £225 increase; Port Elizabeth (month of August), receipts £4,014, expenditure £1,979.

Bexleyheath.—The construction of the electric tramways at this place by the Urban District Council is well on the way to commencement. The foundations of the generating station at Old Bexley are already dug out, and the members of the Council are showing a spirit to hasten the matter towards completion. It is anticipated that the Council will be in a position to open the lines by March 31, 1903. Mr. A. E. Barber, of East Ham, has been appointed clerk of works to the Council at a salary of £250 per annum, conditionally on his part that he is appointed manager of the electric tramways when the appointment of clerk of works ceases.

Huddersfield.—Halfpenny fares on the tramcars have been in the minds of members of the Town Council for some time, and at the meeting of the Council on Wednesday the proposal was made that half-mile stages be mapped out, and a fare of ½d per half-mile be established, and 1d for a mile and a half. In view of the criticisms on the borough engineer's report in reference to the recent tramway accident, the General Purposes Committee are considering the desirability of appointing a special committee to enquire into the report and the general equipment of the tramways, both as to traction and laying of the track, together with the suitability of the cars. The committee would have power to engage an expert or experts for this purpose.

West London Tramway Extensions.—On Saturday morning two interesting and important extensions of the electric tramway system in the pleasant suburbs of London were completed and opened—one from Colesbridge to Twickenham town, and the other from Twickenham town to Richmond. The line is double with the exception of a small section near Richmond Bridge. There was a very plentiful supply of cars, most of which were well filled during the whole of the afternoon. Passengers from Kew Bridge to Richmond change at Twickenham; the original line proceeds towards Teddington, and a good beginning with the latter has been made. Progress, however, is now stopped by two large mains which have been discovered so near the roadway that they have to be taken up and relaid.

Paris.—The inauguration of the second section of the Metropolitan underground electric railway in Paris, which will serve the outer boulevards in the north, is to take place early next month, and trials of the new rolling-stock are now being made. As far as the first section of the railway is concerned, it is stated that the net profits during August amounted to £4,432, as compared with a loss in the corresponding month of last year, the improvement being due both to an increase in the traffic and a reduction in the working expenses. The working profits during the first eight months of 1902 have already

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reached £66,250, as against £45,778 in the equivalent period of 1901, whilst the proportion of working expenses to gross receipts has declined from 46·41 per cent. last year to 42·44 per cent. at present.

The Glasgow Accident.—The enquiry ordered by the Board of Trade into the circumstances attending the electric car collisions which took place in Renfield-street on the 6th inst. was opened on Friday by Major E. Druitt, R.E. The proceedings were conducted in private. Evidence from official sources shows that the heavy casualty list in connection with the accident would have been reduced to a minimum if the passengers had kept their places instead of jumping into the streets. All those who remained on the cars were uninjured. It is also a notable fact that scarcely a pane of glass in any of the three cars was broken, with the exception of the car which created the mischief, and which had its front staircase and panels smashed in as a consequence of the impact with the second car. It is estimated that the highest speed the first car attained when running down the hill did not exceed 10 miles an hour.

South Shields.—A report has been prepared by the Tramways Committee with respect to the suggested scheme of new tramways which it is proposed to incorporate in the Parliamentary Bill of next session. The estimated cost of the scheme is £213,630, and the estimates are based on the overhead system of traction, which has been provisionally adopted. The electrical engineer will meanwhile enquire as to other systems. The routes mentioned are seven in number, and traverse the principal thoroughfares in the town—namely, from the pier to Tyne Dock, covering the present route, King-street to Harton Village. Sunderland-road, *via* Meldon-terrace, to Green-street; Green-street, *via* Laygate-lane and Stanhope-road to Tyne Dock; Boldon-lane to Hudson-street; Green-street, along Victoria-road to Westoe, and from Laygate-lane, along Frederick-street to Tyne Dock. In connection with the scheme provision will be made for the carrying out of street work and widening in several of the thoroughfares.

Proposed Edgware-road Tramway.—The town clerk of Marylebone has received a communication from the London County Council on the subject of their proposed tramway from the Marble Arch to Cricklewood, intimating the conditions upon which the Council are prepared to apply to Parliament next session for powers to widen Edgware-road, in accordance with the plan approved by the Council's Improvement Committee The conditions are: (1) That the Councils of Marylebone, Paddington, and Hampstead respectively shall consent to the construction of the projected tramway; (2) that the Councils of Paddington and Hampstead agreed to contribute between them one-third of the net cost of the necessary street widenings in Paddington and Hampstead; (3) that one-third of the net cost of these widenings be charged to the account of the improvement, the remaining third being debited to the tramways account, which will also be charged with the cost of laying down and paving the tramway track.

Dewsbury.—Work in connection with the laying of the electric tramways is proceeding steadily, excepting at one point near the Old Auction Inn. With regard to the laying of the line here, the Corporation and the British Electric Traction Company cannot agree. At the point in question the line comes down a fairly steep decline and swings round at a sharp angle at the bottom. Should any mishap occur to a descending car there is nothing to prevent it dashing into the river, which runs parallel with Aldams-road. The Corporation decline to consent to the line being laid in the manner proposed, arguing that it would be a menace to the public safety. An interview has taken place between the Corporation and the company's engineer, at which it was proposed by the Corporation that the company should purchase some waste land adjoining the roadway and forming the corner, and run the line more in a direct line. The Town Council have now before them an alternative plan submitted by the company, and a further interview has been arranged.

Cardiff.—Negotiations between the Tramways Committee and the tramways company as to the price to be paid the latter for the old horse depôts are still proceeding. The company have now named the minimum figure which they are prepared to accept, and this is about £4,000 in excess of the last sum which the Tramways Committee were authorised to offer—namely, £21,000. The estimated receipts and expenditure in connection with the tramways for the six months ending March, 1903, is as follows: expenditure — management expenses, £3,750; operating expenses, £25,000; power station expenses, £8,000; rolling-stock, £12,500; car sheds, £1,500; electrical equipment, £1,500; permanent way, £3,000; depreciation account, £2,889—total, £78,624. 2s. 7d.; revenue—from fares, less 2½ per cent. for insurance, £67.762. 10s.; from electric lighting for energy to be supplied, £1,562. 10s.; rates raised for six months ending September. £9.299. 2s. 7d—£78.624. 2s. 7d. The Corporation are offering a £10 reward for information leading to the conviction of any person placing obstructions on the tramways. There have been several such cases of late, which have resulted in the derailment of the cars and a consequent stoppage of the system for a time.

Brighton.—In a special report which was presented at yesterday's meeting of the Town Council, the Tramways Committee stated that they have had under consideration the question of routes in respect of which it is advisable that the Council should obtain powers for the construction of tramways in the next session of Parliament. They have also had before them an intimation from the Hove Corporation that they contemplate promoting a Tramway Bill during the ensuing autumn, and a conference between the Tramways Committees of the two Corporations has been held with a view to coming to some arrangement as to intercommunication between the systems of both towns by means of mutual running powers. The Hove representatives intimated that if the Brighton Corporation were willing to grant the Hove Corporation facilities in the shape of powers of construction or running powers over the proposed line along Goldsmid-road, they thought that the Hove Corporation would be willing to grant similar facilities to the Corporation of Brighton over the portion of Dyke-road within the borough of Hove, in the event of the Corporation desiring to construct a tramway along Dyke-road between Vernon-terrace and the north-western boundary of the borough. Negotiations between the two authorities are still proceeding. The total estimated cost of the proposed extensions of the Brighton system is £37,156, and a Bill is to be promoted next session for power to carry out the scheme.

LIGHTING AND GENERAL.

Barton.—The electric lighting contract has been satisfactorily completed for the workhouse.

Sunderland.—The report of Mr. Ellis, referred to in another column, was adopted on Tuesday.

Dorking.—The Urban District Council have decided to borrow £20,000 for an electric lighting installation, with regard to which they have entered into an agreement with Edmundsons.

Stoke Newington.—The Electric Lighting and Sites Committee, in their last report on the London County Council (Electric Supply) Bill, recommend the Council to support the Bill if reintroduced.

Huddersfield.—The Town Council propose to enter into an agreement with the National Telephone Company for the laying of wires underground within the borough for a period not exceeding 25 years, subject to satisfactory terms being arranged.

East London Technical College.—A special course of lectures on electro-chemistry, dealing with the most recent developments of the subject, will be delivered by Prof. Lehfeldt, B.A., D.Sc., on Thursday evenings from 8.45 to 9.45. The course extends from Sept. 25 to March 26. See advertisement.

Newcastle.—At the last meeting of the City Lighting Committee it was reported that the Tramways Committee had decided to reduce the charge per lamp for electric lighting in the city from £18 per lamp per year to £15. 10s., as the latter sum would cover all cost and maintenance. This reduction of 50s. per lamp will mean a saving to the lighting department of about £500 per year.

Edinburgh.—The Town Council have practically completed their negotiations with the Caledonian Railway Company for the supply of electric energy for lighting and motive power for Princes-street station and hotel and for the adjoining goods yard. The contract will be a beneficial one to the municipal undertaking, as the annual consumption will be about half a million units. Hitherto the Caledonian Railway Company have had a private installation, but that will now be abandoned. From July 18 to Sept. 11 the applications for electric current from Edinburgh Corporation amounted to the equivalent of 13,777 8-c.p. lamps, of which 8,828 were for lighting, 4,035 for motors, and 914 for heating. In the corresponding period of last year the total was 13,687 8-c.p. lamps.

Accidents.—In the afternoon of Thursday last week a breakdown occurred in the mains of the Corporation electric lighting system in the Rosemount district of Aberdeen, and for some time the whole of the lighting of the city was affected. Fortunately, the tramway electric supply was not interfered with. It is reported that when the light was again turned on in the evening the pressure was for a time so strong that in a number of cases the wires fused, and gas had to be resorted to. On Saturday a similar occurrence took place at Bath. Early on Friday a fire was discovered in the shed used for the production of the electric light at the Nordrach Sanatorium for Consumptives, which has been erected on the very top of the Mendip Hills, a few miles from Cheddar. Assistance was immediately procured, and the fire was got under, but not until the whole of the plant was rendered useless. Considerable damage was done, but the fire was easily confined to the engine-shed.

Steljes' Typewriting Telegraph.—Mr. E. Liebman, the genial general manager of the Typewriting Telegraph Corporation, Limited, of Dashwood House, New Broad-street, E.C., has received instructions from the War Minister of Germany to demonstrate to the Telegraph Battalion, No. 1, at Berlin, from Oct. 6 to 12, the working of Steljes' telegraph recorders. For the purposes of proving the utility and suitability of this, an English invention, worked without the aid of batteries, for field forces and fortifications, the military authorities have ordered 12 instruments to be brought over for testing purposes. We are informed that the German Government was only made aware of this invention six weeks ago, and they have therefore lost no time to test the suitability for field army purposes of this instrument, which is inexpensive and easily portable. Although this apparatus has been in use at the General Post Office and at all the Metropolitan Police stations for a number of years, the War Office have not at present availed themselves of any opportunity of making similar tests, which we understand had been offered to them about two years ago.

Stock Exchange.—The Stock Exchange Committee have appointed Oct. 1 as a special settling day for Calcutta Tramways Company's further issue of 32,268 shares of £5 each, £2. 10s. paid, Nos. 70,001 to 102,268; and County of London and Brush Provincial Electric Lighting Company's further issue of 10,000 6 per cent. cumulative preference shares of £10 each. Nos. 60,001 to 70,000. The committee have also ordered the undermentioned securities to be quoted in the official list: British Insulated Wire Company's further issue of 30,000 ordinary shares of £5 each, fully paid, Nos. 70,001 to 100,000, and 20,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 80,000 to 100,000; Calcutta Tramways Company's further issue of 32,268 shares of £5 each, £2. 10s. paid, Nos. 70,001 to 102,268; and County of London and Brush Provincial Electric Lighting Company's further issue of 10,000 6 per cent. cumulative preference shares of £10 each, Nos. 66,001 to 70,000 Application has been made to the Stock Exchange Committee to appoint a special settling day in Colombo Electric Tramways and Lighting Company's £120,000 5 per cent. first mortgage debenture stock.

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Prestwich.—The District Council have obtained an extension of their electricity order to August, 1903.

Leatherhead.—We learn that the Leatherhead Electricity Company are now in a position to supply current.

Colwyn Bay.—The Town Council have decided to practically double the resources of the electric lighting station.

Swansea.—The price of electric light during last year worked out at an average price of about 3½d. per unit to consumers.

Llanelly.—The electric light installation is fast approaching completion, and a 15 hours' continuous running trial has been arranged for.

Hull.—The municipal telephone license granted to the city has come to hand, and no time will now be lost in making the installation.

Coatbridge.—Mr. Draycott, engineer of the Scottish House-to-House Electricity Company, is erecting some new arc lamps in Whifflet.

British Insulated Wire Co.—An interim dividend on the ordinary shares to June 30, at the rate of 8 per cent. per annum, is announced, payable now.

Darlington.—The Town Council, in General Purposes Committee, have decided to advance the salary of Mr. Lunn, their electrical engineer, by £50 a year.

Maidenhead.—We learn that applications for current have been received for some 300 or 400 lights. The light is to be switched on in the middle of November.

Rhyl.—The Urban District Council's electric light works are making good progress. There has been an increase equal to 2,029 8-c.p. lamps during the month ending Aug. 14.

Burton.—The quantity of electric light sold during August amounted to 11,847 units, showing an increase of 3,621 units in the corresponding month of last year.

Kilmarnock.—The Town Council intend to ask Prof. Kennedy to report as to the best method of supplying the burgh with electric power both for lighting and traction purposes.

Hampton.—The question of dealing with the electric lighting order, which will expire next July, has been referred to the Highways and Drainage Committee of the Urban District Council.

Change of Address.—Messrs. F. A. Glover and Co., Limited, electrical engineers and contractors, are moving from 97, Queen Victoria-street, E.C., to 10 and 12, Garrick-street, Strand, W.C.

Moss Side.—The Board of Trade have approved of an additional system for the supply of electrical energy by the Manchester Corporation for the purposes of the Moss Side Electric Lighting Order, 1897.

Richmond (Surrey).—The Town Council are asking the Postmaster-General to establish a postal telegraph station at the post office, Sheen-road, the nearest telegraph station being about a mile distant.

Oban.—The Town Council are raising a loan of £20,000 required for the electric lighting undertaking at 3⅜ per cent. interest, repayable in 30 years by equal annual instalments of principal and interest combined.

Frimley.—A special meeting has been called for Sept. 30 to consider the question of applying for powers to supply electricity. We understand that the Staff College and the Royal Military College will be represented.

Alnwick.—On Tuesday the staff of the employés recently engaged in putting in the electric light in Alnwick were entertained to dinner in the Market Hotel to mark the successful installation of the new lighting in the town.

Ramsbottom.—The District Council, after discussing the proposed installation of an electric light and tramway system in the district, have engaged Mr. Chattwood, electrical engineer, at a salary of £250, to formulate a scheme.

Brentwood.—The Urban District Council intend to apply for a provisional order to supply electric light and power in their district. The Board of Trade is to be asked to fix the maximum time for holding the powers in abeyance.

Boston.—We understand that the Town Council have applied to the Board of Trade to extend their provisional order under the Electric Lighting Acts, and that they are open to negotiate with any company that might wish to come in.

Walsall.—A canvass is being made in regard to the proposed extension of electric lighting to the Caldmore and Mellish-road districts. Sanction has been obtained to the borrowing of £1,325 in respect of the proposed economisers and fan.

Hebburn.—The electricity question is making progress. The Northern Counties Company are now wiring business and residential premises, while a committee of the District Council have the provision of an electric tram service under consideration.

Bexhill.—The Council have adopted a report of the Electric Light Committee recommending that additional buildings at the works and generating station should be designed by the engineer. The buildings are to be sufficient for three 300-kw. engines and boilers.

Personal.—We have been asked to note the following marriage: on Thursday, 11th inst., at St. Luke's Church, Southport, W. Macintosh, chief assistant electrical engineer in the Corporation electricity department, Keighley, to Miss M. G. Davies, of Southport.

Presentation.—The popular assistant engineer of the Yarmouth electric lighting station (Mr. W. Denton Parrett) was last Friday presented with a handsome marble clock by the management and staff of the electricity department as a mark of their esteem on the occasion of his approaching marriage.

Cardiff.—The National Telephone Company last week unsuccessfully renewed their application to the Council for consent to lay down underground wires in the town, and pointing out the advantage of having the proposal carried out now that the electric traction system had been inaugurated by the Corporation.

G. E. C. Football Club.—We have been asked to say that the General Electric Company's football club will be pleased to arrange dates with clubs of other electrical houses for fixtures for the coming season. Communications should be addressed to H. Bowthorpe, honorary secretary, 71, Queen Victoria-street, E.C.

King's Lynn.—The Electrical Engineer in a recent report states that since the last meeting applications had been received for 400 additional lamps of 8 c.p., or equivalent, and that a large business firm had discarded lighting by incandescent gas in favour of the electric light The electric lighting of Exton-road has been agreed to.

Teddington.—The Council have adopted a report recommending the Council sanctioning an application from the Postmaster-General to lay telephone pipes in the footways in High-street, and to adopt the surveyor's suggestion to require the Post Office authorities to reinstate the paths to the extent of 9in. on either side in addition to the trench.

Scarborough.—The Municipal Telephones Sub-Committee of the Town Council have accepted the draft license which the Postmaster-General has sent down, and an expert has been instructed to prepare details upon which tenders could be obtained and application made to the Local Government Board. Before asking for tenders, however, the matter will come before the full committee.

Spain.—The *Gaceta de Madrid* contains a Royal Order authorising the Minister of Marine to contract with the Sociedad general gallega de Electricidad, owner of the waterfall of La Fervenza, for the supply of electric energy, and for the acquisition and utilisation of electric motors with all their accessories, in substitution of some of the steam motors at present existing in the Arsenal of Ferrol.—*Board of Trade Journal.*

Dewsbury.—We learn that Mr. A. P. Dryburgh, of Swansea, is the selected candidate for the lately advertised post of chief assistant. There were 84 applicants. The Dewsbury and District Infirmary is to be lighted with electricity. Mr. Campion, the borough electrical engineer, estimates the cost at £250. Mr. S. Mitchell has promised to present a Röntgen-ray apparatus. The matter will come up for consideration next month.

Devonport.—Steps are being taken to oppose an application of the Provincial Electric Supply and Traction Company to the Board of Trade for a provisional order authorising the supply of electricity for public and private purposes in Stonehouse. It has been decided to extend the electric light mains from Albert-road to St. James's Church, Keyham. The question of lighting Stonehouse Gate Bridge has been referred back to committee.

Whitehaven.—At the last meeting of the Town Council the Deputy-Mayor, in moving the confirmation of the minutes of the Water and Lighting Committee, complimented the electrical engineer on the completion without mishap of the turnover to the higher voltage. The committee have instructed the engineer to prepare a report upon the charges for current supplied for lighting purposes with a view to a reduction being made.

Amalgamation.—The Electrical Company, Limited, of 122 and 124, Charing Cross-road, and the Allgemeine Electric Company, of 25, Victoria-street, London, have amalgamated, and the joint business will be conducted under the name of the Electrical Company, Limited. Mr. Hadley, formerly manager of the Allgemeine Electric Company, has been appointed joint general manager of the Electrical Company, and will conduct the central-station and tramway business both at home and abroad.

Ashton-under-Lyne.—At the last meeting of the Town Council it was stated that during the last month, owing to the utilisation of the destructor and new condenser, the consumption of coal had been reduced from 120 to 80 tons. The price of current supplied to the Corporation tramways has been fixed at 1½d. per unit. The question of fixing mechanical stokers to the boilers has been referred to the Works Sub-Committee for consideration and to report with the view to minimising the emission of smoke from the electricity station.

Post Office Telephone.—The work of laying the underground telephone in the City area is practically finished, Croydon and Redhill being the boundary in the south, Enfield in the north, Romford in the east, and Hounslow in the west. The original estimate of £2,000,000 will probably be doubled. In central London over 160 miles of trenches have been excavated; 600 miles of ducts and pipes laid; and in the pipes, again, cables representing some 70,000 miles of wire placed. Already over 4,000 customers have been secured in the completed areas.

Dartmouth.—We understand that in all probability the public electric lighting of the borough will be ready by the middle of October. The arc lamps will be placed in position immediately. Most of the work of laying the public lighting mains has been done, only about a quarter remaining to be completed. This comprises the southern end of the town. A number of private installations have been carried out, and great progress made with the plant and works at Sandquay. The lighting of the new hospital for the naval cadets is almost complete.

Sandgate.—The delay of the British Electric Traction Company in signing their agreement with the Folkestone Electric Supply Company was discussed at the last meeting of the Urban District Council. A letter was read which had been received from Mr. Hesketh, the Folkestone company's engineer, stating that it was impossible to supply any more consumers until a larger cable was laid

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down. The Chairman emphasised his remark that delay did not arise with the Council, and it suggested that unless the companies completed the agreement promptly, the Council's consent should be withheld.

Walton (Surrey).—The Urban District Council have allowed the Weybridge Electric Lighting Company to lay over a mile of cable to supply residents of Walton, subject to an agreement being entered into to hand over the cables to the Council (at cost price, we understand) if required (or to the company to whom the Council transferred their order), and that the company will not oppose the Council's application for an order. A committee has been appointed to deal with the question of applying for a provisional order, etc. A motion that the refuse destructor scheme be referred to the same committee has been deferred for the present.

Taunton.—The Town Council have entered into an agreement by which the Council pay the National Free Wiring Company 11 per cent. per annum on the cost of the unpurchased installations, which at present stand at £2,119 1s. 10d., in lieu of the present charge of 1d. per unit with a minimum of 1s. per annum per 8-c.p. lamp installed. This will make an annual payment to the company of £232. 2s., and will, taking the last year's supply of current to free-wired consumers, represent a payment to the company of 1·37 per unit. The amounts payable to the Company for the years 1900 and 1901 respectively were £245 18s. 2d. and £255. 15s. 4d., and the company's claim in respect of these years will be settled on the same basis.

Edmonton.—At the last meeting of the District Council the Electric Lighting Committee recommended that the Council invite three electrical engineers to submit reports and estimates of the cost of schemes for carrying out the electric lighting order of the Council: (1) for generating station and generating plant, and (2) for electric mains and distribution; and also an estimate of annual expenses and revenue. Also that the North Metropolitan Electric Power Supply Company be invited to submit their terms: (1) for supplying electric energy in bulk and (2) for supply and distribution complete for all purposes. The report was amended to the effect that others besides the North Metropolitan Company should be invited to tender, and was then adopted.

Stonehaven.—A communication was read at the last meeting of the Town Council from Messrs. Barlow and Young, electrical engineers, London, as to the terms on which they would undertake to supply Stonehaven with electric light. The terms are: (1) all electricity used in the area controlled by the Council to be taken from their service; (2) the rate per unit at which the Council would be supplied for street-lighting purposes to be 4d., and the rate at which the public would be supplied to be 6d.; (3) the complete undertaking to be carried out by the engineers, the Council giving all moral support possible; (4) the Council to have first option of purchasing the undertaking at the end of 12 years from the completion of the lighting at valuation. On the motion of the chairman, the communication was remitted to the Lighting Committee.

Southport.—The Council have resolved to rescind a former resolution, and have decided that in lieu thereof the easterly side of Lord-street, from St. George's-place to Portland-street, be illuminated by means of 3,875 lamps, and that the electrical engineer be instructed to proceed with the installation forthwith. The chairman and vice-chairman of the Electricity Committee and the electrical engineer have been empowered to control the installation and to regulate the times at which such installation or part thereof be used. The electrical engineer considers that from March 31 to Oct. 1 in each year the whole installation could be worked at 2d. per unit without interfering with the supply of the ordinary consumers. During the winter months it could be worked any evening after nine o'clock, on Christmas Day, New Year's Day, or on bank holidays at the same price.

Brighton.—The forthcoming electrical exhibition at the Brighton Aquarium promises, according to the *Sussex Daily News*, to be a great success in every way. The entire main corridor of the institution will be occupied, all the available space, covering some 5,000 square feet, having, in fact, been let. Altogether some 28 or 29 firms have taken spaces, and these represent the leading electrical firms throughout the country. The exhibition, as at present contemplated, will begin on Oct. 4 and terminate on the 18th of that month. The stalls will practically occupy the whole of the Aquarium, but will allow a fair margin for promenaders between each tent and stall. Mr. Christie, of the Brighton Corporation electricity works, is very busy in connection with the contemplated display, which will comprise the latest and most up-to-date collection of electric lighting and decorative fittings, heating, cooking, and ventilating apparatus, electric motors, domestic machinery of all descriptions, incandescent lamps, glass-blowing, meters, and electrical medical apparatus. The firms exhibiting include Messrs. Adams Bros., Brighton; British Insulated Wire Company, Prescot; Babcock and Wilcox, Renfrew and London; Bruce Peebles and Co., Edinburgh; Dowsing and Co., London; Dolter Electrical Traction Company, Limited, London; Fifeman, King's-road, Brighton; J. H. Galliers, Brighton; Hignett and Co., Brighton; J. H. Holmes and Co., Newcastle and London; Incandescent Electric Lamp Company, Limited, London; Sir Hiram Maxim Electrical and Engineering Company, Limited, London; Merryatt and Place, London; Page and Miles, Limited, Brighton; Reason Manufacturing Company, Brighton; Reed and Sons, Brighton; Simplex Conduit Company, London; Veritys, Limited, London; Wood and Co., London; Waterhouse and Co., London; and Waghorn and Co., London. Dr. Draper, chief of the Brighton Technical Institute, will exhibit scientific apparatus and models by the students of the school of which he has the charge. Our contemporary states it will be seen that the leading firms in the electrical trade throughout the country will be represented at the exhibition, which should prove a success from every point of view.

Sunderland.—A special meeting of the Town Council will shortly be held to consider a recommendation of the Electricity Committee to expend £74,000 to enable the Corporation to supply shipyards and other works on the Wear with electric power. Satisfactory negotiations are in progress with six large works in the borough, besides a large number of smaller firms. The supply has been hitherto by low-pressure direct current, but Mr. J. F. C. Snell, electrical engineer, in a report (referred to in our issue of May 30) suggested that the system in future should be by the three-phase high-tension current, generated at a pressure of 5,500 volts at a frequency of 50. The current so generated at Hylton road would be transmitted by high-tension cables to certain sub-stations, at which there would be motor-driven generators, the motors being supplied from the high-tension mains, and in turn driving low-tension generators of the same pressure as the present general supply. We understand that the Board of Trade are inclined to sanction the scheme The estimate for carrying out the scheme is follows: two 300-kw. three-phase generators, two 700-kw. three-phase steam generators, three Lancashire boilers, high-tension switchboard, and cable connections, £27,920; Monkwearmouth sub-station—two 275-kw. motor-generators, battery, switchboards, land, and buildings, £7,975; South Docks sub-station—two 250-kw. motor-generators, one 500-kw. motor-generator, and building, £6,820; Hendon sub-station—two 250-kw. motor-generators, switchboards, land, and buildings, £5,170; Pallion sub-station, two 250-kw. motor-generators, switchboards, and buildings, £4,455; high-tension transmission mains, £18,308—total, £70,648. It will be necessary sooner or later to lay additional low-tension mains, estimated at £3,000, making a grand total of £73,648. As the first requirements will be at the South Docks and Monkwearmouth, Mr. Snell states that it will only be necessary to instal the following plant: at Hylton-road station, one 700-kw. steam three-phase generator, two 300-kw. three-phase generators, one Lancashire boiler, high-tension switchboard, etc., £11,000; South Docks station, two 250-kw. motor-generators, switchboards, buildings, etc., £9,800; Monkwearmouth sub-station, two motor-generators, switchboards, etc., £9,835 – total, £30,335. The estimate for 1903-4 shows an output of 3,610,000 units. The cost is put down at £19,045, and the revenue £35,575, leaving a gross profit of £16,530, and after paying sinking fund and interest, amounting to £15,000, there is a net balance of £1,530. The North-Eastern Marine Engineering Works have already applied for power, and will require about 600,000 units per annum. The scale of charges proposed to be made applicable to consumers for motor purposes ranges from 2¾d. per unit for 500 units up to 1½d. for 100,000 units and over per quarter.

Heckmondwike.—It is now about 10 months since the Heckmondwike electricity works were opened, and during that time they have worked most successfully. The original capacity of the works was 180 kw., and enough energy was generated to supply 6,000 8 c.p. lights. When the works were opened 4,700 of these had been applied for, and at present the whole of the amount available is being used. The demand has been excellent, and although the tradesmen are still holding back somewhat, a good demand has accrued from private houses and offices. When the British Electric Traction Company obtained powers for the laying of the lines through the Spen Valley they approached the Heckmondwike Council on the subject of supplying electricity, and terms have now been arranged. Although the Council are under promise not to divulge either the amount or the price, the *Reporter* understands that the latter is quite favourable to the District Council. The extension of the works, which is now rapidly nearing completion will be available both for supplying energy for traction purposes and also for lighting. The proposed extension will provide for 200 additional kilowatts. The Council will be enabled by the new plant to supply an additional 6,000 8-c.p. lamps, while there is still room in the works for another engine and generator. The amount borrowed for the extension has been £6,500. The working of the original plant so far has been most successful, and it is confidently anticipated that the works will be run at a profit during the year commencing in December next. There are at present four firms engaged in the installation of the new machinery. Messrs. Dick, Kerr, and Co., Preston, are busy with the erection of a 260-h.p. engine to run a large generator, which is being put in by Messrs. James Howden and Co., of Glasgow. A condensing plant of 500 h.p. has been entrusted to Messrs. Worthington, of Lancaster, while the water-cooling tower is being erected by Crebbin and Co., of Bradford. It is expected that the whole of the work will be completed in a few days' time, and the Council will then be in perfect readiness to supply the traction company with energy. The switchboards have been fixed, and the wires only need coupling up to the tramways. The existing plant and the new one are to be made interchangeable, so that in case of any mishap either of them may be used for lighting or traction purposes as required. There will be no necessity for the laying of cables in connection with the supply of energy to the trams, as the Council will only have to take the energy as far as the end of Bath-road, the distance served by them being of such a length that the same voltage can be maintained throughout the entire length without feeders being introduced.

PROVISIONAL PATENTS, 1902.

SEPT. 8.

19643. Improvements in electrical switches, junction boxes, and the like. George William Johnson, 47, Lincoln's-inn-fields, London. (Voigt and Haeffner, Germany.)

19647. Improvements in electric elevator rope gear. George Mackie Bremner, 23, Coleman-street, London.

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19652. Improvements in and connected with ammeters and voltmeters. Francis Henry Nalder and Nalder Bros. and Thompson, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19655. Improvements in alternating-current meters. Albin May, 18, Southampton-buildings, Chancery-lane, London.

SEPT. 9.

19672. Improvements in electrical switches. Harry Nunns, 40, South-parade, Halifax.

19688. Improvements in the carbon-feeding and arcing mechanism of electric arc lamps. Veritys, Limited, and William Reginald Ridings, 11, Burlington-chambers, New-street, Birmingham.

19689. Improvements in the carbon-feeding mechanism of electric arc lamps. Veritys, Limited, and William Reginald Ridings, 11, Burlington-chambers, New-street, Birmingham.

19713. Improvement in the composition of electrolytes for the formation of accumulator plates. Eduard Sandhagen and Joseph Lürgen, 81, High Holborn, London. (Complete specification.)

SEPT. 10.

19827. Improvements in surface-contact electric traction systems. The Dolter Electric Traction, Limited, 46, Lincoln's-inn-fields, London. (Henri Dolter, France.)

SEPT 11.

19838. An improved trolley wire clamp of the kind commonly known as "come along" clamps. Joseph Wilkinson, Gough-chambers, Savile-street. Hull.

19839. Improvements in mechanical shunting points used in overhead trolley wire for electric tramways. Henry Brecknell, Edward May Munro, and Hugh Innes Rogers, Thrissell-street, Bristol.

19842. Improvements in electrical switches. William Allan Macfarlane, 154, St. Vincent-street, Glasgow.

19849. An improved automatic suspension and electrical contact appliance for apparatus requiring to be raised and lowered. John Stevenson, jun., 3, Durham-road, Portobello.

19854. A guard wire for preventing tramway trolley wires from falling to earth when broken. Samuel Simpson, 21, Clayton-street, Blackburn.

19866. Improved primary battery. William Clapham and Albert Clapham, 289, Kirkstall-road, Leeds.

19881. Improvements in and relating to electric tramways and railways. Harry Jackson, Avondale, Hill-avenue, Worcester.

19884. Improvements in or relating to telephone systems and apparatus therefor. Albert Smith de Vau and Charles Auth, 111, Hatton-garden, London.

19891. Improvements in electrical contrivances for communicating with passing trains. Ernest William Gover, 8, Quality-court, Chancery-lane, London. (Edward Charles Buck and Harry Eustace Alfred Thatcher, Transvaal.)

19901. Improved apparatus for converting variations in the intensity of an electric current into variations in the intensity of light. Christian Hulsmeyer, 322, High Holborn, London. (Complete specification.)

19903. Improvements in methods of insulating multiple-branched cables at the points of branching and ends. Georg Zapf, 6, Lord-street, Liverpool.

19911. Improvements in and relating to the magnetic separation of ore. William Kennedy-Laurie Dickson, 18, Southampton-buildings, Chancery-lane, London.

SEPT. 12

19933. Improvements in electric igniting means for explosive engines. Charles Augustus Wilkinson, Fife House, Kingston-on-Thames.

19938. Improvements in electrically or magnetically-operated door bells. Charles Kenyon, 62, Market-street, Manchester.

19952. Improvements in safety automatic differential speed governors for electrical tramcars and the like. David Maxwell, 41, Reform-street, Dundee.

19967. An improvement in an electro deposit of zinc. William Arthur Thoms and James Ernest Green, 8, Regent-street, London.

19985. Improvements in electricity meters. The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

19991. Improvements in and relating to alternating-current electric machines. John Mannheim, 18, Southampton-buildings, Chancery-lane, London.

19999. Improvements in secondary battery elements and in the process of producing same. Lóthar Fiedler and Gerhard Puchmüller, 77, Chancery-lane, London.

20003. Improvements in or relating to electric arc lamps. Alfred Julius Boult, 111, Hatton-garden, London. (Alfred Kunze, Germany.) (Complete specification.)

SEPT. 13.

20024. Improvements in trolley-wire holders for electric tramways and railways. Percy Redford, 70, Market-street, Manchester.

20025. An improved adjustable bracket for gas, oil, electric, candle, and other lamps or lights. Robert William Young, 30, Park-row, Leeds.

20054. Improvements in junction frogs and trolley heads for use on the overhead system of electric tramcars. David Blythe Foster, 39, Stratford-street, Leeds.

20074. Improvements in electric arc lamps. Luis Wirtz and Thomas Hamilton-Adams, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 2.

1901.

18169. Searchlights or projectors for naval and military purposes. Crompton and Co., Limited, Crompton, Hodgson, and Ewart.

18346. Recording apparatus for electrical currents. Ziegenberg.

18417. Plastic compositions applicable as electric insulating and acid-proof materials and for manufacturing various articles. Abrey.

19314. Electric coupling. Elizabeth Kinross Murphy, Administratrix of the late Walter John Murphy.

21362. Secondary batteries. Oppermann.

22223. Electric igniter for internal-combustion engines. Manguin and Martin.

22298. Electro-dynamic traction. Lake (Dulait, Rosenfeld, and Zelenay.)

22647. Electric motor control systems. British Thomson-Houston Company, Limited. (Potter.)

22658. Controlling apparatus for electrically-propelled trains. de Kando.

26487. Carbide electrodes for arc lamps and process of manufacturing same. Hopfelt.

1902.

1690. Punching registers especially adapted for use in connection with fire-alarms and police telegraph systems. Berst.

3622. Device for cleaning and polishing electrical collectors. Küppers.

5618B. Electric switches especially applicable for use in connection with wireless telegraphy. Cervera. (Baviera.) (Date claimed under Patents Rule 19, March 6. 1902.)

7150. Methods of forming coils for electrical apparatus. British Thomson-Houston Company, Limited. (Lundskog.)

7151. Electric arc lamps and induction coils. British Thomson-Houston Company, Limited. (Fish.)

8389. Electric clock winding mechanism. Tuerk.

11075. Electric switches. British Thomson-Houston Company, Limited. (Hewlett.)

11078. Electric arc lamps. British Thomson-Houston Company, Limited. (Fish.)

14538. Apparatus for measuring phase differences on electric alternating-current circuits. Grammont. (Date applied for under International Convention, Dec. 20, 1901.)

14547. Electrical measuring instruments. Weston.

14781. Process and apparatus for subjecting gases to high-tension electrical discharges. Mills. (Atmospheric Products Company.)

15784. Thermo-electric couples and generators. Thwing.

16117. Attaching pole-pieces or shoes to the castings of dynamo-electric machines or electric motors. Ransford. (Deutsche Elektrizitäts Werke zu Aachen—Garbe, Lahmeyer, und Co.—Aktiengesellschaft.)

16319. Device for adjusting the length of and taking up the slack in electric lamp cords and the like. Marks. (Crescent Novelty Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-⅜
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7¼-7⅜
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	103-105
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16¼
—— 5 per cent. Pref.	5 ..	5¼-6¼
Crompton and Co.	3 ..	2¼-3
—— 5 per cent. Debentures	100 ..	101-106 p.

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Name.	Amount paid.	Last price.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1½-2½
—— 5 per cent. Debentures	100 ..	78-83
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent Perp. 1st Mort. Deb.	100 ..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10⅛
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	100-103
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5½-5⅝
—— 4½ per cent. Debentures	100 ..	109-113
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20½-21½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15½
Telegraph Construction and Maintenance	12 ..	38-41
—— 5 per cent. Bonds	100 ..	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3½-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9 9½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	12½-13½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12½-12⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	125-128
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5½
—— 5 per cent. Deb. Stock, Red.	100 ..	104-107
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	4¾-5⅛
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-4⅜ xd
Kidderminster and District Lighting and Traction, Pref.	5 ..	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	11½-12
—— " " " "	5 ..	8¾-9⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	108-110
—— " " " Prov. Crts.	50 ..	82-84
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅞
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8½-9½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	14s. ..	¾
—— £50,000 " "	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	70 p.c. ..	70 p.c

Telephones.—

National Telephone, Preferred	100 ..	93-95
—— Deferred Stock	100 ..	55-57
—— 6 per cent. Cum. First Pref.	10 ..	12-13
—— 6 per cent. Cum. Second Pref.	10 ..	11-12
—— 5 per cent. Non. Cum. Third Pref	5 ..	4⅞ 5⅛
—— 3½ per cent. Deb. Stock, Red.	100 ..	96 98
—— 4 per cent. Deb. Stock, Red.	100	102-106
Oriental Telephone and Electric Company	1	⅛-1

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	½-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	103-106
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	10½-10⅝
—— 7 per cent. Preference	5 ..	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7-8
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— " " £10 Ord.	6 ..	10⅝
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-108
Charing Cross and Strand	5 ..	9-9½
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅝-5⅛
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5½-5⅝
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12½-13½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	8½-9½
—— 6 per cent. Cum. Pref.	10 ..	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6½-6⅝
—— 6 per cent. Cum. Pref.	5 ..	6-6½
—— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5⅜-6½
—— 4½ per cent. First Deb Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10½-11½
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛
London Electric, Ordinary	3 ..	1½-2½
—— 6 per cent. Pref.	5 ..	4⅜-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	96-99
Metropolitan, Ordinary	10 ..	15-16
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	110-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6½-6¾
Notting Hill Electric Lighting	10 ..	13½-14½
Oriental, 1879	1 ..	—
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6½-6⅝
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	97-100
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2⅛
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2⅛-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8¼-8½
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	6 6½

Electric Railways.—

Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	105-108
—— " " deferred	100 ..	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	72-74
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	128-131
—— " " " '96	100 ..	126-129
—— " " " '01	100 ..	121-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	80-85

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week ending	1902.	1901.	Increase or decrease. Week	Current year.	Miles of single track open. 1901.	1900.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sept. 13	1,087	821	+ 266	+ 4,259	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	" 13	5,089	4,812	+ 277	+12,846	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	22½	—	—	—	—	1,140,000	—	—	—	—
Blackburn Corporation	" 12	903	808	+ 95	+ 3,742	24	—	—	26,064	—	738,557	—	11·86	—	—
Blackpool Corporation	" 11	2,183	1,950	+ 233	— 305	16½	—	Mar. 31	41,818	5,809,190	753,563	—	—	—	—
Blackpool-Fleetwood Tramways	" 13	1,495	1,234	+ 261	— 672	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 7	1,731	1,464	+ 267	+ 4,759	32	—		77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	" 7	3,692	1,191	+2,501	+67,794	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57ᵃ
Bristol Tramways Company	" 12	5,180	4,011	+1,169	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	" 15	201	191	+ 10	+ 435	—	—	" 31	8,675	2,010,873	323,044ʰ	1·03	6·46	—	4·65
Central London Railway	" 13	6,137	5,658	+ 479	+ 5,795ʰ	12	12	" 31	335,086	41,188,383	1,243,730ᵃ	1·88	64·29ᵃ	27,923	34·89ᵃ
City and South London Railway	" 14	3,029	1,836	+1,193	+10,134	12½	9½	" 31	62,601ᵃ	7,008,842ᵃ	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	" 11	907	524	+ 383	+ 3,743	15	13·69		—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	" 13	285	276	+ 10	+ 136	4½	—	" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 7	147	131	+ 16	— 52ʰ	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	" 12	3,956	3,791	+ 172	— 50	46	46	" 31	246,255	45,813,734	6,670,000	1·29	8·89	—	5·71
Dublin S. District, Electric	" 12	1,016	968	+ 48											
Dundee City Tramways	" 10	823	693	+ 130	- 138	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	" 13	13,709	13,706	— 6	—	101	95	" 31	582,146ᵉ	155,213,378	11,935,039	0·90	11·71	5,597	7·51
Halifax Corporation	" 10	1,439	1,201	+ 229	+ 2,047	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	" 13	1,175	953	+ 222	—	—	—	" 31	49,011	7,624,865	1,001,033	1·54	11·7	—	13·90
Hull Corporation, E. S.	" 13	1,780	1,637	+ 142	+ 1,852	19	9½	" 31	72,331	17,264,013	1,647,026	1·00	10·54	—	4·72
Liverpool Corporation	" 6	10,673	9,331	+ 342	+28,210	93	78	Dec. 31	87,707	21,065,999	2,218,695	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	" 14	1,522	1,607	— 85	— 1,148	15½	15½	June 30	69,152	8,426,976	787,010ᵃ	—	21·07ᵃ	—	15·91ᵃ
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	" 13	2,062	1,072	+ 790	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	" 14	4,123	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82ᶠ
Southampton Corporation	" 11	1,199	959	+ 240	—	11	—	" 31	28,973	4,761,149	696,159	1·45	9·96	2,630	—
Sunderland Corporation	" 7	1,321	1,193	+ 128	—	19	17	" 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. ᵃ Train mile.
ʰ Half-year's figures. ᶜ Include rail and tram. ᵈ Total receipts. ᵉ Electric traction only. ᶠ Including one section of horse traction.

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NOTES.

The Finsen Light.—The Finsen light treatment for lupus has recently been introduced into the Manchester Skin Hospital, which is adding several new buildings to its already extensive dimensions. The new treatment is said to have proved most successful, the average number of patients subjected to it daily being estimated at 115.

Books Received.—We have received from Messrs. Crosby Lockwood and Son "Electro-Plating and Electro-Refining of Metals," being a new edition of Alexander Watt's "Electro-Deposition," revised and largely rewritten by Arnold Philip. The price of the book is 12s. 6d. From the same publishers we have to acknowledge a new work by Tyson Sewell, entitled "The Elements of Electrical Engineering." It is intended as a first year's course for students, and is priced at 7s. 6d.

Electrical Boat Steering.—Successful results are said to have been obtained by a Mr. Storey, of Lancaster, on Lake Windermere with a boat steered from the shore by an adaptation of wireless telegraphy. The experiments were conducted in private, and no particulars are to hand as to how Mr. Storey accomplished his reported achievement. It is stated, however, that he was able to steer the boat from the shore, directing it in safety in and out a fleet of sloops and steam launches at their moorings.

A New Telegraph Instrument.—A new telegraph instrument, the invention of Mr. Donald Murray, has been on trial between Edinburgh and the London Central Telegraph Office for the past few weeks, and is reported to have given satisfactory results. We are not in possession of the technical details of Mr. Murray's invention, but it is claimed that with it messages can be transmitted at the rate of 150 words a minute, which by the ordinary duplex system may be increased to 300 a minute. The instrument is said to be in practical working in New York, while the German Government are at present experimenting with it.

Municipal Electrical Association.—The executive council of the Incorporated Municipal Electrical Association recently held a meeting at Hull, which was attended, among others, by Mr. J. H. Rider, the president of the association. A visit was made to Earle's shipbuilding works, where the party inspected the electrical driving plant, which is supplied with current from the municipal generating station. The council were afterwards entertained to dinner by Mr. A. S. Barnard, the city electrical engineer of Hull. During the afternoon visits were made to the Sculcoates-lane generating station, the tramway power station, and to the Albion-street sub station.

Guttapercha Supply.—It is reported that the guttapercha tree has been discovered in abundance in German New Guinea, giving an excellent quality of gutta equivalent to "gutta merah" and other finer sorts. Samples sent to Germany are now undergoing a detailed technical examination. It is, however, certain that German New Guinea will in the future prove a valuable source of supply of guttapercha, which will be welcome news to the cable industry, inasmuch as the supply from other countries is declining for the better sorts. The discoverer of the plant in New Guinea is Mr. Oldemeyer, who thus secures a prize of £150, offered by a Bremen merchant to the explorer who should find in a German colony a wild-growing gutta plant giving a good latex.

New French Cables.—We understand that, in order to place Paris in direct telegraphic communication with the French colonial possessions, the Government have decided to lay quite a number of exclusively national cables. The first to be taken in hand will reach from Brest to Dakar, from Tamatave to Réunion and from the latter place to St. Morice, and from Saigon to Pontianak, in Borneo, respectively. Already the Government have laid submarine telegraphic lines between Tourane and Amoy, in the Far East, and between Oran and Tangier, while the Dakar-Konokry, the Grand Bassam-Kotonu, and Kotonou-Libreville lines have now become the property of the State. All the new cables have to be laid and ready for operation within 12 months.

Marconi Telegraph Rates.—An agreement has, we understand, been arrived at between the Marconi Company of America and the Postal Telegraph Cable Company, under which the former company undertakes to transmit postal messages through the medium of its station at Sagaponach to any vessel fitted with the Marconi apparatus. The rates for this service, it must be confessed, are at present rather high A message of 10 words, exclusive of address and signature, costs the sender 8s., in addition to the regular rate to the Marconi station at Sagaponach. The passenger vessels regularly entering New York at present equipped with the Marconi apparatus are the Lucania, Campania, Etruria, Umbria, Philadelphia, Minneapolis, Minnetorka, Kaiser Wilhelm der Grosse, Kronprinz Wilhelm, and La Savoie.

Electricity in Agriculture.—At a recent conference of German electrical engineers, Dr. Haas, of Hanover, referred in the course of a paper to the electric power supplied for agricultural purposes in that neighbourhood. The greatest demand for current is for the operation of threshing machinery, for hay presses, straw-cutters, etc. Of the total horse-power installed 77 per cent. represents purely agricultural operations and 8 per cent. factories. On an average, the annual revenue per horse-power installed amounts to 27s., at a price of 2s. 3d. per kilowatt-hour, as compared with from 68s. to 146s. in towns, and the average period of use does not reach 150 hours, as against 500 hours in towns. The author concludes from the experience in the Hanover district that satisfactory results are possible in agricultural operations only where cables already exist for the transmission of power or for electric tramways.

Letter-Stamping by Electricity.—From time to time we have noted in these columns the progress which is being made at the General Post Office, St. Martin's-le-Grand, in the use of electric letter-stamping machines. The method cannot as yet be said to have been generally adopted by the Post Office, the previous operations being more or less in the nature of experiments with different types of machines. The one which has now been found to work most satisfactorily after some months' use is known as the Columbia electric motor type, and it is stated that the authorities have given an order for a number of these machines for use at St. Martin's-le-Grand. The rate of operation with the Columbia machine has been found to be about 500 letters a minute, whereas with the earlier types the average was more like 100 a minute. Each machine requires only one man to operate it, whose sole duty consists in placing the letters in position.

Timekeeping on Tramways.—With any large system of tramways the suburban cars have to run over the same rails in the middle of the town, and any want of strict schedule running is apt to make a block of traffic on these much-used sections of the system. The block so caused sets up further delays in the schedule, which are exceedingly difficult to make up. It hence becomes of importance that the traffic manager should get to know which of the cars are responsible for the delay. At Cardiff a new system of allocating the blame has been adopted, and consists of using time recorders at the ends of the

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routes, on which every conductor registers his time at the beginning or end of each journey. The recorders are of the type which are used in works for keeping men's time, and the clocks on the same will be of considerable service to the general public. As long as these clocks are kept in order, the system should be of great value in keeping the trams running up to time.

Civil and Mechanical Engineers.—The Civil and Mechanical Engineers' Society, of Victoria-street, Westminster, has issued its programme for next session. Owing to the unavoidable absence of the president, Mr. A. Hanssen, A.M.I.C.E., who is in Russia, the presidential address will be delivered at the meeting to be held on Nov. 6 at Caxton Hall, instead of on Oct. 2 as previously arranged. In the emergency, Mr. E. Howard has promised to read a paper on "Some Engineering Features of the Garden City Scheme" at the opening meeting on the latter date. The remainder of the programme for the session is as follows: Dec. 4, "Some Notes on Tunnelling," by Mr. A. W. Manton, B.Sc.; Jan. 1, "Indicating High-Speed Engines," by Mr. A. Marshall-Arter; Feb. 5, "A Description of a Few of the Most Recent Water-Turbine Plants in Great Britain and Abroad," by Mr. Alphonse Steiger; March 5, "The Production of Power by Means of Gas Producers and Engines," by Mr. R. W. A. Brewer; April 2, "Recent Experiments with Centrifugal Fans," by Mr. W. Gilbert, Wh.Sc.; and May 7, "On the Choice of Steam-Boilers," by Mr. C. E. Stromeyer.

Palace of Electricity at St. Louis.—One of the leading features of the World's Fair at St. Louis in 1904 will be the palace of electricity, which is located on the central avenue of the exhibition grounds. The building is simple and well treated, and for it a scheme of indirect illumination is being worked out, which will accentuate at night its beauty as seen by day. It is not so much the idea to fill the building with machinery and appliances on exhibition, as to bring together within it such typical processes in the manufacture of electric machines and appliances as will represent in the highest sense a picture of the active life and vigour which the electrical industry now presents to the world. It is hoped that the engineers of world-renowned factories and operating companies will lend their energies to the perfection of a scheme whereby they can show to the visitors of the exposition at least one important process which has become characteristic of the electrical work over which they preside. The space in the building will be free to exhibitors, and they will be granted free power for the operation of working exhibits. The heartiest co-operation will be extended to all exhibitors by the management.

Wireless Telegraphy.—The King of Italy has conferred upon Mr. Marconi the Grand Cross of the Order of the Crown of Italy in recognition of his distinguished services to science. The inventor of the system of wireless telegraphy which bears his name has been in Italy for some time experimenting with a view to establishing a wireless service between that country and England, and has been so far successful as to exchange messages between his Cornwall station and the Italian warship "The Carlo Alberto," then lying in Spezia Harbour. It is now announced that the Italian Government have agreed to place at the disposal of Mr. Marconi a sum of £28,000 for the erection of a wireless telegraph station at Rome. With regard to the steps which are being taken upon the initiative of Germany with a view to holding in October next an international conference of the Powers interested in the subject, for the purpose of establishing the general principles upon which an international agreement can be based, we believe that the view generally held is that the use of wireless telegraphy should be made subject to rules similar to those laid down in the International Telegraph Convention.

Photo-Engraving and Lithography.—The prospectus of the London County Council School of Photo-Engraving and Lithography is issued for the new session commencing next Monday. The Technical Education Board are, we think, to be congratulated on the effort they are making to exclude from the school any student who is not actually engaged in the trade. Thus the school is open to those who are genuinely engaged in business in any branch of the photo-mechanical, photographic, designing, illustrative, lithographic, engraving, and printing crafts, no provision whatever being made for amateurs. In this way instruction will be given where it is most wanted, and the school will not become overcrowded with students who merely take the work up as a hobby. The fee admitting a student to the classes is 3s. a term of three months inclusive for those in receipt of not more than 30s. a week. For those earning more than this sum the fee is 7s. 6d. a term, or 15s. a session of three terms.

The Protection of Transformers.—At the recent meeting of the National Electric Light Convention in the United States the question of the protection of transformers used to supply in parallel on to various points of a large network was discussed. The various speakers advocated fusing, not only of the transformers, but also those parts in the network, which were situated equally between two transforming sub-stations. As is well known, this placing of fuses in boxes on low-tension networks does not find favour with the bulk of central-station engineers in the United Kingdom. Mr. Leonard Andrews, of Hastings, took part in the discussion, and practically laid before the meeting the best English practice in this respect. He advised the use of non-return cut-outs for the transformers in order that when a transformer broke down, it should not act as a short on to the network—in other words, there is much more trouble in consequence of failures in apparatus than of failures in mains. No system of distributed fuses can be relied upon to give consistent results in the event of a short occurring in any part, and, in consequence, instead of being a safeguard, the fuses become a means of increasing interruptions of the supply.

Power Machinery.—It is the intention of the British Westinghouse Company to show in the power equipment of their huge manufacturing works at Manchester typical examples of modern machinery as manufactured by them, and with this end in view the electric generating plant is to consist of reciprocating steam-engines, steam-turbines, and gas-engines. Two types of Westinghouse steam-engines are at present installed—namely, two of 1,200 h.p. each of the Westinghouse-Corliss type, and two of 350 h.p. each of the older and more widely used Westinghouse single-acting type. Large as these generators may appear as power producers for single engineering works, their capacity is not nearly sufficient for the demands of the works of the British Westinghouse Company. They simply represent the first instalment of an electric power generating centre which will eventually be in keeping with the immense size and nature of the works driven. Apart from the general interest which a power equipment consisting of all the most modern types of power producers is bound to attract, the working results obtained and the opportunities for clear comparisons should be of immense benefit from an engineering point of view.

Electric Lighting Installations.—A correspondent to one of the daily papers last week advised those who are having the electric light installed in their houses as to the best way to proceed. He advocated that having obtained

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estimates for the work, they should be submitted to some expert before being signed. He also suggested that the work should be carried out in two parts, the first contract being for the wiring alone, and the next for the supply and connection of the electric light fittings. It seems to us that the time to consult the expert is before the estimates are obtained. The ordinary householder is no judge of the number of lights really required to give first-class illumination in the different rooms, and in consequence he places himself entirely in the hands of the contractors. It frequently happens, therefore, that the lowest tender is for an insufficient number of lights, and the extras absolutely required from the first are a cause of an increase not only in the bill but in the rate for carrying out the work. The trouble and wrangling which often arise after the work has been done is of a nature which an expert can hardly settle with satisfaction to either party. If he be only consulted in the first place, all the tenderers send in a quotation for carrying out exactly the same work, and the consumer gets the lighting equipment he requires at the lowest possible price.

A High-Speed Electric Railway.—The Aurora, Elgin, and Chicago Electric Railway, of which we have previously written in these columns, has now been opened for traffic. For the traction engineer this new line has a special interest from the fact that it is proposed to run the trains at a high rate of speed, and we believe that a regular series of speed trials will be undertaken which will only be rivalled in importance by the recent tests on the Berlin-Zossen military railway. The line is equipped on the third-rail direct-current system. A maximum train consists of a motorcar and four coaches, the former being equipped with four 125-h.p. motors of the highest speed gearing. There is thus 500 h.p. in motors on each motorcar. The high-speed trials are not likely to be commenced for the present, although a schedule running time of 60 miles an hour, including stops, is looked for by the company in the passenger service. Extremely high rates of speed will, however, not be attempted with passenger trains, and we assume they will be undertaken at night time, when there is little traffic. The new line competes with the old steam railway running in the same direction, the through fare on the former being 3s. 7d., as compared with 5s. by the steam trains. The right of way of the new railway is private, and in places where danger from the third rail might be apprehended, the track is fenced in by a 6ft. woven-wire fence.

Electricity in the Human Life.—In the medical practice of to-day there are many well-known applications of electricity, but it has remained for Mr. S. Leduc to devise a method of producing sleep and local anæsthesia by means of electric currents. He describes his idea in a recent issue of *Comptes Rendus*. Direct currents are used, with a small resistance in the circuit, and are best furnished by a storage battery. An interrupter, free from inductance, and giving 150 to 200 breaks per second, is inserted in the circuit. The effect of the electric current was first tried on an animal, a moist electrode being placed on its head and another on the back near the tail. The E.M.F. was rapidly increased till the animal showed contractions and respiration stopped. The current was then reduced to about five milliamperes, with 12 to 30 volts. Respiration then set in again, and the animal slept a profound and tranquil sleep, which lasted as long as the current was applied. No evil consequences are said to have resulted to the animal from the experiments. The inventor asserts that similarly a current applied to the root of a human nerve, such as the median of the wrist, gives rise to complete anæsthesia of the region innervated, accompanied by a prickling sensation, which, however, is not painful. There is no record of electric sleep-producing experiments on a human subject, and we are afraid that the plan of stopping respiration temporarily would not commend itself to many patients, although the after effects are said to have no evil consequences.

Electrical Resistance of Metallic Sulphides.—In the September number of the *Journal* of the Chemical Society is given a good abstract of a paper by Mr. J. Guinchant on this subject. The author has determined the electrical resistance of previously fused metallic sulphides at various temperatures between – 25deg. and 920deg. The resistance of lead sulphide between – 25deg. and 100deg. is represented by the equation $\rho_t = 0{\cdot}000928\ (1 + 0{\cdot}00501\ t)$, and it increases with the temperature up to 920deg. In the case of stannous sulphide, the resistance decreases continually with the temperature up to 920deg.; between 0deg. and 100deg. it is represented by the expression $\rho_t = 1{,}071\ \ (1 - 0{\cdot}00662\ t)$. Ferrous sulphide behaves differently; its resistance decreases as the temperature rises up to 550deg., and then increases with the temperature until at about 870deg. it has the same resistance as at 200deg. During cooling, the reverse changes take place, but the resistance lags somewhat behind the temperature. Between 0deg. and 100deg. the resistance is represented by the equation $\rho = 0{\cdot}114\ (1 - 0{\cdot}00798\ t)$. Other sulphides belong to one or other of these types, according to their conductivity. In all cases the rate of change of the resistance increases with the temperature, and its value is higher the greater the resistance. With good conductors the value is always positive; with bad conductors it is at first negative, but changes in sign when the value of the resistance has reached a certain low point. It seems probable that the sign of the coefficient of temperature depends on the magnitude of the resistance, or causes which determine it, and not on accessory phenomena such as electrolysis.

Electric v. Steam Power.—In 1899, at the same time that the new sewage works were established at Eton, the Urban District Council laid down a complete steam plant for operating the sewage pumps at an actual cost of £1,200. The plant has now been working long enough to show that the annual outlay upon the pumping station, exclusive of the maintenance of building, averages nearly £450, the actual expenditure last year amounting to £484. The Council have recently received an offer from the Windsor Electrical Installation Company which, from the point of view of economy alone, they would do well to accept. In placing its proposals before the Council for the supply of electricity to discharge the work at present performed by steam power, the company has offered to provide a preliminary test, and to fix, free of charge, the necessary cable and motors, the test to last for a period of six months. The Council would, of course, pay for the electric current consumed themselves, the charge for this being fixed by the company at 3d. per unit. The expert advice of Mr. E. Bailey Denton has been obtained on the proposed change, who has estimated the annual outlay on the pumping station with electrical operation at £405. 15s., including a yearly payment of £132. 10s. for 11 years in respect of the loan raised when the steam plant was laid down. The item of electric current comes out at £138. 15s., as compared with £142, the amount of the coal bill with steam power last year, and that of labour £104 and £142 respectively. The annual total saving to the Council, if electrical power be substituted for steam is estimated by Mr. Denton at close upon £180, and this with current at the abnormally high price of 3d. per unit. Not unnaturally, therefore, he is in favour of the proposed

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change. The Council have the report of the engineer now under consideration, and in view of the above facts it will be interesting to see what decision they will come to at their next meeting.

Electricity in Coast Defence.—An ingenious electrical contrivance for use in coast defence has during the past few weeks been the subject of experiments at the mining establishment, Stokes Bay. It is the invention of Captain McEvoy, the well-known torpedo and submarine mining expert, whose aim has been to devise an apparatus to aid in the defence of roadsteads, anchorages, and mine fields by giving warning by audible signals on shore of the approach at night or in thick weather of hostile vessels. The instrument has been named by its inventor the "hydrophone." It consists of two parts. The one apparatus is placed at the bottom of the water outside the anchorage or mine field at a depth of from five to fifteen fathoms, and the other is fixed at a station on shore. These two parts are connected by an electric cable at distances of from one to five miles. The submerged instrument consists of a bell-shaped iron case, at the top of which is fitted a sensitive vibrator or diaphragm, enclosed in a copper box, and when the case is submerged the delicate mechanism is kept clear of the water by means of a column of compressed air, which is enclosed as in the diving bell On the approach of a man-of-war, submarine, or of any vessel which is moved by propellers, the pulsations of her propellers produce a vibratory movement inside the submerged case, and these vibrations are transmitted electrically to the telephonic apparatus on shore, which gives timely warning of the presence of the vessel. The idea is certainly ingenious, and should prove of good service where the approach of vessels in the neighbourhood of the contrivance is the exception and not the rule. Obviously it would not be of much practical value in a roadstead or channel where vessels were continuously passing. As for the efficacy of the invention, the experiments at Stokes Bay, which were witnessed by a representative of the War Office and a committee of Royal Engineers, are said to have been most successful.

Electricity Supply Undertakings.—On Tuesday the Board of Trade issued a return giving details of the electricity supply undertakings in the United Kingdom for the year 1900—information which, it will be noted, must have been available over 18 months ago. After making all due allowance for the complicated nature of the return and the difficulty in some cases of obtaining the necessary figures, this certainly beats all records of the dilatory methods employed in some of the Government departments. Except from the statistician's point of view, to publish figures relating to the working of an undertaking nearly two years ago is of very little value, except, perhaps, for reference purposes. But even at this belated hour the return is anything but perfect in several of its particulars. For instance, in numerous cases the price charged per Board of Trade unit is not stated, nor is the quantity of energy generated and sold recorded. Particulars as to these very important items have apparently been refused by the local authority or company in many cases, and the result is that the return is incomplete. To turn to some of the figures given, it appears that the total capital authorised at the end of the year 1900 in respect of undertakings belonging to companies was £10,744,944; the total "called up" at the end of the year was £7,619,466; while the loan capital raised was £3,180,680. The total capital expended at the end of the year was £10,954,188. The total receipts amounted to £1,383,779, the net profit on which was £321,880. At the end of the year the aggregate sum devoted to depreciation was £462,880. As regards the undertakings belonging to local authorities the total capital expended at the end of the year was £14,943,122, the receipts for the 12 months amounting to £1,661,760. The gross profit "before providing for interest, sinking fund, etc.," is given as £604,032, and the profit, "after deducting expenditure on maintenance and interest on loans," as £206,453. A loss of £102,931, however, is shown after providing for interest, sinking fund, etc. It thus appears that the total capital expended on electricity supply undertakings at the end of the year 1900 was £25,897,310.

Use of the Telegraph in Geography. — The presidential address of Colonel Sir T. H. Haldich, C.B., to Section E at the Belfast meeting of the British Association was of considerable length, and treated of many things of geographical interest. Not the least important question which thus came within the scope of the address was with reference to the use of the telegraph in geography. Few people appreciate the important rôle which is played by the telegraph in these days in this field—in fact, it may truly be said to have outdistanced railways as a means of physical access towards the development of an uncivilised and unknown country. It is, however, the facility which it places in the hands of the geographer for determining his position in longitude that renders it so important a factor in the prosecution of a geographical survey. The telegraph places in his hands the means of differential determinations within a degree of exactness that surpasses even that of the most careful determinations of latitude. Supplementary to the facilities of time-signalling by telegraph is the wonderful accuracy of graduation introduced into the smaller classes of new instruments which in these days replace the cumbersome equipment of the past. For the normal conditions of land configuration (allowing that the explorer is specially careful about his base measurements and his initial data) he can certainly with modern instruments and the facilities for check given him by the telegraph, carry on a rapid and comprehensive geographical survey which will fulfil all the conditions required by the administrator, economist, political geographer, or military commander within such limits of accuracy as will ensure its standing all the subsequent tests that geodesy may apply without any apparent map dislocation. Few people (even scientific geographers) have really grasped the full meaning of the term "rapid" as applied to surveys on geographical scales—*i.e.*, 1 : 250,000, or about 4in. per mile, or less—under normal conditions. Such surveys can be completed quite as fast as an army can advance in the field, even granting that the advance is continuous. They can even to a certain extent precede that advance in face of an enemy. A single triangulator with a staff of two or three topographers in a fairly favourable country will be responsible for an outturn which may be counted by hundreds of square miles per day. The records of both American and Canadian surveys will prove that the marvellous progress made in the frontier reconnaissance surveys of India is nothing abnormal or unexpected.

Military Wireless Telegraphy.—The extended use to which wireless telegraphy was put in the recent German military manœuvres for transmitting orders to different parts of the field, while proving its efficiency for maintaining communication between the various sections of the army, has also shown what we have all along urged—*i.e.*, that in the present stage of wireless telegraphy it is impossible to avoid publicity of the messages thus dispatched. We have it on the authority of the special correspondent of the *Daily Telegraph* at the manœuvres,

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who followed in minute detail all the workings of the wireless telegraph apparatus, that at the present time wireless telegraphy is too open and too easily interfered with to be of any real service in military operations. This undoubted defect of the system, however, seems in a good way to be remedied, as Mr. Marconi's recent experiments in that direction have shown. If secrecy can be obtained, then its usefulness in war would be boundless. In the words of the correspondent, "If ever the problem of secret wireless telegraphy is solved, the soldier will have to listen as carefully for the crackle of a Marconi transmitter within his lines as he now seeks to guard against the passage of a spy." In the German manœuvres five wireless signal stations were set up, two attached to towers at Sonnenburg and Buchwald, and three portable ones attached to balloons with each army corps. These latter were very ingenious contrivances. The difficulty of carrying heavy electric batteries was got over by employing a specially-designed wagon, equipped with a small petrol motor and a dynamo, which generated the electric current on the spot. The weight of the plant with an ample supply of fuel was much less than that of a battery of the size required to give the necessary current. The receiving wire attached to the coherer was carried aloft by the balloon, and the transmitter was worked on the wagon, like an ordinary sounder telegraph instrument. It will perhaps also interest our readers to hear that a heliograph by which messages can be sent over long distances has been invented by a German officer, and was experimented with during the manœuvres. The light used is obtained by burning magnesium powder. The principle of the working of the apparatus, so far as is known at present, is that the operation of the mirror closes an electric circuit and discharges a current powerful enough to deflagrate a pinch of magnesium, the length of the flash corresponding with the dot and dash of the Morse code. The invention, however, is still in the experimental stage.

Tramways in Paris.—In continuation of our note last week on this subject, the Paris correspondent of the *Financial Times*, in succeeding articles, throws more light on the financial state of the electrical tramway undertakings in the French capital. Over-capitalisation, as previously explained, is primarily responsible for the deplorably bad financial condition of the Parisian companies, but other causes, due principally to the arbitrary conditions imposed by the Municipality, have helped towards the present unsatisfactory state of things. A typical case is provided by the working results of the West Parisian Company, whose lines have only been in operation for about 18 months. The loss on operation in 1901 was over £17,000. The cars are heavy vehicles, and are run on the accumulator system. The loss per car per kilometre was 2d. in 1901; this year the loss has not worked out at more than 1½d. It is now proposed to reduce the number of cars running and to increase the fares, which in this case are absurdly low. The official tramway statistics published in the *Journal Officiel* show that the lines which produce the least return are those operated by electricity. Thus the average rate of production on capital invested on tramlines worked by electric traction is given at 2·3 per cent., as compared with 4·5 per cent. with steam and compressed-air lines and 5·6 per cent. with animal traction. Discussing the future prospects of the electric tramway in Paris, the correspondent says there is little hope that the capital so far engaged in many of the new electric tramways in Paris will ever receive any remuneration. In the future there is the competition of the Metropolitan underground electric lines to be faced, and when these are completed they are bound to take away from the tramway companies a great deal of their traffic. Things, indeed, are in such a bad way that it is thought by some that sooner or later, if the authorities do not help the companies to live by granting easier conditions than are now afforded them, it is probable that the city will have to take over and work the electric tramways as a municipal undertaking. We understand that the Minister of Public Works has now authorised the introduction of the overhead trolley system "temporarily" in the Rue du 4 Septembre and the Rue Réaumur. The Parisians look jealously after the beauty of their streets, and it is thought that the innovation is not likely to prove popular with the people. There is no doubt, however, but that the authorities have done the right thing in sanctioning the overhead system, and it is to be hoped that the same privilege will be granted the other electric companies who are at present working at a loss when they need to extend their lines.

Steam-Turbines in America.—We have before described the steam turbo-generator manufactured by the Westinghouse Company for the Hartford Electric Lighting Company. This turbine, which is manufactured under a license from Messrs. C. A. Parsons and Co., is of 1,500 kw. output, and has proved under trial to be easily capable of working up to 2,000 kw. The steam consumption trials and efficiencies were made by Prof. W. Lispenard Robb, assisted by students of the electrical laboratory of Trinity College, Hartford. The steam pressure during the trials was about 152lb., and a vacuum of about 27in. was maintained. Steam was superheated to somewhere about 32deg., The steam consumption was obtained for various loads. The results plotted in the form of a curve show the following steam consumptions per kilowatt-hour: at 2,000 kw. output, 19lb.; at 1,500 kw. output, 21lb.; at 1,000 kw. output, 24·8lb.; and at 500 kw. output, 31lb. It is interesting to compare these figures with those given in the recent paper read by the Hon. C. A. Parsons before Section G of the British Association. In it he stated that the lowest steam consumption so far recorded with steam-turbines was 17·3lb. per kilowatt-hour. This result was obtained on a 1,000-kw. continuous-current plant built for the Newcastle and District Electric Lighting Company. It seems to us that in the case of the Hartford turbine the superheat on the steam might be increased with advantage. While on this subject we are able to give some particulars of a steam-turbine of the disc type, which is being used as the motor in the equipment of a new type of locomotive headlight. We have previously described the general arrangement of this headlight, but the new feature of the equipment is the turbine. This engine is provided with a propeller wheel, which is wholly constructed of rolled steel. It is said to have a factor of safety of about 7, for while the normal speed of the engine and dynamo is about 2,000 revolutions per minute, the wheel will withstand successfully a speed of about 14,000 revolutions per minute. The speed of the engine is held constant, or practically so, regardless of change of load or initial pressure by a simple and efficient governor, which is so arranged with relation to the other parts of the engine as to be easily and readily accessible should occasion demand. The wheel shaft is carried on ball bearings, and the coefficient of friction is said to be so low that the turbine will operate, running to its full speed, under a pressure so slight that the pointer of a 180lb steam-gauge will not leave its stop, the gauge being connected between the governor valve and the nozzle. All the moving parts are encased in a cast-iron housing, so designed as to thoroughly protect it from the elements, dust, dirt, etc. The lubrication is automatic, and is provided by loose rings feeding the oil to the ball bearings from the oil-wells.

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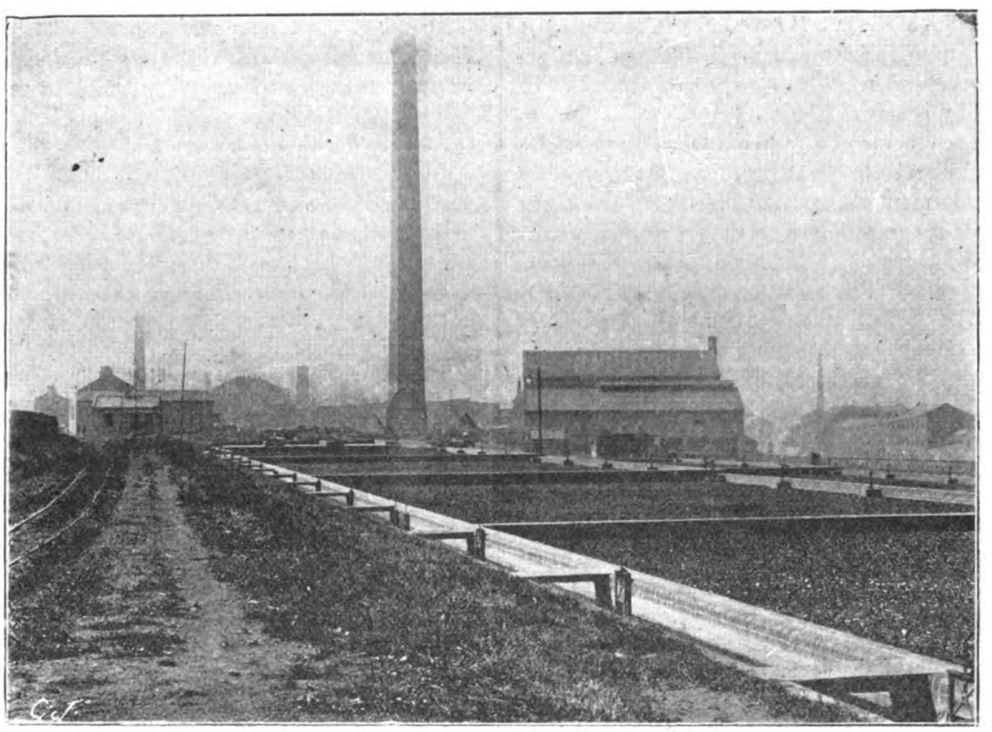
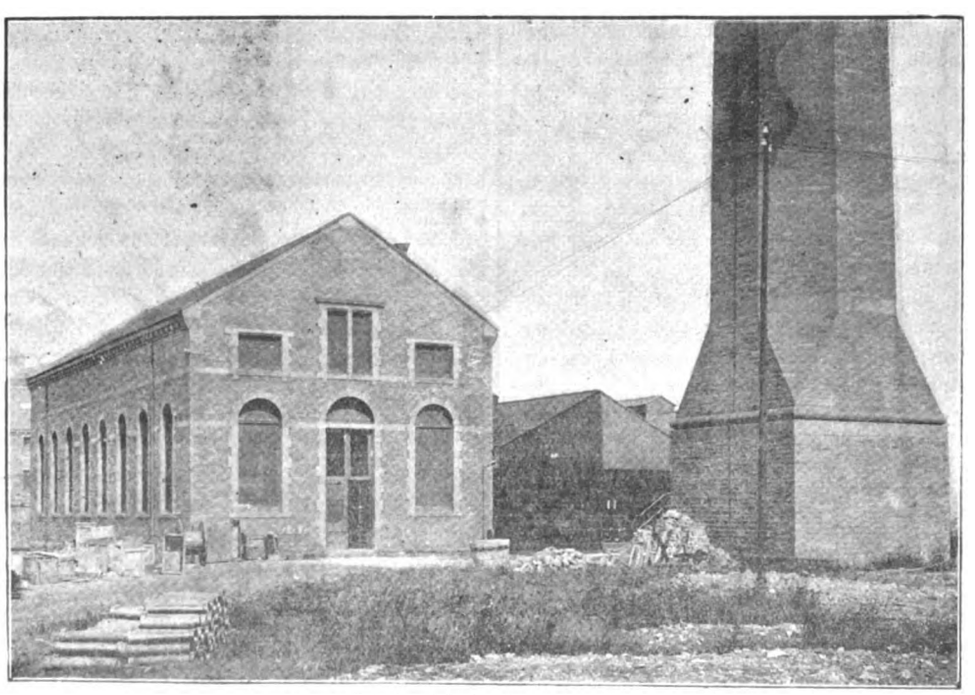
ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

On Saturday last this association held a district meeting at Shipley, Yorks, when Mr. I. Lindow, the clerk to the District Council, read a paper describing the work his Council had carried out. Part of the work of the Council has been the dealing with refuse, and for this a destructor has been erected, the waste heat of which is used to obtain steam for an electric installation. The portions of the paper relating more especially to the electrical work of the Council are given herewith.



Refuse Destructor and Electricity Works, Shipley.

Tramways.—The Council have obtained power for an extensive provision of tramways for the district. The first purchase of tramways by the Shipley Council took place in 1894, when they acquired the lines which had previously been used for horse trams by a company which failed to make them pay. This line, known as the Bradford and Keighley Road Tramway, was afterwards leased to a tramway company at a rental, but in the present year the Council arranged for the conversion of the line for electric traction. In May the conversion was completed to double line for a distance of about 1½ miles. In the meantime the Council had installed their electricity works, and they were able to add to their supply of current for lighting and power that of tramway traction. The Council were not called upon to decide the question as to what system of haulage—overhead equipment, surface contact, or conduit—should be adopted, this point being settled by an agreement come to in 1897 with the Bradford Corporation, whereby this particular line had to be leased to the Bradford authority and converted to the same system of haulage which they adopted for the city tramways. As this was the overhead trolley system, the Shipley Council followed suit with their line. The tramway works in the Bradford and Keighley roads have been carried out on the plans of Mr. R. C. Quin, M.I.E.E.,



Exterior of Engine House, Shipley.

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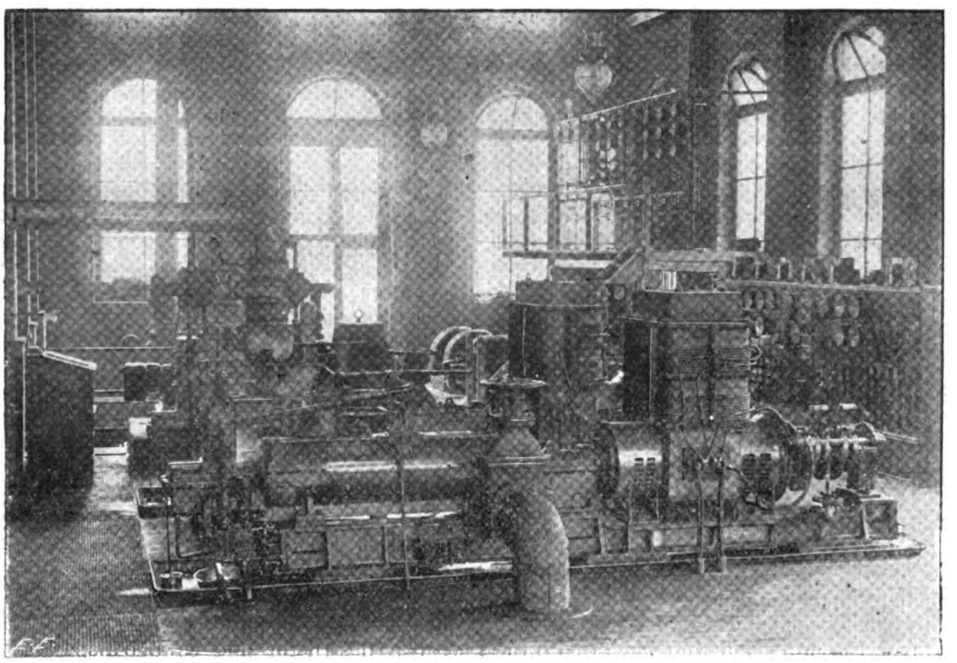
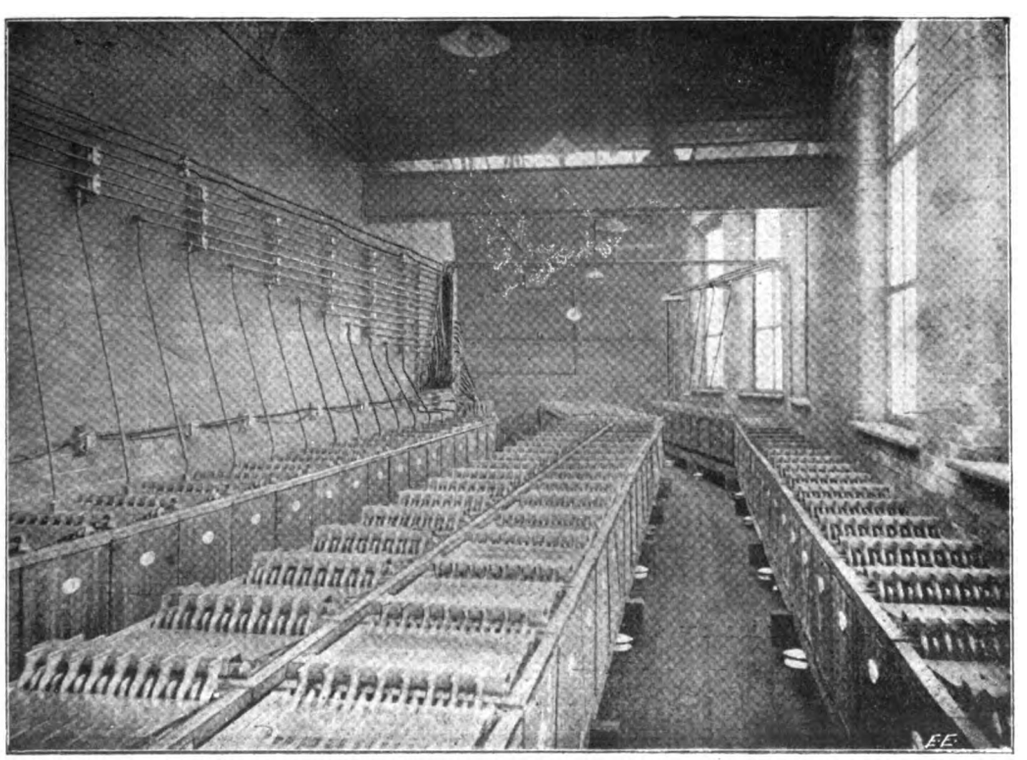
consulting engineer, who has directed the contracts except those for the permanent way, which have been superintended by Mr. Dawson, the Council's surveyor. The tramway is constructed with girder rails weighing 91lb. to the yard, fastened with girder joints and fish-plates with



View of the Engine Room at the Shipley Electricity Works, showing Parsons Turbo-Generators.

helicoid lock-nuts to the bolts, the bed of the rails and granite setts being 6in. solid concrete. In the construction of the permanent way the engineer has taken the view that the life of a tramway rail is the life of the joint, and given extra strength to this part of the work to prevent excessive wear. With regard to the overhead line, this is constructed of 000 S.W.G. hard-drawn copper, supported on insulators made under Quin's patent. This insulator, while having the merit of being slightly cheaper than the older form, has also the advantage that it will stand considerably higher electrical pressures than any other type, and that it is also mechanically stronger. The line throughout is protected by Quin's patent automatic cut outs, for prevention of trolley wire accidents arising from falling telegraph or telephone wires and broken trolley wire. The current is supplied from the Council's central station at Dockfield, from whence the feeder cables are laid a distance of about a mile These cables will, however, serve for the future lines, which will take the current at points much nearer the electricity works.

Sewerage Works.—After plans for the destructors and engine-house had been submitted to the Local Government Board, the Council considered it would be an advantage to have electricity works also on this site, in order that the steam raised by the burning of the refuse (over and above that required for sewage pumping) might be used in this direction. The result is that Shipley holds the almost unique position of having sewage outfall works, refuse destructors, and electricity works upon the same site. The destructor is of the Meldrum regenerative type, consisting of furnace, combustion chamber, Lancashire boiler,



Interior of Battery Room, Shipley.

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and regenerator. Refuse is tipped into the adjoining hoppers, then withdrawn from the bottom by hand, and fed into the furnace opposite. The cells are so arranged that the fire is continuous over the whole surface of the grate, the forced draught being localised by closed ashpits. By this method any part of the grate can be worked singly, or any part shut off whilst the remainder are in use. The air for the blast is heated by being passed around cast-iron pipes, through which the gases from the boiler flues are directed. The temperature of the air as it enters the destructor varies from 280deg. to 350deg., 320deg. being the average. Another advantage of the open grate is the mingling of the gases from the duller and brighter portions of the fire, thus giving a better and more even combustion in the furnace itself. After passing over the furnace bridge the flames and gases enter the combustion chamber, and the temperature obtained therein is so high that the deposited dust is fused into solid clinker. The maximum capacity of the destructor, with average ashpit refuse, is 50 to 55 tons per 24 hours. At Shipley there is not more than an average daily supply of 25 tons, and this, of course, is easily disposed of. It would obviously be an advantage if the supply of refuse was more nearly equal to the capacity of the destructor, but that is a matter which the future expansion of the district will put right. The boiler-house equipment also includes a Green's economiser with 192 tubes, and a second 30ft. by 8ft. Lancashire boiler, to which is attached one of Dixon's patent superheaters.

To revert to the destructor itself, it may be said that hand firing is considered preferable—in fact, the success or failure of a destructor depends largely upon the individual attention of the workmen who have to do the firing. Only by the workmen exercising discretion in this matter can the best results be obtained. In this way the wet privy refuse can be mixed with the dry refuse, and the whole of the worst description of the material to be dealt with is got rid of, whilst at the same time the heat is kept fairly even throughout. The refuse burnt at Shipley, which for steam raising is equal to about one-tenth best steam coal, averages about 600 tons a month, but were the refuse obtainable it would be quite possible to consume 300 tons weekly in this four-cell destructor. The most difficult kind of refuse to deal with is that from the abattoir, and the Council have decided to purchase a special offal hopper similar to the one in use at Nelson, so that this very offensive refuse will not have to be handled by the workmen.

The engine-room plant consists of two Parsons turbines direct coupled to two 240-kw. compound-wound direct-current generators, suitable for running on either traction or lighting circuits; one 45-i.h.p. reciprocating engine direct coupled to a 25-kw. compound-wound generator, which can be run on either side of a three-wire lighting system, and was originally intended for driving the smaller sewage pump; storage battery, 260 cells, Victoria type, 17 plates, supplied by the British Power, Traction, and Lighting Company; a three-wire lighting switchboard by Mavor and Coulson, of Glasgow, comprising six generator panels, four feeder panels, two battery panels, and centre panel carrying neutral 'bus bar and small recording ammeter for registering earth leakage from the mains. The traction switchboard consists of feeder panels for two 0·4 and one 0·6 positive feeders, battery booster panels, negative booster panels, motor-generator panels, and Board of Trade panel, with the usual complement of starting switches, rheostats, ammeters, voltmeters, recording instruments, and kilowatt-hour meters for registering the supply of current for traction purposes. There are also a 60-kw. traction motor direct coupled to two 25-kw. lighting generators, which can be used for supplying traction current from the lighting side, lighting current from traction side, and also run as an ordinary balancer; reversible battery booster driven by motor off the traction 'bus bars for equalising the load on the traction generator. (This set is intended to keep an approximately constant load on the traction generator the whole of the time it is running.) In addition to these there are two negative boosters driven by shunt-wound traction motor for keeping the voltage drop in return feeders within the Board of Trade limit of seven volts. A special board controls the works lighting and motors (including those driving the sewage pumps). The special change-over switches are mounted on this board, so that any out-of-balance current in the town may be compensated for at the works. An independent condensing plant, with steam-driven air-pump and motor-driven circulating pump, is in use, capable of dealing with 10,000lb. of steam per hour. The sewage pumping plant comprises a 9in. Gwynne's centrifugal pump direct coupled to 66-b.h.p. compound-wound "Castle" motor, and 7in. Gwynne's pump coupled to 30-b.h.p. motor supplied by Messrs. Wilson Hartnell, Limited, of Leeds. The 9in. pump has a maximum duty of 2,200 gallons per minute, and the 7in. pump 1,200—a total pumping capacity of 3,600 gallons per minute. It would be a very exceptional flow that required such a capacity. The electrically-driven centrifugal pump is very effective as regards speed regulation, seeing that a very slight difference in the speed makes a very material alteration in the output of the pump. The regulating switch in series with the shunt winding of the large motor varies the load from 90 to 200 amperes at 240 volts, and the output of the pump in the same proportion. The arrangement of the suction pipes is very effective, and well worth inspection.

From this brief outline of this plant, it will be seen that the object of the Council was so to combine the three works—destructor, sewage pumping, and electric lighting—that there could not only be utilisation of the steam produced by the burning of the ashpit refuse, but that there should be economy in management. The policy of combining an electric lighting and tramway supply station with a destructor and sewage-disposal works was quite unique, and has much in its favour. The same staff and the same management suffice for all undertakings. The mechanical work and superintendence involved in the pumping station is very little addition to the work of following the engines, dynamos, pipework, boilers, and pumps of the ordinary central-station type. The advisability of using steam raised by the destructor in the electricity station is a very debatable question. With the lighting station alone, apart from a motor load, very little steam is required during the day, the bulk of the demand being confined to the hours between dusk and 9 p.m. The most economical way of working a destructor is to equalise the work during the whole of the 24 hours, and it is an obvious saving when it is possible to bring on, as at Shipley, a day load in the shape of traction and motor supply, which utilises the steam during the whole of the day, when the bulk of the refuse is being dealt with. The sewage pumping load can be and is used to equalise the load on the lighting network, which, again, also provides a regular load for the destructor. The increased demand for current for traction, motor, and lighting purposes has, of course, necessitated the use of the second Lancashire boiler for steam production, but has resulted in a saving in the cost of working the destructor. When the destructor was started it was run on eight-hour shifts seven days a week. It was afterwards dropped to six days a week, and then altered to two shifts a day, the fires being banked up from 11 p.m. to 4 a.m. At present steam is raised by the coal-fired boiler from 4 p.m. to 7 a.m., and then the destructor runs the day load until 6 to 10 p.m. according to the quantity of refuse to be destroyed. An electrical engineer would always prefer to raise his steam from coal rather than from a refuse destructor; but it would be folly for a town the size of Shipley to allow steam power raised by the destruction of refuse to be wasted. On the whole, the success obtained at Dockfield has been very gratifying, and even better results are hoped for when the different units can be run on full load instead of being run at quarter load or even less than that, and at times have been actually run non-condensing in order to utilise the steam and get rid of the refuse.

The electrical plant at Dockfield has been designed by Mr. Quin; but the whole of the works, comprising destructor, sewage outfall pumps, and electrical station, are now under the control of Mr. S. D. Schofield, A.M.I.E.E., the Council's resident engineer.

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THE USE OF ELECTRICITY IN IRON AND STEEL WORKS.*

BY F. KYLBERG, BENRATH, NEAR DUSSELDORF.

In recent years, as is generally known, the application of electricity to the driving of mechanical appliances in ironworks has grown to an unprecedented extent. This may be due primarily to the fact that the cost of generating the electric current has been reduced beyond all previous conception, and the time is even now within measurable distance when modern central power stations driven by blast-furnace gas will render the use of electric power in iron and steel works practice still more general. In fact, it appears probable that at no distant date both auxiliary steam-engines and hydraulic power will be entirely superseded. Hitherto the necessity has existed of laying down extensive steam-boiler installations, for the heating of which either coal or blast furnace was required. Despite every effort to effect a reduction in the consumption of steam by the introduction of central condensing and cooling plants, as well as by increasing the efficiency of the steam-engine, it was nevertheless found impossible to lower the cost of generating the power by these means till it approximated to that attainable by the use of direct-driven gas-engines. The blast-furnace owner of the present day can, in fact, avail himself of a free supply of thousands of horse-power. Further developments in this direction will no doubt lead to modifications in the construction of the blast furnace and to the perfection of it, not only as a pig-iron producer, but also as a gas producer. This, again, involves the adoption of the requisite modern gas-purifying plant, the need for which had formerly never been experienced. The development of the blast-furnace gas-engine and the electric potential possibilities thus opened up gave occasion to the metallurgical engineer to employ this energy in driving machinery of every conceivable variety. The American works in particular, which are laid out for production on a large scale, have achieved wonders in the use of electricity, although they have only recently begun to employ gas-driven engines. These American appliances have often been introduced into Europe without regard as to whether they were adapted to European conditions, with the consequent result of occasional failure. The author proposes in the following paper to describe some developments based on American experience and adapted to European requirements.

Gas-Driven Engines for Generating Electricity in Central Stations.—Descriptions of the central power stations and gas-washing plant at the Differdingen ironworks and at the Düdelingen Eisenhütten-Aktienverein in Luxemburg appeared recently in *Stahl und Eisen* (issues of May 1 and 15, 1901), in which much information was given regarding the consumption of gas per horse-power per hour, besides a number of analyses. Additional interesting facts have since then been noted during the long period of constant working of the blast-furnace gas-engines at Differdingen, and by the kindness of the managing director the author has been permitted to publish these. In Differdingen there are nine blast-furnance gas engines of the Cockerill system, each of which consumes, according to the various tests made, 2·9 cubic metres of gas per horse-power per hour. Of these nine gas-engines, each of 600 h.p., six are available as blowing engines for the four blast furnaces, and the remaining three for the generation of electric energy for the works. Besides these, there are two smaller gas motors, each of 75 h.p., for the purpose of electric lighting. The gas-washing installation at Differdingen is also working at the present time in a manner which exceeds all anticipation. The results of trials have shown that the gas which comes direct from the blast furnace contains 10 grm. of dust per cubic metre. It is proposed now to follow this gas in its progress through the cleansing process. On issuing from the apparatus for extracting the moisture the dust contained in the gas is already reduced to 4 grm. On reaching the first fan the gas only contains 3 grm. of dust, having deposited 1 grm. during its passage through the mains. After passing the first fan, and at the entrance of the second, the dust in the gas is reduced to 1·5 grm., and after issuing from the second fan the quantity of dust has fallen still further from 0·2 grm. to 0·3 grm., and the gas enters the engine

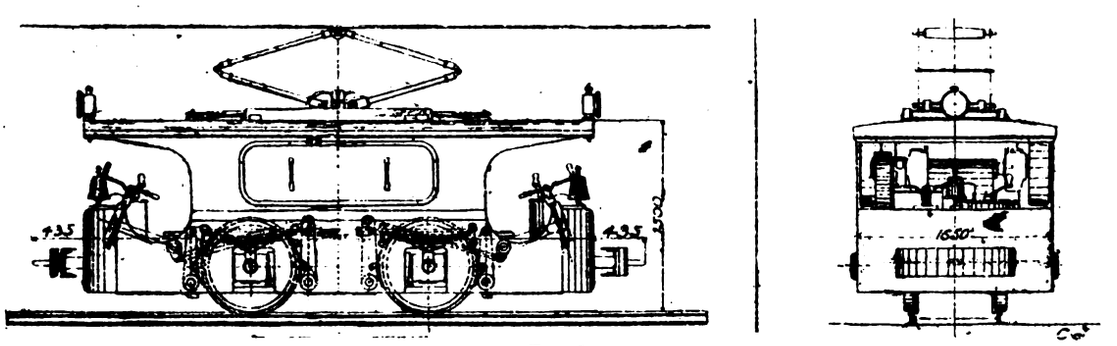

FIG. 1.

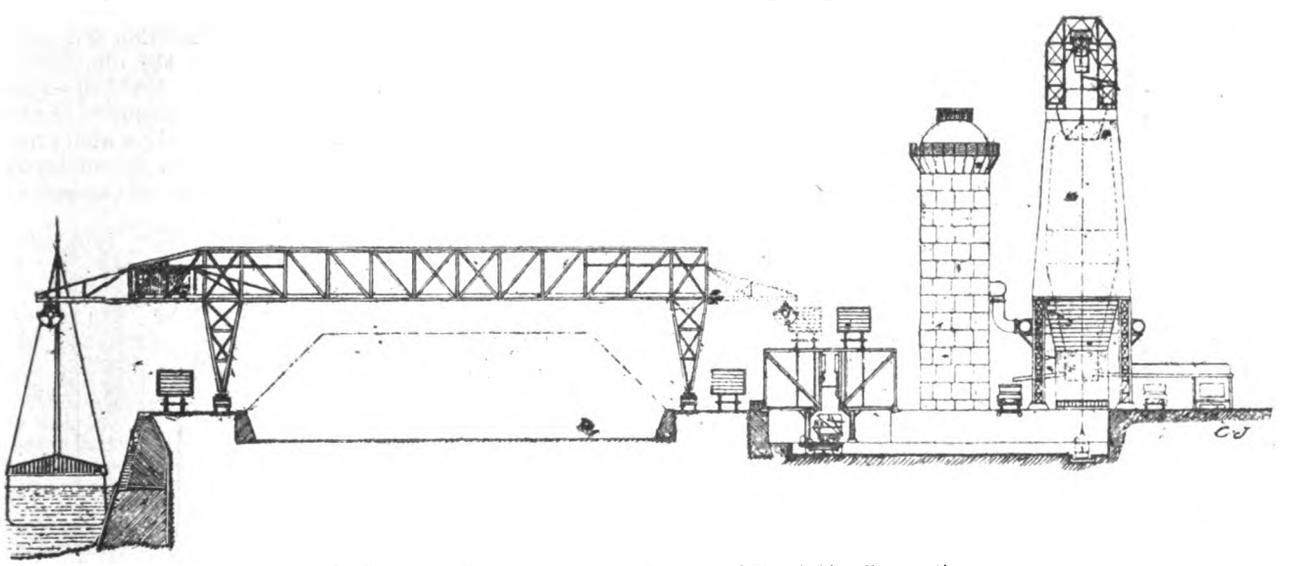

FIG. 2.—Electric Ore Transporter Below the Ore Bins and Electric Blast Furnace Charger.

* Paper read before the Iron and Steel Institute at Düsseldorf.

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with only 0·1 grm. to 0·075 grm. of dust per cubic metre. It has, moreover, been observed at Differdingen that in order to obtain the above degree of purity in the gas, it is necessary to inject 1 litre of water into the fans for every cubic metre of gas passing through. The pressure of the fans during these operations is equal to a pressure of a column of water of 8in. in height, and is equivalent to an increase of temperature of 8deg. C. to 10deg. C. Referring again to an article by Mr. F. W. Lürmann in *Stahl und Eisen* (March 15, 1898) upon the application of

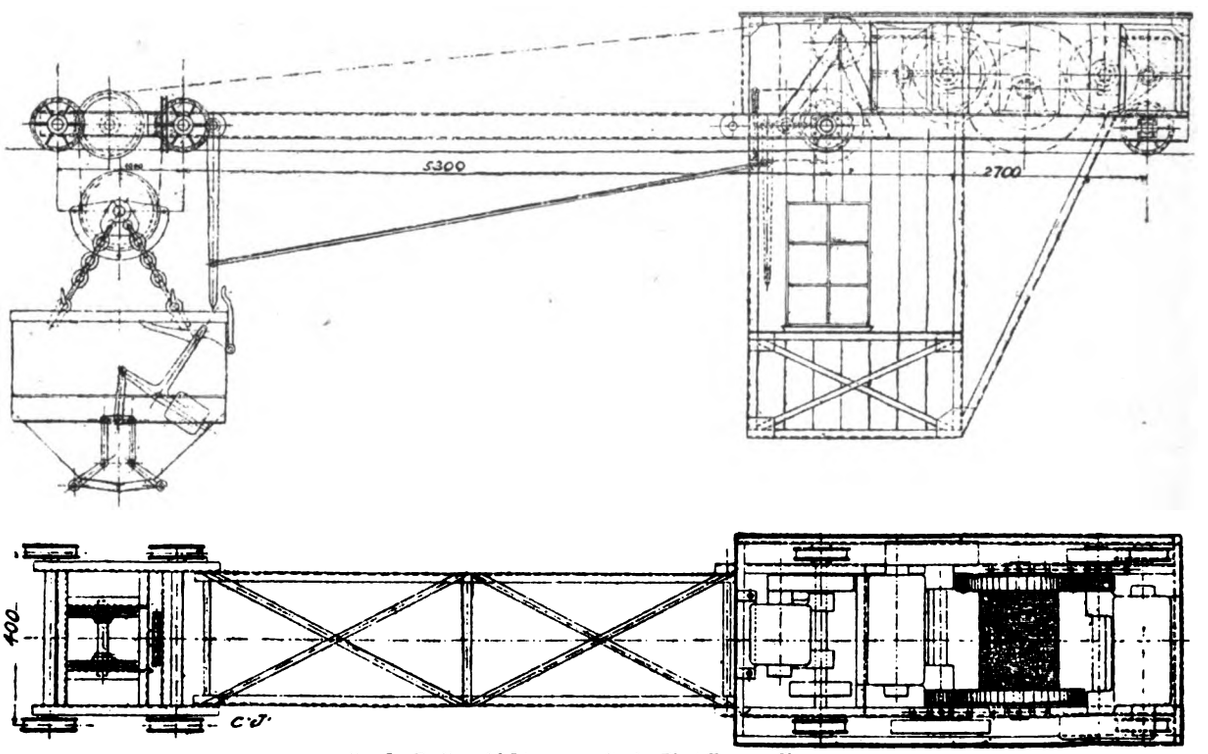

FIG. 3.—Trolley of 8·5 tons capacity for Blast Furnace Charger.

blast-furnace gas to the direct production of power, data will be found which show that for the production of one ton of pig iron 4,500 cubic metres of gas are generated, of which 10 per cent. is lost by leakage at the throat of the blast furnace and 50 per cent. is consumed in heating the blast, leaving available for driving the gas-engines a surplus of 2,000 cubic metres. Assuming that 2·9 cubic metres of gas are required per horse-power per hour, the amount of horse-power obtained per ton of pig iron is 690 h.p., which is directly convertible into electric energy.

Since at the present time the extreme difficulties which were at first encountered in the application of blast-furnace gas-engines, due to the impurities of the gas, have been obviated, and since it is possible to transform by simple means the great excess of blast-furnace gas into electric energy, it may be said without exaggeration that it is the duty of every blast-furnace owner to provide in his works the means of generating this electric energy.

Electric Shunting and Mine Locomotives (Fig. 1).—The great advantages of the utilisation of electric power as compared with steam are particularly noticeable in this connection, as is proved by the reduction in the cost of working and an efficiency hitherto unattainable. The following are the two types of locomotives which have proved most serviceable: first, the shunting locomotive of medium tractive power and high speed; and, secondly, mine locomotives of high tractive power and low speed. Both of these types are distinguishable from one another chiefly by their general mode of construction. The following are the chief points in the construction of standard electric locomotives. Each axle is driven by a special motor, by which means great efficiency and high tractive power are assured. The motors are, moreover, arranged that any one of them can be cut out if desired, and as the result the speed of the engine can be regulated according to the load. The shocks experienced at starting and stopping are also less severe. Table A gives the dimensions and capacities of the standard types of locomotives as constructed by the Benrath Engineering Company. In the smaller steelworks where the use of locomotives would not be profitable, electrically-driven capstans can be employed to advantage. The driving mechanism of these capstans is

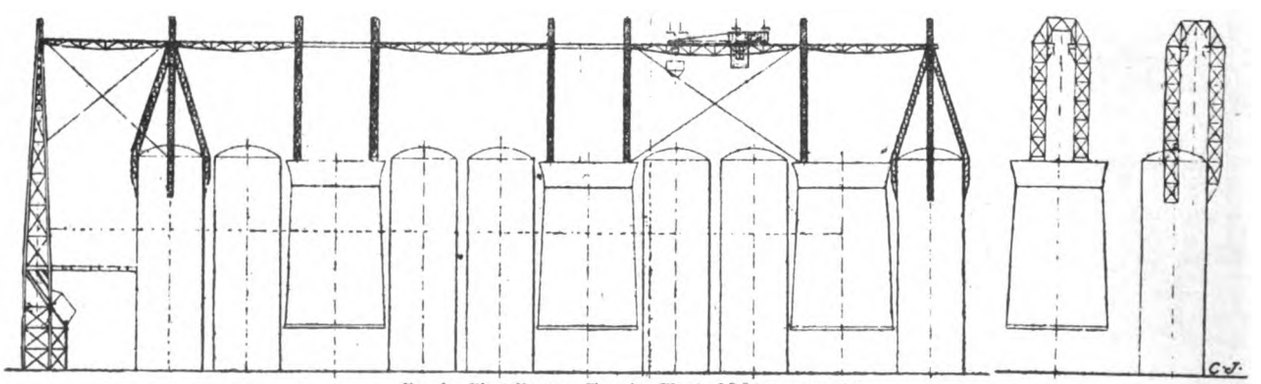

FIG. 4.—Blast Furnace Charging Plant of 8·5 tons capacity.

enclosed in water-tight cast-iron casings, which are placed beneath the level of the platform so that only the round warping end of the capstan projects. These capstans are usually constructed with a tractive power of five tons.

Ore and Coal Transporting Appliances.—The construction of ore and coal unloading appliances was first developed in the United States, an arrangement of this kind being indeed necessitated by the vast quantities of coal and ore which required transportation in the harbours or ironworks in that country. The Brown Hoisting Company was the pioneer in this respect, and has earned for itself, both in America and in Europe, a well-deserved reputation. The

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unloading arrangements correspond in their general features to the construction adopted by the Benrath Engineering Company, which pays special attention to the avoidance of the use of wire ropes. The transport of the materials upon the overhead track is effected by means of an electrically-driven trolley, equipped with a hoisting arrangement of simple design. This trolley can be constructed with either one or two jibs, within the range of which are the ship at the one extremity and the railway track at the other. The transporting capacity of the Brown conveyors is considerable, varying between 80 and 100 tons of ore or coal per hour. It is a further advantage of this system that for the manipulation of the entire transporter only one operator is necessary. Moreover, after each lift that portion of the jib projecting over the ship is automatically drawn back, so that either the ship can be warped or the travelling bridge be moved along without the necessity of folding up any part of the bridge.

Electrically-Driven Ore-Transporting Arrangements beneath the Ore Bins and the Electric Blast-Furnace Charger (Figs. 2, 3, and 4).—After the ores have been conveyed to the ore tipping ground or to the ore bins by means of the transporter previously described, it is an essential condition that the ore and coke should be transferred to the top of the blast furnace with the least possible handling and cost of labour. For the performance of this work also electric energy is admirably adapted. Fig. 2 shows a charging apparatus in the design of which particular attention has been paid to the following points: (1) the whole of the mechanism is driven electrically; (2) hopper-shaped trolleys are provided to run beneath the ore bins; (3) a single hoisting arrangement serves several blast furnaces. Parallel to the row of blast furnaces are arranged the two ore and coal bins, which are filled direct by the ore transporter or from the railway cars on a track above them. Below these bins runs a hopper trolley, which can be filled from any one of the bins above it. A platform is built along the row of blast furnaces, which conveys the hopper to the hoist, where it is tipped into the hoisting skip. This skip is attached to a trolley (see Figs. 3 and 4), which is provided with a hoisting gear and runs on an elevated track above the blast furnaces. The skip after hoisting is conveyed by means of this trolley to any one of the furnaces and the contents are automatically discharged on to the bell. Assuming that a single charge which the bell is capable of supporting amounts to 10 tons, the arrangement above described can deal with a quantity amounting to 200 tons per hour.

(To be continued.)

THE BRITISH ASSOCIATION.

Address to the Engineering Section.

BY PROF. JOHN PERRY, M.E., D.SC., PRESIDENT OF THE SECTION.

This section has had 66 presidents, all different types of engineer. As each has had perfect freedom in choosing the subject for his address, and each has known of the rule* that presidential addresses are not subject to debate afterwards, and as, being an engineer, he has always been a man of originality, of course he has always chosen a subject outside his own work. An engineer knows that the great inventions, the great suggestions of change in any profession, come from outsiders. Lawyers seem like fish out of water when trying to act as lawmakers. The radical change that some of us hope to see before we die in the construction of locomotives will certainly not come from a locomotive superintendent who cannot imagine a locomotive which is not somehow a lineal descendant of the "Rocket."

Hence it is that in almost every case the president of this section has devoted a small or large part of his address to the subject of the education of engineers. I grant that every president has devoted his life to the education of one engineer—himself—and it is characteristic of engineers that their professional education proceeds throughout the whole of their lives. Perhaps of no other men can this be said so completely. To utilise the forces of Nature, to combat Nature, to comprehend Nature as a child comprehends its mother, this is the pleasure and the pain of the engineer. A mere scientific man analyses Nature—takes a phenomenon, dissects it into its simpler elements, and investigates these elements separately in his laboratory. The engineer cannot do this. He must take Nature as she is, in all her exasperating complexity. He must understand one of Nature's problems as a whole. He must have all the knowledge of the scientific man, and ever so much more. He uses the methods of the scientific man, and adds to them methods of his own. The name given to these scientific methods of his own or their results is sometimes "commonsense," sometimes "character," or "individuality," or "faculty," or "business ability," or "instinct." They come to him through a very wide experience of engineering processes, of acquaintance with things and men. No school or college can do more than prepare a young man for this higher engineering education which lasts through life. Without it a man follows only rule of thumb, like a sheep following the bell-wether, or else he lets his inventiveness or love of theory act the tyrant.

When a man has become a great engineer, and he is asked how it happened, what his education has been, how young engineers ought to be trained, as a rule it is a question that he is least able to answer, and yet is a question that he is most ready to answer. He sees that he benefited greatly by overcoming certain difficulties in his life; and forgetting that every boy will have difficulties enough of his own, forgetting that although a few difficulties may be good for discipline many difficulties may be overwhelming, forgetting also that he himself is a very exceptional man, he insists upon it that those difficulties which were personal to himself ought to be thrown in the path of every boy. It often happens that he is a man who is accustomed to think that early education can only be given through ancient classics. He forgets the dulness, the weariness of his schooldays. Whatever pleasure he had in youth—pleasure mainly due to the fact that the average Anglo-Saxon boy invents infinite ways of escaping school drudgery—he somehow connects with the fact that he had to learn classics. Being an exceptional boy he was not altogether stupefied, and did not altogether lose his natural inclination to know something of his own language; and he is in the habit of thinking that he learnt English through Latin, and that ancient classics are the best mediums through which an English boy can study anything. The very people who talk so much of learning English through Latin neglect in the most curious ways those Platt-Deutsch languages, Dutch and Scandinavian, a knowledge of which is 10 times more valuable in the study of what is becoming the speech of the world. And how they do scorn Lowland Scotch! The cleverest men of our time have been brought up on the classics, and so the engineer who cannot even quote correctly a tag from the Latin grammar, who never knew anything of classical literature, insists upon it that a classical education is essential for all men. He forgets the weary hours he spent getting off Euclid, and the relief it was to escape from the classroom not quite stupefied, and he advocates the study of pure mathematics and abstract dynamics as absolutely necessary for the training of the mind of every young engineer. I have known the ordinary abominable system of mathematical study to be advocated by engineers who, because they had passed through it themselves, had really got to loathe all kinds of mathematics higher than that of the grocer or housekeeper. They said that mathematics had trained their minds, but they did not need it in their profession. There is no profession which so much requires a man to have the mathematical tool always ready for use on all sorts of problems, the mathematical habit of thought the one most exercised by him; and yet these men insist upon it that they can get all their calculations done for them by mathematicians paid so much a week. If they really thought about what they were saying, it would be an expression of the greatest contempt for all engineering computation and knowledge. He was pitchforked into works with no knowledge of mathematics, or dynamics, or physics, or chemistry, and, worse still, ignorant of the methods of study which a study of these things would have produced; into works where there was no man whose duty it was to teach an apprentice; and because he, one in a thousand, has been successful, he assures us that this pitchforking process is absolutely necessary for every young engineer. He forgets that the average boy leaves an English school with no power to think for himself, with a hatred for books, with less than none of the knowledge which might help him to understand what he sees, and he has learnt what is called mathematics in such a fashion that he hates the sight of an algebraic expression all his life after.

I do not want to speak of boys in general. I want only to speak of the boy who may become an engineer, and before speaking of his training I want to mention his essential natural qualification—that he really wishes to become an engineer. I take it to be a rule to which there are no exceptions that no boy ought to enter a profession—or, rather, to continue in a profession—if he does not love it. We all know the young man who thinks of engineering things during office hours and never thinks of them outside office hours. We know how his fond mother talks of her son as an engineer who, with a little more family influence and personal favour, and if there was not so much competition in the profession, would do so well. It is true, family influence may perhaps get such a man a better position, but he will never be an engineer. He is not fit even to be a hewer of wood and drawer of water to engineers. Love for his profession keeps a man alive to its interests all his time, although, of course, it does not prevent his taking an interest in all sorts of other things as well; but it is only a professional problem that warms him through with enthusiasm. I think we may assume that there never yet was an engineer worth his salt who was not fond of engineering, and so I shall speak only of the education of the young man who is likely to be fond of engineering.

How are we to detect this fondness in a boy? I think that if the general education of all boys were of the rational kind which I shall presently describe, there would be no great difficulty; but as the present academic want of system is likely to continue for some time, it is well to consider things as they are. Mistakes must be made, and the parent who tries during the early years of his offspring to find out by crafty suggestion what line his son is likely to wish to

* The committees of Sections G and L arranged a discussion on "The Education of Engineers," this address being regarded as opening the discussion. Thus the rule was not in force this year.

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follow will just as probably do evil by commission as the utterly careless parent is likely to do evil by omission. He is like the botanical enthusiast who digs up plants to see how they are getting on. But in my experience the Anglo-Saxon boy can stand a very great deal of mismanagement without permanent hurt, and it can do no kind of boy any very great harm to try him on engineering for a while. Even R. L. Stevenson, whose father seems to have been very persistent indeed in trying to make an engineer of him against his will, does not seem, to a Philistine like myself, to have been really hurt as a literary man through his attendance on Fleeming Jenkins's course at Edinburgh—on the contrary, indeed. It may be prejudice, but I have always felt that there is no great public person of whom I have ever read who would not have benefited by the early training which is suitable for an engineer. I am glad to see that Mr. Wells, whose literary fame, great as it is, is still on the increase, distinguishes the salt of the earth or saviours of society from the degraded, useless, luxurious, pleasure-loving people doomed to the abyss by their having had the training of engineers and by their possessing the engineer's methods of thinking

It may be that there are some boys of great genius to whom all physical science or application of science is hateful. I have been told that this is so, and if so I still think that only gross mismanagement of a youthful nature can have produced such detestation. For such curious persons engineering experience is, of course, quite unsuitable. I call them "curious" because every child's education in very early years is one in the methods of the study of physical science; it is Nature's own method of training, which proceeds successfully until it is interfered with by ignorant teachers who check all power of observation, and the natural desire of every boy to find out things for himself. If he asks a question, he is snubbed; if he observes Nature as a loving student, he is said to be lazy and a dunce, and is punished as being neglectful of school work. Unprovided with apparatus he makes experiments in his own way, and he is said to be destructive and full of mischief. But however much we try to make the wild ass submit to bonds and the unicorn to abide by the crib, however bullied and beaten into the average schoolboy type, I cannot imagine any healthy boy suffering afterwards by part of a course of study suitable for engineers, for all such study must follow Nature's own system of observation and experiment. Well, whether or not a mistake has been made, I shall assume the boy to be likely to love engineering, and we have to consider how he ought to be prepared for his profession.

I want to say at the outset that I usually care only to speak of the average boy, the boy usually said to be stupid, 95 per cent. of all boys. Of the boy said to be exceptionally clever I need not speak much. Even if he is pitchforked into works immediately on leaving a bad school, it will not be long before he chooses his own course of study and follows it, whatever course may have been laid down for him by others. I recollect that when in 1863 I attended an evening class held in the Model School, Belfast, under the Science and Art Department, on practical geometry and mechanical drawing, there was a young man attending it who is now well known as the Right Hon. William J. Pirrie. He had found out for himself that he needed a certain kind of knowledge if he was to escape from mere rule-of-thumb methods in shipbuilding work; it could at that time be obtained nowhere in the North of Ireland except at that class, and, of course, he attended the class. For 42 years the Science and Art Department, which has recently doubled its already great efficiency, has been giving chances of this kind to every clever young man in the country from long before any physical science was taught in any English public school. The one essential thing for the exceptional boy is that he shall find within his reach chances to take advantage of, chances of learning, chances of practice, and, over and above all, chances of meeting great men. It takes me off my subject a little, but I should like here to illustrate this matter from my own personal experience.

I had already been an apprentice for four years at the Lagan Foundry when I entered Queen's College for a course of civil engineering. I suppose that there never was on this earth a college so poorly equipped for a course of engineering study. Even the lecture-room—this lecture-room in which you are now sitting—was borrowed from the physics professor. There was a narrow passage, ironically called a "drawing-room," and this was the only space reserved for engineering in a town whose engineering work was even then very important. There were some theodolites and levels and chains for surveying, but nothing else in the way of apparatus. But there was as professor a man of very great individuality; he acted as president of this section 28 years ago. I can hardly express my obligations to Prof. James Thomson. It was my good fortune to be a pupil both of this great man and of his younger brother Lord Kelvin, as well as of Dr. Andrews. It is not because these three men were born in Belfast that we here call them great. It is not because Tait (late of Edinburgh) and Purser (now the president of Section A) were professors at this college that we call them great. All the scientific men of the world are agreed to call these men very great indeed. To come in contact with any of them, even for a little while, as a student altered for ever one's attitude to Nature. It was not that they gave us information, knowledge, facts. The syllabuses of their courses of study were nothing like so perfect as that of the smallest German polytechnic. And yet if a youth with a liking for physical science had gone to a German gymnasium to the age of 19, and had become a walking encyclopædia on leaving one's polytechnic at the age of 24, the course of that life study would not have done for him as much good as was done by a month's contact with one of these men. People call it "personal magnetism," and think there is something occult about it. In truth, they revealed to the student that he himself was a man, that mere learning was unimportant, that one's own observation of some common phenomenon might lead to important results unknown to the writers of books. They made one begin to think for oneself for the first time. Let me give an example of how the thing worked.

James Thomson was known to me as the son of the author of my best mathematical books, but more particularly as the man who had first used Carnot's principle in combination with the discovery of Joule, and I often wondered why Rankine and Clausius and Kelvin got all the credit of the discovery of the second law of thermodynamics Men think of this work of his merely as having given the first explanation of regelation of ice and the motion of glaciers. He was known to me as the inventor of the Thomson turbine and centrifugal pump and jet pump. His name was to be found here and there in all my text-books, always in connection with some thoroughly well-worked-out investigation, as it is to be found in all good text-books now; for wherever he left a subject, there that subject has remained until this day; nobody has added to it or found a mistake in it. He was to me a very famous man, and yet he treated me as a fellow-student. One of his early lectures was about flowing water, and he told us of a lot of things he had observed, which I also had observed without much thought; and he showed how these simple observations completely destroyed the value of everything printed in every text-book on the subject of water flowing over gauge-notches, even in the otherwise very perfect Rankine. I felt how stupid I had been in not having drawn these conclusions myself, but, in truth, till then I had never ventured for a moment to criticise anything in a book. I have been a cautious critic of all statements in text-books ever since. If any engineer wants to read what is almost the most instructive paper that has ever been written for engineers, let him refer to the latest paper written by James Thomson on this subject. The reasoning there given was given to me in lectures in this very room in 1868, and had been given to students for many years previous.

Again, soon afterwards, he let me see that although I had often looked at the whirlpool in a basin of water when the central bottom hole is open, and although I had read Edgar Allen Poe's mythical description of the maelstrom, I had been very much too careless in my observation. Among other things, Thomson had observed that particles of sand gradually passed along the bottom towards the hole. When he found out the cause of this, it led him at once to several discoveries of great importance. Indeed, the study of this simple observation gave rise to all his work on (1) what occurs at bends of pipes and channels, and why rivers in alluvial plains bend more and more; (2) the explanation of the curious phenomena that accompany great forest fires; (3) the complete theory of the great wind circulation of the earth, published in its final form as the Bakerian lecture of the Royal Society in 1892.

But why go on? He taught me to see that the very commonest phenomenon had still to reveal important secrets to the understanding eye and brain, and that no man is a true student unless he is a discoverer. And so it was with Kelvin and Andrews. Their names were great before the world, and yet they treated one as a fellow-student. Is any expenditure of money too large if we can obtain great men like these for our engineering colleges? Money is wanted for apparatus, and more particularly for men, and we spend what little we have on bricks and mortar!

The memory of a man so absolutely honest as Prof. James Thomson was compels me to say here that I was in an exceptionally fit state to benefit by contact with him, for I hungered for scientific information. I do not think that there was so much benefit for the average student whose early education had almost unfitted him for engineering studies. To work quantitatively with apparatus is good for all students, but it is absolutely necessary for the average student, and, as I said before, there was no apparatus. Also, the average student cannot learn from lectures merely, but needs constant tutorial teaching, and the professor had no assistant.

Anybody who wants to know what kind of engineering school there ought to be in such a college as this can see excellent specimens (sometimes several in one town) in Glasgow, Birmingham, Liverpool London, Manchester, Leeds, Bristol, Nottingham, Edinburgh, and other great cities. There the fortunate manufacturers have given many hundreds of thousands of pounds for instruction in applied science (engineering). In America the equipment of such schools is much more thorough, and there are large staffs of teachers, for fortunate Americans have contributed tens of millions of pounds for this kind of assistance to the rising generation. Germany and Switzerland compete with America in such preparation for supremacy in manufacture and engineering, and nearly every country in the world is more and more recognising its importance as they see the great inventions of Englishmen like Faraday and Perkin and Hughes and Swan developed almost altogether in those countries which believe in education. Even £100,000 would provide Queen's College, Belfast, with the equipment of an engineering school worthy of its traditions and position, and Belfast is a city in which many large business fortunes have been made.

It is interesting to note that the present arrangements of the Royal University of Ireland, with which the college is affiliated, are such that most of the successful graduates in engineering of Queen's University would now be debarred from taking the degree. Even in London University Latin is not a compulsory subject for degrees in science; Ireland has taken a step backwards towards the Middle Ages at the very time when other countries are stepping forward.

Well-equipped schools of applied science are getting to be numerous, but I am sorry to say that only a few of the men who leave them every year are really likely to become good engineers. The most important reason for this is that the students who enter them come usually from the public schools; they cannot write English; they know nothing of English subjects; they do not care to read anything except the sporting news in the daily papers; they cannot compute; they know nothing of natural science; in fact, they are quite deficient in that kind of general education which every man ought to have.

I am not sure that such ignorant boys would not benefit more by entering works at once than by entering a great engineering school. They cannot follow the college courses of instruction at all, in spite of having passed the entrance examination by cramming. Whereas after a while they do begin to understand what goes on in a workshop; and

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if they have the true engineer's spirit, their workshop observation will greatly correct the faults due to stupid school work.

Perhaps I had better state plainly my views as to what general education is best for the average English boy. The public schools of England teach English through Latin, a survival of the time when only special boys were taught at all, and when there was only one language in which people wrote. Now the *average* boy is also taught Latin, and when he leaves school for the army or any other pursuit open to average boys he cannot write a letter, he cannot a grammatical sentence, he cannot describe anything he has seen. The public school curriculum is always growing, and it is never subtracted from or rearranged. There is one subject which ordinary schoolmasters can teach well — Latin. The other usual nine subjects have gradually been added to the curriculum for examination purposes; they are taught in watertight compartments—or, rather, they are only crammed, and not taught at all. Our school system resembles the ordinary type of old-established works, where gradual accretion has produced a higgledy-piggledy set of shops which one looks at with stupefaction, for it is impossible to get business done in them well and promptly, and yet it seems impossible to start a reform anywhere. What is wanted is an earthquake or a fire—a good fire—to destroy the whole works and enable the business to be reconstructed on a consistent and simple plan. And for much the same reason our whole public school system ought to be "scrapped." What we want to see is that a boy of fifteen shall be fond of reading, shall be able to compute, and shall have some knowledge of natural science; or, to put it in another way, that he shall have had mental training in the study of his own language, in the experimental study of mathematics, and in the methods of the student of natural science. Such a boy is fit to begin any ordinary profession, and whether he is to enter the Church, or take up medicine or surgery, or become a soldier, every boy ought to have this kind of training. When I have advocated this kind of education in the past I have usually been told that I was thinking only of boys who intend to be engineers; that it was a specialised kind of instruction. But this is very untrue. Let me quote from the recommendations of the 1902 Military Education Committee (Report, p. 5): "The fifth subject which may be considered as an essential part of a sound general education is experimental science—that is to say, the science of physics and chemistry treated experimentally. As a means of mental training, and also viewed as useful knowledge, this may be considered a necessary part of the intellectual equipment of every educated man, and especially so of the officer, whose profession in all its branches is daily becoming more and more dependent on science." When statements of this kind have been made by some of us in the past, nobody has paid much attention; but I beg you to observe that the headmaster of Eton and the headmaster of St. Paul's School are two of the members of the important committee who signed this recommendation, and it is impossible to ignore it. Last year, for the first time, the president of the Royal Society made a statement of much the same kind, only stronger, in his annual address. I am glad to see that the real value of education in physical science is now appreciated; that mere knowledge of scientific facts is known to be unimportant compared with the production of certain habits of thought and action which the methods of scientific study usually produce.

As to English the committee say: "They have no hesitation in insisting that a knowledge of English, as tested by composition, together with an acquaintance with the main facts of the history and geography of the British Empire, ought in the future to hold the *first* place in the examination and to be exacted from all candidates." The italics are mine. It will be noticed that they say nothing about the practical impossibility of obtaining teachers. As to mathematics, the committee say: "It is of almost equal importance that every officer should have a thorough grounding in the elementary part of mathematics. But they think that elementary mechanics and geometrical drawing, which under the name of practical geometry is now often used as an introduction to theoretical instruction, should be added to this part of the examination, so as to ensure that at this stage of instruction the practical application of mathematics may not be left out of sight." As Sir Hugh Evans would have said, "It is a very discretion answer—the meaning is good"; but I would that the committee had condemned abstract mathematics for these army candidates altogether. This committee recommends for the Woolwich and Sandhurst candidates a reform that has already been carried out by London University. No dead language is to be compulsory, but unfortunately some language other than English is still to be compulsory. Those boys, of whom there are so many, who dislike and cannot learn another language are still to be labelled "uneducated."

This report appears in good time. It would be well if committees would sit and take evidence as to the education of men in the other professions entered by our average boys. It is likely that when an authoritative report is prepared on the want of education of clergymen, for example, exactly the same statements will be made in regard to the general education which ought to precede the technical training; but perhaps a reference may be made in the report to the importance of a study of geology and biology as well as physical science. Think of the clergyman being able to meet his scientific enemies in the gate!

Thanks mainly to the efforts of a British Association committee, really good teaching of experimental science is now being introduced into all public schools, in spite of most persistent opposition wearing an appearance of friendliness. In consequence, too, of the appointment of a British Association committee last year, at what might be called the psychological moment, a great reform has already begun in the teaching of mathematics. Even in the regulations for the Oxford Locals for 1903 Euclid is repudiated. It seems probable that at the end of another five years no average boy of 15 years of age will have been compelled to attempt any abstract reasoning about things of which he knows nothing; he will be versed in experimental mathematics, which he may or may not call mensuration; he will use logarithms, and mere multiplication and division will be a joy to him; he will have a working power with algebra and sines and cosines; he will be able to tackle at once any curious new problem which can be solved by squared paper; and he will have no fear of the symbols of the infinitesimal calculus. When I insist that a boy ought to be able to compute, this is the sort of computation that I mean. Five years hence it will be called "elementary mathematics." Four years ago it was an unorthodox subject called "practical mathematics," but it is establishing itself in every polytechnical and technical college and evening or day science school in the country. Several times I have been informed that on starting an evening class, when plans have been made for a possible attendance of 10 or 20 students, the actual attendance has been 200 to 300. Pupils may come for one or two nights to a class on academic mathematics, but then stay away for ever; a class in practical mathematics maintains its large numbers to the end of the winter.

Hitherto the average boy has been taught mathematics and mechanics as if he were going to be a Newton or a Laplace; he learnt nothing and became stupid. I am sorry to say that the teaching of mechanics and mechanical engineering through experiment is comparatively unknown. Cambridge writers and other writers of books on experimental mechanics are unfortunately ignorant of engineering. University courses on engineering—with one splendid exception, under Prof. Ewing at Cambridge—assume that undergraduates are taught their mechanics as a logical development of one or two axioms; whereas in many technical schools under the Science and Art Department apprentices go through a wonderfully good laboratory course in mechanical engineering. We really want to give only a few fundamental ideas about momentum and the transformations of energy and the properties of materials, and to give them from so many points of view that they become part of a student's mental machinery, so that he uses them continually. Instead of giving a hundred labour-saving rules which must be forgotten, we ought to give the one or two ideas which a man's common-sense will enable him to apply to any problem whatsoever and which cannot be forgotten. A boy of good mathematical attainments may build on this experimental knowledge afterwards a superstructure more elaborate than Rankine or Kelvin or Maxwell ever dreamt of as being possible. Every boy will build some superstructure of his own.

I must not dwell any longer on the three essential parts of a good general education which lead to the three powers which all boys of 15 ought to possess: power to use books and to enjoy reading; power to use mathematics and to enjoy its use; power to study Nature sympathetically. English Board school boys who go to evening classes in many technical schools after they become apprentices are really obtaining this kind of education. The Scotch Education Board is trying to give it to all boys in primary and secondary schools. It will, I fear, be some time before the sons of well-to-do parents in England have a chance of obtaining it.

When a boy or man of any age or any kind of experience enters an engineering college, and wishes to learn the scientific principles underlying a trade or profession, how ought we to teach him? Here is the reasonable general principle which Profs. Ayrton and Armstrong and I have acted upon, and which has so far led us to much success. Whether he comes from a bad or a good school, whether he is an old or young boy or man, approach his intelligence through the knowledge and experience he already possesses. This principle involves that we shall compel the teacher to take the pupil's point of view rather than the pupil the teacher's; give the student a choice of many directions in which he may study; let lectures be rather to instruct the student how to teach himself than to teach him; show the student how to learn through experiment, and how to use books, and, except for suggestion and help when asked for, leave him greatly to himself. If a teacher understands the principle he will have no difficulty in carrying it out with any class of students. I myself prefer to have students of very different qualifications and experience in one class because of the education that each gives to the others. Usually, however, except in evening classes, one has a set of boys coming from much the same kind of school, and although, perhaps, differing considerably as to the places they might take in an ordinary examination, really all of much the same average intelligence. Perhaps I had better describe how the principle is carried out in one case—the sons of well-to-do parents such as now leave English schools at about 15 years of age.

It was for such boys that the courses of instruction at the Finsbury Technical College (the City and Guilds of London Institute) were arranged 22 years ago. It was attempted to supply that kind of training which ought already to have been given at school, together with so much technical training as might enable a boy at the end of a two years' course to enter any kind of factory where applied science was important, with an observing eye, an understanding brain, and a fairly skilful hand. The system, in so far as it applies to various kinds of mechanical engineering, will be found described in one of a small collection of essays called "England's Neglect of Science," pp. 57-67. I am sure that any engineer who reads that description will feel satisfied that it was the very best course imaginable for the average boy of the present time. A boy was taught how he must teach himself after he entered works. If after two or three years in the works he cared to go for a year or so to one of the greater colleges, or did not so care, it was assured that he had had such a training as would enable him to choose the course which was really the best for him.

Old Finsbury students are to be found everywhere in important posts. The experiment has proved so successful that every London polytechnic, every municipal technical school in the country has adopted the system, and in the present state of our schools I feel sure that all important colleges ought to adopt the Finsbury system. It hardly seems appropriate to apply the word "system" to what was so plastic and uncrystallised, and had nothing to do with any kind of ritual.

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The professors were given a free hand at Finsbury, and there were no outside examiners. I need not dwell upon the courses in chemistry and physics (some critics might call the subjects *rational* chemistry and applied physics); they were as different from all other courses of study in these subjects as the courses on rational mathematics and mechanics differed from all courses elsewhere. The course on mechanics was really one on mechanical engineering. There were workshops in wood and iron, not to teach trades, but rather to teach boys the properties of materials. There were a steam-engine and a gas-engine, and shafting and gearing of many kinds, and dynamos which advanced students in turn were allowed to look after under competent men. There was no machine which might not be experimented with occasionally. Elementary and advanced courses of lectures were given; there was an elaborate system of tutorial classes, where numerical and squared paper exercise work was done; there were classes in experimental plane and solid geometry, including much graphical calculation; boys were taught to make drawing-office drawings in pencil only, and tracings and blue prints, such as would be respected in the workshop, and not the ordinary drawing-class drawings, which cannot be respected anywhere; but the most important part of the training was in the laboratory, in which every student worked, making quantitative experiments. An offer of a 100-ton testing machine for that laboratory was made but refused; the advanced students usually had one opportunity given them of testing with a large machine, but not in their own laboratory. I consider that there is very little educational value in such a machine; the student thinks of the great machine, and not of the tiny specimen. Junior students loaded wires and beams, or twisted things with very visible weights, and saw exactly what was happening, or they studied vibrating bodies. Many hours were devoted to experiments on a battered, rusty old screw-jack, or some other lifting machine, its efficiency under many kinds of load being determined, and students studied their observations using squared paper, as intently as if nobody had ever made such experiments before. There was one piece of apparatus, an old flywheel bought at a rag-and-bone shop, to which kinetic energy was given by a falling weight, which, I remember, occupied the attention of four white-headed directors of electric companies in 1882 (evening students) for many weeks. A casual first measurement led on to corrections for friction and stiffness of a cord, and much else of a most interesting kind. At the end of six weeks these gentlemen had gained a most thorough computational acquaintance with every important principle of mechanics, a knowledge never to be forgotten. They had also had a revelation such as comes to the true experimenter—but that is too deep a subject.

Perhaps teachers in the greater colleges will smile in a superior way when they hear of this kind of experimental mechanics being called engineering laboratory work. True, it was elementary mechanics; but is not every principle which every engineer constantly needs called a mere elementary principle of mechanics by superior persons? I find that these elementary principles are very much unknown to men who have passed through elaborate mathematical studies of mechanics. Students found out in that laboratory the worth of formulæ; they gained courage in making calculations from formulæ, for they had found out the extent of their own ignorance and knowledge.

I have never approved of elaborate steam-engines got up for students' laboratory exercise work. A professor who had devoted much thought for a year to the construction of such a four-cylinder engine showed a friend how any one or any two or any three or all four cylinders, with or without jacketing, could be used in all sorts of ways. The friend ventured to say, "This engine will be used just once and never after." The professor was angry, but his friend proved to be right. The professor made experiments with it once himself with a few good students. Unfortunately it was not a sufficiently elaborate investigation for publication. Afterwards he never had time personally to superintend such work; his assistants were busy at other things; his students could not be trusted with the engine by themselves; and to this day it stands in the laboratory a beautiful but useless piece of apparatus. At Finsbury there was an excellent one-cylinder engine with vaporising condenser. It drove the workshops and electric generators. On a field day it drove an electric generator only, and perhaps 30 students made measurements. Each of them had already acted as stoker and engine-driver, as oiler and tester of the machinery, lighting fires, taking indicator diagrams, weighing coal, opening and closing cocks from 7 in the morning to 10 at night, so that everything was well known to him. They maintained three different steady loads for trials of three hours each. They divided into groups, one from each group ceasing to take a particular kind of observation every 10 minutes and removing to another job. All watches were made to agree, and each student noted the time of each observation. These observations were: taking indicator diagrams, checking the speed indicator, taking temperature of feed water, quantity of feed by meter (the meter had been carefully checked by gauge notch, and every other instrument used by us had been tested weeks before), taking the actual horse-power passing through a dynamometer coupling on the shaft, taking boiler and valve-chest pressures and vacuum pressures on the roof and in the engine-room, weighing coal (the calorific value had already been tested), taking the horse-power given out by the dynamo, counting the electric lamps in use, and so on. Each student was well prepared beforehand. During the next week he reduced his own observations, and some of the results were gathered on one great table. One lesson that this taught could never be forgotten—how the energy of 1lb. of coal was disposed of. So much up the chimney or by radiation from boiler or steam jacket and pipes; in condensation in the cylinder; to the condenser; in engine friction; in shaft friction, etc. I cannot imagine a more important lesson to a young engineer than this one taught through a common working engine. The students had the same sort of experience with a gas-engine. I need hardly say how important it was that the professor himself should take charge of the whole work leading up to, during, and after such a field day.

The difficulty about all laboratory exercise work worth the name is that of finding demonstrators and assistants who are wise and energetic. Through foolishness and laziness the most beautiful system becomes an unmeaning routine, and the more smoothly it works the less educational it is. In England just now the curse of all education is the small amount of money available for the wages of teachers—just enough to attract mediocre men. I have been told, and I can easily imagine that such men have one talent over-developed, the talent for making their job softer and softer, until at length they just sit at a table, maintaining discipline merely by their presence, answering the questions of such students as are earnest enough to come and worry them. In such cases it is absolutely necessary to periodically upset their clockwork arrangements. After such an artificial earthquake one might be reminded of what occurred at the pool of Bethesda, whose waters had their healing property restored when the angel came down and troubled them. But for a permanently good arrangement there ought to be very much higher wages all round in the teaching profession.

No kind of engineering has developed so rapidly as the electrical. Why, it was at the meeting here in Belfast 28 years ago (I remember, for I was a secretary of Section A that year, and took the machine to pieces afterwards in Lord Kelvin's laboratory) that there was exhibited for the first time in these islands a small Gramme machine. This handmaid of all kinds of engineering is now so important that every young engineer may be called uneducated who has not had a training in that kind of mechanical engineering which is called electrical engineering. Prof. Ayrton's laboratory at Finsbury is the model copied by every other electrical engineering laboratory in the world. He and I had the same notions; we had both been students of Lord Kelvin; we had worked together in Japan since 1875; but whereas I was trying to make my system of teaching mechanical engineering replace an existing system, or want of system, there was no existing system for his to replace. Thus it will be found that in every electrical engineering laboratory the elementary principles are made part of a pupil's mental machinery by many quantitative experiments, and nobody suggests that it is mere elementary physics which is being taught—a suggestion often enough made about the work in my mechanical laboratory. When students know these elementary principles well, they can apply their mathematics to the subject. As they advance in knowledge they are allowed to find out by their own experiments how their simple theories must be made more complex in real machines. Their study may be very complete, but, however much mathematics and graphical calculation may come in, their designs of electrical machinery are really based upon the knowledge acquired by them in the electrical and mechanical laboratories.

The electrical engineer has an enormous advantage over other engineers; everything lends itself to exact calculation, and a completed machine or any of its parts may be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by other engineers, do not destroy the body tested. But for this very reason, as a finished product, the electrical engineer cannot have that training in the exercise of his judgment in actual practical work after he leaves a college that some other engineers must have. In tunnelling, earthwork, and building, in making railways and canals, the engineer is supremely dependent on the natural conditions provided for him, and these conditions are never twice the same. There are no simple laws known to us about the way in which sea and river currents will act upon sand and gravel, and engineers who have had to do with such problems are continually appealing to Nature, continually making observations and bringing to bear upon their work all the knowledge and and habits of thought that all their past experience has given them. I do not know that there is any job which a good teacher would have greater pleasure in undertaking than the arrangement of a laboratory in which students might study for themselves such problems as come before railway, canal, river, harbour, and coast protection engineers. There is no such laboratory in existence at the present time, and in any case it could only be of use in the way of mere suggestion to an engineer who had already a good knowledge of his profession.

It was a curious illustration of mental inertia that the usual engineering visitor, even if he was a professor of engineering, always seemed to suppose that the work done at Finsbury was the same as that done in all the great engineering colleges. As a matter of fact no subject was taught there in the same manner as it was taught elsewhere.

Most of the students were preparing for electrical or mechanical engineering, and therefore we thought it important that nearly every professor or demonstrator or teacher should be an engineer. I know of nothing worse than that an engineering student should be taught mathematics or physics or chemistry by men who are ignorant of engineering, and yet nothing is more common in colleges of applied science. The usual courses are only suitable for men who are preparing to be mere mathematicians, or mere physicists, or mere chemists. Each subject is taken up in a stereotyped way, and it is thought quite natural that in one year a student shall have only a most elementary knowledge of what is to the teacher such a great subject. The young engineer never reaches the advanced parts which might be of use to him; he is not sufficiently grounded in general principles: his whole course is only a preliminary course to a more advanced one which there is no intention of allowing him to pursue, and, not being quite a fool, he soon sees how useless the thing is to him. The professor of chemistry ought to know that until a young engineer can calculate exactly by means of a principle, that principle is really unknown to him. For example, take the equation supposed to be known so well,

$$2H_2 + O_2 = 2H_2O.$$

It is never understood by the ordinary elementary chemical student who writes it down so readily. Every one of the six cunning ways in which that equation conveys information ought to be as familiar

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to the young engineer as they are, or ought to be, to the most specialised chemist. Without this he cannot compute in connection with combustion in gas and oil engines and in furnaces. But I have no time to dwell on the importance of this kind of exact knowledge in the education of an engineer.

Mathematics and physics and chemistry are usually taught in watertight compartments, as if they had no connection with one another. In an engineering college this is particularly bad. Every subject ought to be taught through illustrations from the professional work in which a student is to be engaged. An engineer has been wasting his time if he is able to answer the questions of an ordinary examination paper in chemistry or pure mathematics. The usual mathematical teacher thinks most of those very parts of mathematics which to an ordinary man who wants to *use* mathematics are quite valueless, and those parts which would be altogether useful and easy enough to understand he never reaches ; and, as I have said, so it is also in chemistry. Luckily, the physics professor has usually some small knowledge of engineering ; at all events, he respects it. When the pure mathematician is compelled to leave the logical sequence which he loves to teach mechanics he is apt scornfully to do what gives him least trouble—namely, to give as "mechanics" that disguised pure mathematics which forms 90 per cent. of the pretence of theory to be found in so many French and German books on machinery. As pure mathematical exercise work it is even meaner than the stupid exercises in school algebras ; as pretended engineering it does much harm, because a student does not find out its futility until after he has gone through it, and his enthusiasm for mathematics applied to engineering problems is permanently hurt. But how is a poor mathematical professor who dislikes engineering, feeling like Pegasus harnessed to a common wagon—how is he to distinguish good from evil? He fails to see how worthless are some of the books on "Theoretical Mechanics" written by mathematical coaches to enable students to pass examinations. An engineer teaching mathematics would avoid all futilities ; he would base his reasoning on that experimental knowledge already possessed by a student ; he would know that the finished engineer cannot hope to remember anything except a few general principles, but that he ought to be able to apply these, clumsily or not, to the solution of any problem whatsoever. Of course he would encourage some of his pupils to take up Thomson or Tait, or Rayleigh's "Sound," or some other classical treatise as an advanced study.

Not only do I think that every teacher in an engineering college ought to have some acquaintance with engineering, but it seems to me equally important to allow a professor of engineering, who ought, above all things, to be a practical engineer, to keep in touch with his profession. A man who is not competing with other engineers in practical work very quickly becomes antiquated in his knowledge : the designing work in his drawing office is entirely out of date ; he lectures about old difficulties which are troubles no longer ; his pupils have no enthusiasm in their work because it is merely academic and lifeless ; even when he is a man distinguished for important work in the past his students have that kind of disrespect for his teaching which makes it useless to them. If there is fear that too much well-paid professional work will prevent efficiency in teaching, there is no great difficulty in applying a remedy.

One most important fact to be borne in mind is that efficient teachers cannot be obtained at such poor salaries as are now given. An efficient labourer is worthy of his hire ; an inefficient labourer is not worthy of any hire, however small. Again, there is a necessity for three times as many teachers as are usually provided in England. The average man is in future to be really educated. This means very much more personal attention, and from thoughtful teachers. Is England prepared to face the problem of technical education in the only way which can lead to success, prepared to pay a proper price for the real article ? If not, she must be prepared to see the average man remaining uneducated.

Advocacy of teaching of the kind that was given at Finsbury is often met by the opposition not only of pure mathematicians and academic teachers, but I am sorry to say also of engineers. The average engineer not merely looks askance at, he is really opposed to the college training of engineers, and I think, on the whole, that he has much justification for his views. University degrees in engineering science are often conferred upon students who follow an academic course, in which they learn little except how to pass examinations. The graduate of to-day even does not often possess the three powers to which I have referred. He is not fond of reading, and therefore he has no imagination, and the idea of an engineer without imagination is as absurd as Teufelsdröch's notion of a cast-iron king. He cannot really compute, in spite of all his mathematics, and he is absurdly innocent of the methods of the true student of Nature. This kind of labelled scientific engineer is being manufactured now in bulk, because there is a money value attached to a degree. He is not an engineer in any sense of the word, and does not care for engineering, but he sometimes gets employment in technical colleges. He is said to teach when he is really only impressing upon deluded pupils the importance of formulæ, and that whatever is printed in books must be true. The real young engineer, caught in this eddy, will no doubt find his way out of it, for the healthy experience of the workshop will bring back his common-sense. For the average pupil of such graduates there is no help. If he enters works, he knows but little more than if he had gone direct from school. He is still without the three qualifications which are absolutely necessary for a young engineer. He is fairly certain to be a nuisance in the works and to try another profession at the end of his pupilage. But if it is his father's busines he can make a show of knowing something about it, and he is usually called an engineer.

Standardisation in an industry usually means easier and cheaper and better manufacture, and a certain amount of it must be good even in engineering, but when we see a great deal of it we know that in that industry the true engineer is disliked. I consider that in the scholastic industry there has been far too much standardisation. Gymnasien and polytechnic systems are standardised in Germany, and there is a tendency to import them into England ; but in my opinion we are very far indeed from knowing any system which deserves to be standardised, and the worst we can copy is what we find now in Germany and Switzerland. What we must strive for is the discovery of a British system suiting the British boy and man. The English boy may be called stupid so often that he actually believes himself to be stupid ; but of one thing we may be sure—he will find in some way or other an escape from the stupefying kind of school work to which the German boy submits. And if it were possible to make the average English boy of 19 pass such a silly school-leaving examination as the German boy,* and to pass through a polytechnic, I am quite sure that there would be little employment among common-sense English engineers for such a manufactured article. But is it possible that British boys could be manufactured into such obedient academic machines, without initiative or invention or individuality, by teachers who are none of them engineers? No, we must have a British system of education. We cannot go on much longer as we have done in the past without engineering education ; and, furthermore, it must be such as to commend itself to employers. Of my Finsbury students, I think I may say that not one failed to get into works on a two or three years' engagement, receiving some very small wage from the beginning, and without paying a premium. To obtain such employment was obviously one test of fitness to be an engineer, because experienced men thought it impossible. One test of the system was the greater ease with which new men obtained employment in shops which had already taken some of our students. It is certainly very difficult to convince an employer that a college man will not be a nuisance in the shops. In Germany and in France, and to a less extent in America, there is among employers a belief in the value of technical education. In England there is still complete unbelief. I have known the subscribers of money to a large technical college in England (the members of its governing board) to laugh, all of them, at the idea that the college could be of any possible benefit to the industries of the town. They subscribed because just then there was a craze for technical education due to a recent panic. They were ignorant masters of works (sons of the men who had created the works), ignorant administrators of the college affairs, and ignorant critics of their mismanaged college. I feel sure that if the true meaning of technical education were understood, it would commend itself to Englishmen. Technical education is an education in the scientific and artistic principles which govern the ordinary operations in any industry. It is neither a science, nor an art, nor the teaching of a handicraft. It is that without which a master is an unskilled master ; a foreman an unskilled foreman ; a workman an unskilled workman ; and a clerk or farmer an unskilled clerk or farmer. The cry for technical education is simply a protest against the existence of unskilled labour of all kinds.

To have any good general system the employers must co-operate. Much of the training is workshop practice, and it cannot be too often said that this is not to be given in any college. The workshop in a college serves a quite different purpose. Now how may the practice best be given? I must say that I like the Finsbury plan very much indeed, but there are others. When I attended this college in winter I was allowed to work in the Lagan Foundry in summer. In Japan the advanced students did the same thing ; they had their winter courses at the college, and the summer was spent in the large Government workshops. The system worked very well indeed. In Germany recently the great unions of manufacturers made facilities for giving a year of real factory work to the polytechnic students, but it seems to me that these men are much too old for entrance to works, and, besides, a year is too short a time if the finished product is to call itself a real engineer. Possibly the British solution may be quite different from any of these. A boy may enter works at 14 on leaving a primary school or not later than 16 on leaving a secondary school. In either case he must have the three powers to which I have already referred so often. It will be recognised as the duty of the owners of works to provide, either in one large works or near several works, in a well-equipped school following the Finsbury principle, all that training in the principles underlying the trade or profession which is necessary for the engineer.

No right-thinking engineer has been scared by the newspaper writers who tell us of our loss of supremacy in manufacture, but I think that every engineer sees the necessity for reform in many of our ways, and especially in this of education. People talk of the good done to our workmen's ideas by the strike of two years ago. It is to be hoped that the employers' ideas were also expanded by their having been forced to travel and to see that their shops were quite out of date. In fact, we have all got to see that there is far too much unskilled labour among workmen, and foremen, and managers, and especially in owners. There may be some kinds of manufacture so standardised that everything goes like a wound-up clock, and no thought is needed anywhere ; but certainly it is not in any branch of engineering. Many engineering things may be standardised, but not the engineer himself. Millions of money may build up trusts, but they will be wasted if the unskilled labour of mere clerks is expected to take the place of the thoughtful skilled labour of owners and managers. I go further, and say that no perfection in labour-saving

* The following is, I understand, a stock question at certain gymnasien : "Write out all the trigonometrical formulæ you know." I asked my young informant, "Well, how many did you write?" "Sixty-two" was the answer. The young man informed me that a boy could not pass this examination unless he knew "*all* algebra and *all* trigonometry and *all* science." Strassburg geese used to be fed in France ; now they are fed in Germany. German education seems to be like smothering a fire with too much fuel or wet slack which has the appearance of fuel.

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tools will enable you to do without the skilled, educated, thoughtful, honest, faithful workman with brains. I laugh at the idea that any country has better workmen than ours, and I consider education of our workmen to be the corner-stone of prosperity in all engineering manufacture. It is from him in countless ways that all hints leading to great inventions come. New countries like America and Germany have their chance just now. They are starting, without having to "scrap" any old machinery or old ideas, with the latest machinery and the latest ideas. For them also the time will come when their machines will be getting out of date, and the cost of "scrapping" will loom large in their eyes. In the meantime they have taught us lessons, and this greatest of all lessons: that unless we look ahead with much judgment, unless we take reasonable precautions, unless we pay some regard to the fact that the cleverest people in several nations are hungry for our trade and jealous of our supremacy, we may for a time lose a little of that supremacy. In the last 23 years I have written a good deal about the harm done to England by the general dislike that there is among all classes for any kind of education. I do not say that this dislike is greater than it used to be in England; I complain that it is about as great. But I have never spoken of the decadence of England. It is only that we have been too confident that those manufactures and that commerce and that skill in engineering, for which Napoleon sneered at us, would remain with us for ever. Many writers have long been pointing out the consequences of neglecting education; prophesying those very losses of trade, that very failure of engineers to keep their houses in order, which now alarms all newspaper writers. Panics are ridiculous, but there is nothing ridiculous in showing that we can take a hint. We have had a very strong hint given us that we cannot for ever go on with absolutely no education in the scientific principles which underlie all engineering. There is another important thing to remember. Should foreigners get the notion that we are decaying, we shall no longer have our industries kept up by an influx of clever Uitlanders, and we are much too much in the habit of forgetting what we owe to foreigners, Fleming and German, Hollander, Huguenot, and Hebrew, for the development of our natural resources. Think of how much we sometimes owe to one foreigner like the late Sir William Siemens.

But I am going too far; there is, after all, not so very much of the foolishness of Ishbosheth among us, and I cannot help but feel hopeful as I think lovingly of what British engineers have done in the past. We who meet here have lived through the pioneering time of mechanical and electrical and various other kinds of engineering. Our days and nights have been delightful because we have had the feeling that we also were helping in the creation of a quite new thing never before known. It may be that our successors will have a better time—will see a more rapid development of some other applications of science. Who knows? In every laboratory of the world men are discovering more and more of Nature's secrets. The laboratory experiment of to-day gives rise to the engineering achievement of to-morrow. But I do say that, however great may be the growth of engineering, there can never be a time in the future history of the world, as there has never before been a time, when men will have more satisfaction in the growth of their profession than engineers have had during the reign of Queen Victoria.

And now I want to call your attention to a new phenomenon Over and over again has attention been called to the fact that the engineer has created what is called "modern civilisation," has given luxuries of all kinds to the poorest people, has provided engines to do all the slave labour of the world, has given leisure and freedom from drudgery, and chances of refinement and high thought and high emotion to thousands instead of units. But it is doing things more striking still. Probably the most important of all things is that the yoke of superstitions of all kinds on the souls of men should be lifted. The study of natural science is alone able to do this, but education through natural science for the great mass of the people, even for the select few called the distinguished men of the country, has been quite impossible till recently. I say that it is to engineers that the world owes the possibility of this new study becoming general. In our country nearly all discoveries come from below. The leaders of science, the inventors, receive from a thousand obscure sources the germs of their great discoveries and inventions. When every unit of the population is familiar with scientific ideas our leaders will not only be more numerous, but they will be individually greater. And it is we, and not the schoolmasters, who are familiarising the people with a better knowledge of Nature. When men can hardly take a step without seeing steam-engines and electromotors and telegraphs and telephones and steamships, with drainage and waterworks, with railways and electric tramways and motor cars; when every shop window is filled with the products of engineering enterprise, it is getting rather difficult for people to have any belief in evil spirits and witchcraft.

All the heart-breaking preaching of enthusiasts in education would produce very little effect upon an old society like that of England if it were not for the engineer. He has produced peace. He is turning the brown desert lands of the earth into green pastures. He is producing that intense competition among nations which compels education. If England has always been the last to begin reform, she has always been the most thorough and steadfast of the nations on any reform when once she has started on it. Education, pedagogy, is a progressive science; and who am I that I should say that the system of education advocated by me is that which will be found best for England? In school education of the average boy or man England has as yet had practically no experience, for she has given no real thought to it. Yet when she does, I feel that although the Finsbury scheme for engineers may need great improvement, it contains the germ of that system which must be adopted by a race which has always learnt through trial and error, which has been led less by abstract principles or abstract methods of reasoning than any race known in history.

The above address was discussed at a joint meeting of the Engineering and Educational Sections on Monday afternoon, Sept. 15, which was presided over by Prof. H. Armstrong.

Previous to the discussion, **Prof. John Perry** gave an exceedingly brief *résumé* of his address, concluding by drawing the attention of those present to one problem which should be borne in mind in the discussion. This was the question of the workshop experience. Ought this to come before, or during the engineering college course? In Japan his students had come to the college in the winter and worked in the Government works in the summer. His own experience had been on the same lines. They also should endeavour to get employers and the great engineers interested in the education of young engineers.

Sir Philip Magnus, in opening the discussion, said that the only claim he had to speak on the subject was derived from his association with Profs. Armstrong, Ayrton, and Perry in the establishment of the Finsbury College and the Central Institution. In 1883 he expressed his opinion that the agitation on methods of education would not subside until it had reorganised our education from the most elementary form up to the highest. He recently had been concerned with the creation of a faculty of engineering for the University of London, and had endeavoured to so arrange the programme that the objections often made to other college engineering degrees might not attach to the university. The fact that a degree could often be obtained by a mere academical course, followed by examinations, had not raised in the opinion of the manufacturer the value of the degree. In the training of a doctor practice and theory went together, and he suggested that something of the same kind might be done with engineering. For instance, if they had a mixed course, with five or six months in the year in the college and the remaining time spent in the workshops, it might do good. The interval when the students were in the workshops would give the professors a chance of keeping in touch with practical professional work.

Colonel R. E. Crompton, as an old public schoolboy, felt keenly the attacks lately made by Mr. Wells on public school education. Whatever the educational differences, the public schools cultivated in boys the manly habit of self-reliance, which was afterwards of value to the nation. He agreed with Prof. Perry that pupils in engineering colleges would do better if their previous training had been what it ought to be. The student should also be led to see results from his training as quickly as possible, so as to encourage him to further effort. Colonel Crompton then commented on the extreme value which education and training had on a body of men in war time. The Electrical Engineers in South Africa had proved what could be done with such a trained corps on emergencies.

Mr. Charles Hawksley, the president of the Institution of Civil Engineers, expressed his entire agreement with the statement that the preliminary training of boys must be such as would adapt them for the profession they were afterwards to adopt. He also agreed that the work should be made more pleasant than it had hitherto been to the boys themselves, so that they might see the advantage of learning. He thought that much good might come from what Sir P. Magnus had called the half time system, and the student might in actual work apply the scientific knowledge he had gained.

Sir W. H. Preece, K.C.B., protested against the idea that the Westminster engineers had any feeling against college-trained men. He had organised at Southampton, in 1868, the first school of electrical engineering in this country, and when the telegraph companies were taken over by the Government he had organised for the Post Office the educational system for telegraph engineers throughout the country. He believed in the education of the higher classes of engineers rather than giving a smattering of knowledge to a much larger number. He advocated that the college training should come first and the workshop experience afterwards, and that they should not be intermixed. It was of the utmost importance to encourage the powers of observation, and also the practice of writing or describing intelligibly what had been observed. Comparatively few men were able to write really clear reports of engineering processes. He quoted an instance of a German firm requiring English engineers for Colonial work, because they had found that college-trained German engineers were not self-reliant. The first requisite in the training was a good teacher, who should teach the pupils how to teach themselves, and it was of the utmost importance that these teachers should have actual experience of what they taught. He lamented that there was not more endowed engineering research in this country.

Prof. Griffiths attributed a good deal of our backwardness in scientific work to the idea which permeated public schools, that all science was bad form. This idea came quite as much from the parents as from the boys. He was afraid that it might take generations to convince certain classes of society that a knowledge of science was not derogatory. The fact remains that our engineering schools—and he specially referred to the University College of South Wales, with which he was connected—were not so successful as they might be. He had accordingly arranged a commission of enquiry, which was to be composed of practical engineers, employers of labour, teachers at the school, and parents of pupils, in order that the cause of the want of success could be gone into. He advocated that in all educational societies the discussions should not be confined so much as at present to those who taught only. In fact, teaching experts should not compose half of the membership of such societies. As regards the not mixing of the workshop and college experience, he thought that six months at the works was not long enough. He suggested that after nine months at college pupils should go to works for 15 months and then return and complete their college course. It was suggested, however, that under this procedure they might lose a considerable number of pupils from the college.

Mr. C. M. Stuart advocated more scientific methods of teaching, and that boys should be encouraged to experiment. He gave instances

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of how after university training in mathematics men settled down to a trade or profession without attempting to use in any way in their business the mathematics they knew. He was of opinion that few parents were really able to judge any more than their sons were as to their boys' capabilities for becoming engineers.

Mr. Mark Barr concluded the discussion. He said that under the old *régime* pupils were considered brilliant if they learned a certain number of accomplished facts. In this way they acquired practically no knowledge of synthesis, and were not taught how to think. Under the new system of teaching engineering students, it was of the utmost importance that they should learn how to attack new problems; in other words, they should aim at a synthetic system rather than an analytical one. He thought it a mistake to bring the workshop into the technical schools. The students should learn their workshop experience outside, and he thought that one year in the shops was quite sufficient for this. He advocated this workshop experience coming first, and that the lads should apply at the yard gate for ordinary lad's work. In the course of a year they would not learn to be expert workmen, but would learn generally how work was done, which was, he thought, sufficient for one who did not aim at taking a foreman's job. He advocated, in fact, that the college training should teach the students how to approach new problems and develop their inventive faculties.

The **President** (Prof. Armstrong), in closing the discussion, said that he had formed the idea that engineers were undertrained, as a rule, on the theoretical side and overtrained on the practical side. With reference to what Mr. Barr had said about boys asking for jobs themselves, the boy from school did not know how to ask, and would not do so until they were sent out into the world at an earlier age. He advocated the making men of our boys at an earlier age than at present.

A verbatim report of the above discussion is shortly to be published by Prof. J. Perry.

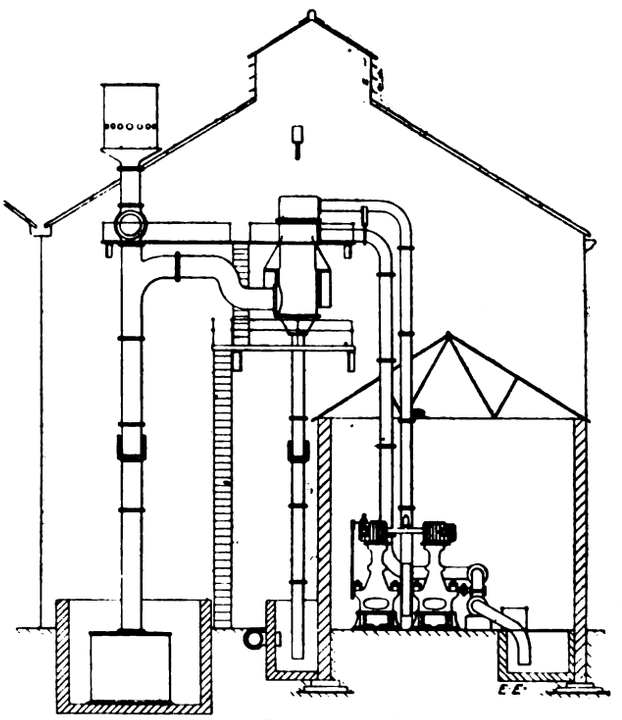
TRADE NOTICES AND NOVELTIES.

Atlas Engines and Boilers.

We have received from Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, London, E.C., an advance catalogue of Atlas engines and boilers, for which we are informed they are now the sole agents in this country. The goods manufactured by the Atlas Company include not only Corliss engines of any power, but also a small line comprising plain slide-valve engines and automatically controlled engines. The latter have a special feature in their shaft governor which, it is claimed, by means of its construction renders the regulation practically perfect, and the economy obtainable is about 25 per cent. greater than that to be obtained from a throttling engine. The prices of the goods described in this catalogue are given in a separate list, at the end of which is a useful table showing the horse-powers obtainable from the different sized engines with varying mean effective pressures and speeds. On p. 27 of the same price-list there is also a table showing the mean effective steam pressures with different initial pressures and points of cut-off, and by using this table in conjunction with the other table it is possible to find any size engine which is required to develop a certain horse-power. Messrs. Robert W. Blackwell and Co. have adopted this method in order to put their customers in a position to themselves determine the size engine which they require.

Condensing Plant.

Messrs. Cole, Marchent, and Morley, Limited, Prospect Foundry, Bradford, have recently published a new catalogue of their condensing equipments. We have no hesitation in recommending this catalogue to the notice of our readers. It certainly treats of its subject in a most thorough manner. Surface condensers, jet condensers, pumps, water coolers and towers, and auxiliary appliances are separately dealt with and fully illustrated by means of line drawings and photographic reproductions. Much matter of an instructive character is also included beyond what is usually found in catalogues. In the section devoted to combined independent jet condensing plants, the accompanying arrangement of a barometric jet condenser is shown. This form of plant consists of a jet condenser of the counter-current type, air-pump, and a rotary or reciprocating injection water-pump. The operation of the condensing plant is as follows: The condenser is placed about 29ft. above water level, and the steam entering at the bottom tends to rise, meeting on its upward movement the injection water falling in the opposite direction, and is consequently condensed. The water and the condensed steam fall to the bottom of the condenser, from which it passes by gravity to the well below through the barometric tube. In order to avoid any possible chance of water getting back into the engine, the exhaust pipe is taken up to 34ft. above the water level. As the position of the injection inlet is 30ft. to 40ft. above the water level, a pump is required to lift this water to the condenser. The vacuum will, however, lift that water part of the way, say 26ft. to 30ft. The water-pump is, therefore, only required to do the rest. The air-pumps are required for the purpose of clearing the condenser of air, and this is done very economically owing to its being cold. The barometric condenser is most useful in situations where there is a natural water supply. The barometric condenser in the form illustrated is claimed to require less power for its operation than any other form of condenser. The illustration shows the condenser supported from the end of an existing building. The exhaust steam, after passing through a grease separator, is taken upwards to an automatic exhaust relief valve, on the top of which is mounted an exhaust head. A branch on this pipe conveys the steam downwards to the condenser. The pumps are shown in a separate house, for convenience of illustration, but, as a matter

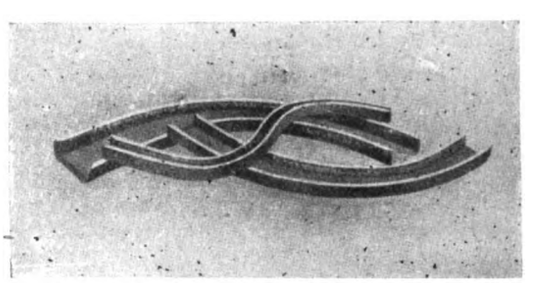


Arrangement of Barometric Jet Condenser.

of fact, they are placed in the engine-room of the electric supply station for which they were designed.

Bends in Troughing.

We are informed by the Howard Conduit Company, Limited, Trafford Park, Manchester, that the latest improvement in their well-known asphalt troughing is the method of making bends. For the purpose of these bends special troughs are made, similar in every respect to the ordinary asphalt trough, except that the inside of the sheet-iron casing is treated with a substance that allows the asphalt trough (when made slightly flexible by warming) to be removed from it with the aid of a knife passed between them. The asphalt trough can then be bent, as shown in the accompanying illustration, at any place



Bends in Troughing.

where warmed into any shape that may be required. These special troughs can be used also (as in the case of asphalt conduits) to advantage in the avoiding of obstructions in the trench. They are supplied at the same price as the troughs of the Howard Conduit Company's ordinary make.

Twin-Carbon Enclosed Arc Lamp.

From the British Thomson-Houston Company, Limited, we have received a copy of their pamphlet No. 133, which deals with the twin-carbon enclosed arc lamp described in our issue of Aug. 22 last.

Additional Traffic Returns.—Anglo-Argentine, £60 decrease; Barcelona Ensanche y Gracia, £61 decrease; Barcelona, £359 increase; Brisbane, £404 increase (month of August, £11,442, increase £2,942); Buenos Ayres and Belgrano Electric, £5 increase; Calcutta, £246 increase; Cape Town (month of August), receipts £15,450, expenditure £7,801; Isle of Thanet Electric, £233 increase; Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £209 increase; Port Elizabeth (month of August), receipts £4,014, expenditure £1,979.

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THE

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CONTENTS.

Notes	433	Questions and Answers	454
Association of Municipal and County Engineers	438	Companies' Meetings and Reports	459
The Use of Electricity in Iron and Steel Works	441	Contracts for Electrical Supplies	460
The British Association	443	Appointments Vacant	461
Trade Notices and Novelties	449	Traction Notes	462
The Education of Engineers	450	Lighting Notes	464
Forthcoming Events	451	Provisional Patents, 1902	466
Correspondence	451	Specifications Accepted	467
Reviews	452	Companies' Stock and Share List	467
Volts and Amperes in Relation to the Human Body	453	Traffic Returns	468

TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration*

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE EDUCATION OF ENGINEERS.

Amongst the various causes to which our loss of supremacy in certain branches of engineering has been attributed by those journals who delight in advertising Germany and the United States is that of deficient education. These papers glibly quote the large sums spent in Germany on technical schools, and neglect entirely to consider the class of education obtained for the expenditure in question. In certain branches of chemical industry the conclusions drawn are correct, but this is not the case with the education of engineers. This subject was fully discussed at Belfast at a joint meeting of the Mechanical and Educational Sections of the B.A., and an abstract of the various speeches appears in this issue. The presidential address of Prof. John Perry was on the same subject, and it was used to introduce the joint discussion. We leave on one side the effective pleas of this expert for a more rational educational system in our elementary and public schools with the remark that at present much valuable time is wasted in giving boys false ideas of mathematics and smatterings of dead languages which only serve as the bases of incorrect quotation. With a more reasonable system, the work of engineering schools would be lightened and more time could be spent on technical subjects. The most practical point under discussion from the parents' point of view was the question whether a boy should go first to an engineering school or to works. Suggestions were made as to the workshop and theoretical courses being intermixed, but there are considerable difficulties in doing so. We were pleased to find that the workshop training should, in the opinion of many, precede the time spent in acquiring theoretical knowledge. This preliminary experience in the works is of great value, as it gives a better idea of materials and of the use of tools than can be acquired in a few hours per week in a laboratory. Of more importance still is the knowledge obtained of workmen, and of the ways in which they can or cannot be controlled. With this practical experience, which need not extend over more than a year or so, a lad is better fitted to take the full benefit of the theoretical training to follow. It then remains to make the theoretical instruction of a kind best suited to produce good engineers. One essential is that the teachers shall be practical men, and that they shall keep well in touch with modern developments. Many of our large schools suffer at the present time from defects in their teaching staff which results from absurdly low salaries. This point can be amended in two ways: the first is to largely increase the salaries of the staff, so as to attract better men, and to continue to demand their whole time being devoted to their work; the other, which in certain cases is practical, is to employ a larger number of men actually engaged in practical work to devote a few hours per week only to teaching their special subjects This also would involve larger annual outlay, but it would effectually prevent that severance of theory from practice which is the fault of the German technical schools. Whatever is done, it is manifestly impossible to teach in a three-year course the whole range of subjects coming under the heading of "engineering." What, therefore, is wanted is a more perfect system of teaching students how to acquire knowledge and how to attack new problems on original lines. It is this class of training which is explained in Prof. Perry's address, and which is infinitely more valuable than giving to the student a stereotyped collection of facts and formulæ, to be accepted as sole requisites—in fact, in these days of extreme specialisation, the rising generation of engineers have to make positions for themselves in sections of the profession, which cannot usually be selected until they leave the

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technical colleges. It is, therefore, most essential that they should be so well grounded in general theory and in the application of it, that they can attack the special work in after life with confidence.

FORTHCOMING EVENTS.

MONDAY, SEPT. 29.

Opening.—Formal opening of the Tyneside Tramways and Tramroads Company's tramway system.

THURSDAY, OCTOBER 2

City and Mechanical Engineers' Society.—At 8 p.m., Caxton Hall, Westminster. Paper: "The General Engineering Scheme of Garden City," by Mr. E. Howard.

The following fixtures have also been made:

Municipal and County Engineers.—District meetings. Midland: Sept. 27, West Bromwich. Eastern: Oct. 25, King's Lynn. Home: October 11, Aldershot.

Municipal Officers' Association.—District meetings at Birmingham, Liverpool, and Newcastle are being arranged.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TENDERS ACCEPTED.

SIR,—In reading our *Electrical Engineer* this week we note, under the heading of "Tenders Accepted," you say "The tender of Belliss and Morcom has been accepted for the engines for the new inebriates' home at Langho." This statement is rather misleading, as our tender for the whole job has been accepted, including the above-named engines and Laurence-Scott dynamos. With reference to the Wolverhampton workhouse, we may say the whole of the electrical plant is also a part of our contract, which is for the complete electrical installation.—Yours, etc.,

G. H. WOODS AND CO.

Blackburn, Sept. 19, 1902.

FIRE DAMAGE.

SIR,—With reference to the fire which occurred at our works on Friday last, we should be obliged if you would afford us the opportunity of intimating to the large number of our customers who are also subscribers to the *Electrical Engineer*, that energetic measures have been taken to prevent any delay in delivery of Simplex material occurring through this mishap. We are pleased to report that no accident occurred, and that the outbreak was confined to one department only, thanks to the prompt action of the Birmingham fire brigade.—Yours, etc.,

THE SIMPLEX STEEL CONDUIT CO., LIMITED.

Birmingham, Sept. 22, 1902.

WATER POWER IN IRELAND.

SIR,—When reading the article in this week's copy of your paper upon the "Water Power in Ireland," I noticed you did not mention any existing works. With the exception of Carlow (co. Dublin) I do not call to mind any other electrical installation worked mainly by water power, for, of course, in the summer or in times of high flood steam auxiliary power has had to be provided. These works have been working for some years. It would be interesting to know of other similar works. Possibly some of your readers can give particulars of them (if any). Yours, etc.,

ASHTON BREMNER.

London, W.C., Sept. 19, 1902.

[The other plants we had in mind were those at Galway and Bushmills. The Galway Electric Company, Limited, have one 40-h.p. and one 80-h.p. turbine in regular work. The Bushmill power station supplies the Portrush and Giant's Causeway tramways, and contains one 75-h.p. and one 50-h.p. turbine working under a 27ft. head. Both the plants have been working for years, and in each case there has been trouble with the fishing-right owners.—ED. *E. E.*]

SIR,—In your last issue I read with interest a very able editorial on "Water Power in Ireland," and as a member of the committee appointed by the Londonderry County Council to investigate the possibility of utilising the water power of the Lower Bann, I was present when Mr. Dick read his very able paper at the recent meeting of the British Association in Belfast. Of course, he bases the minimum flow of water on very accurate daily measurements of the flow in the Shannon, and the minimum occurred only on one occasion during a long period of years. It thus appears that after an almost miraculous dry period the Bann might possibly fall as low as 37,000 cubic feet per minute, which on the 30ft. falls at Kilrea, Movanagher, and Carnroe would produce, with turbines of 70 per cent. efficiency, 1,470 h.p. For some years back the Bann has never fallen below 100,000 cubic feet, and its normal flow may be taken as not less than 200,000 cubic feet per minute, with frequent high water in winter averaging 300,000, and floods exceeding 400,000 cubic feet per minute. Now, Mr. Dick states that while on the Shannon and at Galway the range of level of the loughs is only 2ft., yet on Lough Neagh it varies 4ft. as between winter and summer. It is to this point I wish to draw attention. There is a 4ft. fall at the outlet of Lough Neagh into the Bann at Toome, and a fixed dam or weir. If this was removed and in lieu of it a system of Stoney's patent sluices substituted, similar to those at Belleek (Lough Erne), or on an enormous scale at Assouan (on the Nile), the level of Lough Neagh could be regulated with ease and certainty, so as to prevent the flooding now so bitterly complained of on the shores of the lough, as the water would never be allowed to rise more than (say) 1ft. or 2ft. above summer level, which would provide ample storage to equalise the flow in the river for a power plant, and prevent the water coming down in lumps, as it does at present, to the serious injury of farmers near the Bann.

A few days ago, accompanied by Sir William Preece, K.C.B., Colonel Clarke, chairman, and other members of the Londonderry County Council, I visited the Bann Falls, and we were all of opinion that while it was a great pity that such magnificent works, erected 45 years ago at a cost of £250,000, had proved a failure as regards navigation, they were in every way adapted for putting in a very large hydro-electric installation at a comparatively trifling expense, as the very costly canals and works could be easily adapted for the erection of turbines. I believe the demand for light and power in the neighbouring towns would absorb a very large part of the output: but it would be quite possible to transmit (say) 5,000 h.p. to Belfast, a distance not exceeding 40 miles, with conductors of moderate size, and at a loss of efficiency not over 10 per cent. This would give power more than sufficient to drive the Belfast tramways by electricity when they are taken over by the Corporation, and also run the electric light station in that city.—Yours, etc., S. M. MACRORY.

Limavady, Sept. 23, 1902.

P.S.—The county councils being owners of the county roads can give wayleave for transmission lines free of cost.

The following is a letter on the above subject written to Mr. S. M. Macrory by Mr. A. Steiger (of Messrs. Escher, Wyss, and Co., of Zürich):

Dear Sir,—I regret very much that owing to the change of programme of the British Association, I could not be present when Mr. Dick's paper on "Ireland's Water Powers" was read. I should have liked to have said something about the manner in which varying water powers should be dealt with. If water powers with varying conditions could not be advantageously utilised, we could not make any use of our water powers in Switzerland.

The large rivers in Switzerland run very short of water in winter time owing to the frost, but we have plenty of water in summer with a much reduced fall. I can assure you that we make the very best use of such powers, and I

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think all such undertakings are financially very successful. In Ireland you are better off, in some respects, than we are in Switzerland, in so far as you have plenty of power at a time of heavy load for lighting. I have seen the fall of the River Bann at the Cutts, and although the fall varies much there through the tides, I can assure you we should not allow such a power to remain unutilised in Switzerland. Naturally the falls higher up would be utilised in the first instance.

I am often surprised how little the public in general, and even engineers, know how to make good use of water powers; and I have seen installations in this country on which thousands of pounds have been utterly wasted, either through the use of inefficient turbines or extremely bad planning.

As regards the cost, I think that the working expenses of artificial power is not sufficiently taken into account when a power scheme is contemplated; with coal at a price of 10s. and more, it will be found that the higher capital outlay for low fall water-power plants is soon recovered by the saving of fuel, and that in many places a capital outlay of £60 per b.h.p. will be found a very good investment.—Yours faithfully,

ALPH. STEIGER.

REVIEWS.

Encyclopædia Britannica, Vol. XXVIII. Published by Adam and Charles Black, Edinburgh and London, and the *Times*, Printing House-square, London, E.C.

The volume now before us deals with subjects from ELE up to GLA, in alphabetical order. Consequently both electricity and engineering come within its scope. The result is that the volume contains a very much greater proportion of information of special service to electrical engineers than any of the previous volumes in the new series—for instance, electricity is divided up into no less than six articles on the theoretical side It will be remembered that in the earlier volume of the "Encyclopædia," electric accumulators, atmospheric electricity, and dynamos have been treated in special articles. In the volume now before us, electro-chemistry, the electro-magnet, electro-metallurgy, and electric supply are treated, leaving a range of articles on electro-magnetism, measuring instruments, power transmission, telegraphs, telephones, transformers, etc., for future volumes in alphabetical order. It is specially to the theory of electricity that we look for information in vol. xxvi., and when the authors of the various sections contain such names as Prof. J. A. Fleming, Prof. J J. Thomson, and Prof. W. C. D. Whetham, one can be assured that the search for information will not be in vain. The six sections into which the theory of electricity is divided are respectively "Electric Conduction," "Electrolytic Conduction," "Electric Current," "Electric Units," "Electric Discharge through Gases," and "Electric Waves." At the present time the last two divisions contain the most novel information. These divisions are contributed by Prof. J. J. Thomson, and contain in brief the conclusions arrived at by the physicists of the world during the past half century. When we say that these results are given in brief, our readers must not suppose that the articles themselves are short. On the contrary, that which deals with the electric discharge through gases occupies rather more than 30 pages of the directory. That the article is so long is due to the vast amount of original work which has been done on the subject treated. Amongst other points gone into with great clearness is the observed difference between the behaviour of positive and negatively charged bodies in gases. This difference is traced back to the difference of the masses of positive and negative ions, on which subject Prof. Thomson has done so much good work The conclusions, briefly, are that the mass of the negative ion is exceedingly small compared with that of the mass of the atom of hydrogen, which is the smallest mass recognised in chemistry. In fact, the mass of the negative ion appears to be about one-thousandth part of the mass of the hydrogen atom. On the other hand, the positive ions obey an entirely different set of laws, and the conclusions can consistently be drawn from the results of many experimenters that the mass of the carrier of the positive charge is that of a molecule of some substance present in the vessel in which the ions are produced, and that these carriers vary as the substances are changed. The carriers of negative electricity at low pressures have a constant mass, while the carriers of positive electricity have a variable mass, which is comparable with that of the molecule of the chemical elements. The last part of the article on electric discharge through gases deals with cathode rays, Röntgen rays, and the radiations from such substances as uranium, radium, etc.

The following article, on "Electric Waves," while equally interesting, is much more mathematical in treatment, and, in consequence, is not likely to be read by the average engineering student. Going back, now, to the first of the theoretical subjects under the heading of "Electricity"—*i.e.*, "Electric Conduction"—one finds a large collection of tabulated matter on the specific resistance, or, as the author prefers to call it, the "electric volume resistivity" of various materials, ranging from the best electric conductors to those dielectrics which may be looked upon as insulators. It is pointed cut that liquefied gases hold a high position amongt these non-conductors, according to the experiments of Prof. J. Dewar. The absolute specific resistance of liquid oxygen and liquid air have yet to be determined. In the same way the information on electrolytic conduction is of the character which is required in works of reference, and the descriptive matter surrounding these ascertained facts gives a clear idea of the general laws of electrolytic action even to the uninitiated. Under the heading of "Electric Current," the usual distinctions between the various forms of electric current commercially employed are made. The three main divisions are the unvarying and uni-directional currents, irregular currents, and periodic or alternating currents Single-phase and polyphase currents form respectively the two sub-divisions of this last class. At the head of the article the question of the measurement in practice of electric current is briefly referred to, and the Kelvin balance is described. We fail to see why this instrument should not have been included amongst other electrical measuring instruments which are to be referred to in a forthcoming volume. The general conclusion from these articles, and from that which deals with electric supply, seems to us to be that while for theory and general practice the authors are to be highly commended, they have not been fortunate in their choice of illustrations of practical apparatus. For instance, the incandescent lamp holders are of old and mostly of obsolete types. Under that portion of the "Electric Supply" article which deals with lamps the efficiency of carbon filaments is well considered, and the author describes briefly the Nernst lamp. Reference is also made to the failure up to the present of all attempts to get a satisfactory mixture of the rare oxides and carbon for lamp filaments. This failure has been due to the reduction of these rare oxides in contact with the carbon at any temperature near the melting point of platinum. The question of electric traction occupies some six pages in the "Electric Supply" article, and these pages have been contributed by Mr. Louis Duncan. It seems to us that while the information given is most valuable, it might be extended with considerable advantage, and some commercial results included. With the importance of electric traction at the present day some extra space could have been profitably employed.

"Engines" is another heading which comes within the present volume, and this subject is divided into two main divisions. The first, by Prof. J. A. Ewing, deals with "Steam-Engines"; and the second, by Mr. Dugald Clerk, is on "Gas and Oil Engines." In both of these departments of engineering considerable progress has been made since the issue of the ninth edition of the "Encyclopædia." These advances, as instanced by the Willans and other high-speed engines, and the Parsons and De Laval turbines, are ably explained by the author, who gives extracts from the best results obtained with these newer types of prime movers. The article naturally is not intended to supersede the one in the previous edition on the subject, but only to supplement it. Owing to the more rapid changes in gas and oil engine design, Mr. Dugald Clerk's article is

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naturally more self-contained. It also goes carefully into a number of details of construction which make it most useful and interesting reading. As we have before remarked, the engineering subjects in the "Encyclopædia Britannica" are by no means its sole attraction to engineers. The general information both in this volume and its prefatory essay on the "Growth of Toleration," by Sir Leslie Stephen, K.C.B, form interesting reading matter quite apart from their value as works of reference.

VOLTS AND AMPERES IN RELATION TO THE HUMAN BODY.

BY ALFRED H. MAYES.

For many years past the tendency with regard to central-station practice, whether owned by a private company or a corporation, has been to gradually increase the pressure of supply at the consumers' terminals, and thus we have left the old 100-volt service far behind, and now regard 250 volts as an ordinary and commercial pressure for lighting, whilst 500 or 550 volts appears to be the coming standard for motor work. This change in the order of things has naturally brought in its train new conditions, and some difficulties which did not previously exist; and although eminently satisfactory from the supply authorities' point of view, has, unfortunately, not been wholly unaccompanied by disadvantages to the public, the chief of which, however, certainly cannot in the opinion of the writer be called danger to life and limb.

When very ordinary precautions are observed, supply at 250 volts presents practically no element of danger, and the possibilities of such even at 500 volts may be overestimated. It will not be exceeding the bounds of ascertained knowledge to assert that volts alone can neither injure or kill, and also that amperage alone is in no sense dangerous. In order that injury may result it is necessary that the conditions be such that a certain number of watts of electrical energy are expended in overcoming the resistance of the human body, the action of passing through and overcoming the resistance of the tissues causing the sensation usually described as shock.

In order to remove any misconception with regard to the writer's meaning in making the above statement, and to prove that high voltage alone presents no element of danger, let us take a Wimshurst or other similar statical machine, and having put this into operation until the main collectors become so highly charged that they commence to discharge themselves into the atmosphere (which will mean, in all probability, that they are at a potential some millions of volts above earth), let us place one hand upon a suitable earth connection, say a wire connected to a water-pipe, and then bring the other hand into contact with the highly charged collector in question. The result will be that an infinitesimal current as regards ampereage, but at some millions of volts, will pass through the tissues of the body and go to earth, the current being so small that the wattage expended is not sufficient to cause the slightest inconvenience—in fact, practically no sensation will be felt.

Perhaps the machine which presents the most directly opposite characteristic to the above is that most useful article of commerce, the plating dynamo. Here we have a machine producing, say, 2,000 amperes at a potential of six volts, but, notwithstanding the enormous electrical current produced, the possibilities of obtaining the slightest shock are even more remote than in the previous instance. The reason for this is clearly that the voltage of the machine is insufficient to force the number of watts through the tissues which are requisite in order to produce a sensation either unpleasant or dangerous. The exact number of watts which must be expended in the human frame before fatal results ensue will vary in the cases of different individuals, and will be largely governed by the physical condition of the subject.

Coming to the practical aspect of the question, let us endeavour to apply this reasoning to everyday conditions by considering the surroundings necessary in order to produce a dangerous shock in the case of conductors charged at the usual commercial voltages. To commence with, let us take the case of an ordinary lighting installation, the pressure of supply being 115 volts, a voltage, by the way, rapidly becoming obsolete. At such a low voltage, the danger of shock will be very remote, and the charged conductors may be handled with perfect impunity in any part of the building, provided that a perfect and direct earth is not simultaneously made by means of some exposed part of the body coming into contact with, say, a gas or water pipe. Should such a combination of circumstances arise, nothing in the nature of a *severe* shock will be experienced, even supposing the other conditions are in all respects favourable—for instance, if the conductors are touched by the hand, the state of the skin at the moment of making contact will largely govern the quantity of current which will pass, a hand moist with perspiration offering the most favourable conditions for increasing the severity of the shock, a dry condition of the skin having just the opposite effect. Should accidental contact be made with one hand with a conductor at this potential by a person standing in a damp basement the resulting shock will be very slight, even should the person be wearing a pair of wet or imperfect boots. Thus, we see that the resistance of the human body is so great that when interposed in the path of conductors having a difference of potential amounting to 110 volts that it will limit the current passing, and consequently the watts expended in the tissues to such a small value that no serious results can accrue.

To advance a step further, let us see how far this conclusion is applicable to a higher commercial voltage—namely, 230 volts—at present so largely used for lighting installations. Here, again, the question really resolves itself into one of Ohm's formula, $\frac{E.M.F.}{R} = C$, R being represented by the resistance of the bodily tissues added to the resistance due to the poor nature of the contact made with the conductor from whatever cause arising. All other things being equal, the watts expended in the body, should contact be made with a conductor charged with this potential, will be exactly four times the amount in the first instance, and the shock will be consequently increased in severity. A case was recently reported in which a person met instant death by grasping a conductor charged at this potential—namely, 230 volts above earth—but the writer's experience justifies him in saying that the circumstances surrounding this occurrence must have been altogether abnormal. For instance, the nature of the earth contact made must have been exceptionally good; probably a hand moist with perspiration was brought into firm contact with bare and comparatively clean metal, and it will not be unwise to assume that the physical condition of the subject was extremely unsatisfactory previous to the occurrence. The writer has made accidental contact with conductors at this potential under varying conditions even in an extremely damp underground chamber, making a fairly good earth connection at the same time, but has experienced nothing beyond an unpleasant shock. In dry situations, such as, for instance, when standing upon a boarded floor, such a conductor may be grasped with absolute impunity and without the slightest shock resulting, provided no earthed metal is in contact with the flesh at the same moment.

Reaching the question of power supply at 500 volts, the highest at present allowed by the Board of Trade, we shall find that an element of danger really exists, but one which merely demands a few extra precautions in order to reduce the possibility of mishap to a remote contingency. Contact between a conductor carrying current at a pressure of 500 volts and the bare flesh will under some conditions result in a severe and possibly fatal shock to the system, the nature and severity, however, entirely depending upon the details mentioned above. One may, again, with perfect safety make such a contact when standing in a dry workshop upon a boarded floor, but given a damp situation or an earth connection with some other part of the body at the same moment, and the result may be extremely serious, as at such a voltage the combined resistance will be insufficient to cut the current down to a safe limit.

It will be noted that in the foregoing remarks the voltages have been definitely stated, and the writer thinks

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it will be understood that the *current* available was in each case practically unlimited, as this article deals with conductors charged from the supply mains, the point being that it is possible to have a potential difference of 500 volts or any other value, but with such a small amperage available, that practically no physical effects are obtainable, taking, for instance, the case of the statical machine mentioned, or a set of small batteries having the requisite voltage, but merely a trifling capacity. It has been stated as a somewhat remarkable fact, that a person has grasped the 500-volt trolley line whilst standing upon the top of a tramcar without the slightest inconvenience resulting. Really there is nothing at all remarkable in this, as it simply, again, resolves itself into a question of Ohm's law, the E.M.F. being 500 volts and the R being represented by the resistance of the person's body, plus the resistance to earth through the dry woodwork of the car, the total being so high that the current passing was reduced to a safe limit. Had the experiment been made by a person standing in the road, the result would have been a very severe shock, unless he happened to be wearing a pair of the exceptionally suitable boots referred to later.

It may possibly be remembered that some slight difference of opinion has existed in reference to the results which would ensue should a person make contact with the middle charged conductor and one of the rails upon the Central London Railway or similar system. Some practical experience has now been inadvertently gained in this direction, but the widely different results which have attended the various occurrences would appear at first to be extremely confusing. The writer, however, ventures to think that this diversity of results is exactly what might be expected, remembering the important bearing which small details have upon the outcome of making such a contact. A person might with perfect safety place one foot upon the middle charged conductor and the other upon a rail, provided that the soles of his boots were dry and in good condition and *free from nails.*

It would scarcely be possible to exaggerate the importance of the last detail, as a piece of sound dry leather presents an enormous resistance to the passage of the current, and would prove a perfect safeguard under such conditions, but should the leather be pierced by a number of nails which reach probably to the under side of the inner sole of the boot, the insulating value of the foot covering has practically disappeared, and will not prevent the wearer from receiving a perhaps extremely severe shock. There is also the possibility of a person stumbling and falling in such a manner that his bare hand or hands are in contact with the charged conductor, whilst some other portion of his body touches the rail or earth. Here, again, the nature of the contact will entirely govern results—for instance, should the portion of the body in contact with the earth be covered by dry woollen clothing practically no shock will be felt, but should the clothing happen to be wet the result may be serious.

Looking at the situation broadly, it would appear that the Board of Trade have exercised a wise discretion in fixing the limit for private supply at 500 volts, as the possibility of mishap attending any advance upon this pressure would become too serious to permit in the interest of the public. There is, of course, another aspect to this question of supply voltage—namely, the effect upon the construction and working of the various forms of lighting and power apparatus utilising the current; but as this scarcely comes within the scope of the present article, the writer will not pursue the subject further.

The Instruction of Mining Engineers.—We have received from Houghton, Michigan, U.S.A., the year-book of the Michigan College of Mines, announcing the various courses of study for the session 1902-03. The rapid development of electrical methods as applied to mining and metallurgical operations makes a broad knowledge of the principles of electricity necessary to the well-equipped mining engineer. Ample provision has thus been made at the above-named college for giving instruction in engineering, and, of course, such subjects as are of special prominence in mining are given the greater attention to.

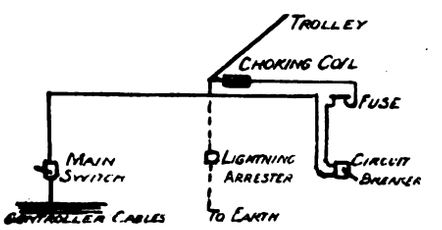
QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

519. According to an illustration of the Preston car in your issue of Sept. 25, 1901, the current, after leaving the choking coil, evidently passes through the main fuse first, and thence through the circuit



breaker and main switch as above. Is this correct, as when attending to the fuse it would be of no use opening the main switch (as is always done), the current being cut off at the controller; and, further, unless he took the trolley off, the driver might stand a chance of receiving a shock, particularly in wet weather. According to other illustrations, the connection to the lightning arrester is taken off beyond the main fuse and circuit breaker, and apparently the lightning must pass through these before being diverted to the earth. This, I think, must be incorrect, as the lightning should blow the fuse or switch. Does the current usually pass through the fuse or circuit breaker first?—F. F. S.

520. What is the simplest method of finding out what kilowatts are likely to be generated by a small river, using turbines or Pelton wheels, supposing no waterfall available, but river course very steep and easy to dam?—D. E. McD.

ANSWERS.

Question No. 512.—Describe what you consider the best system of engine-room telegraph worked by electricity, such as is used on board ship.

Best Answer to No. 512 (*awarded* 10*s.*). — The following system of electric engine-room telegraphs was invented by Messrs. Richards and Evershed, and is fully described in Mr. C. E. Grove's paper dealing with the application of electricity to naval work, which was published in the *Proceedings* of the Electrical Engineers for 1900. This system was fitted on H.M.S "Howe" and "Narcissus" in 1893, and later on the "Royal Sovereign" and several other British warships, so that it appears to give good satisfaction to the naval authorities. The instruments have the same appearance as the usual mechanical telegraphs, the dials being marked "ahead," "astern," and under each the sub-headings "stop," "slow," "half," and "full."

The revolution of the indicating hand is caused by the combined operation of two exactly similar coils, A and B, the axis of which are at right angles. These produce between them a cross magnetic field, the exact direction of which depends on the relative currents flowing in the two coils. In this resultant field the electromagnet, H H, is pivoted, so as to move freely with it. The exciting current of this electromagnet is always flowing in the same direction, so that the polarity of the projections on it is always the same (see Fig. 1). The indicating hand is connected directly to the swinging electromagnet, H H, through multiplying gear. The position of the hand thus depends solely on the ratio of the currents in the two coils. This ratio is controlled by the "transmitter" (see Fig. 2), which consists of a multiple-contact switch, through which the ordinary 80-volt electric light circuit is connected to a pair of ratio arms, included

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in the same circuit as the coils of the indicator. The movement of the transmitter switches resistance out of the circuit of one of the ratio coils, A or B, into the other, thus altering the relative value of the current strength in them, and so controlling the movements of the indicator. An important detail is that the action of this instrument does not depend on the absolute values of the currents in the

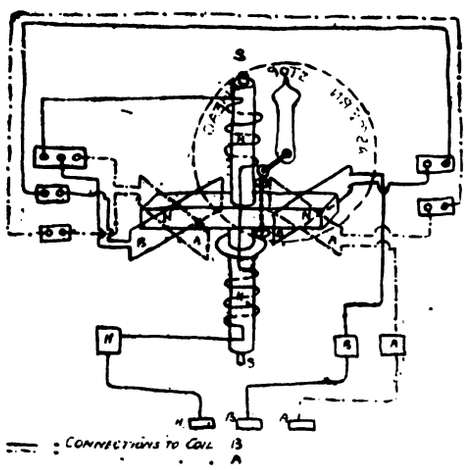

Fig. 1.

ratio coils, A and B, but only on the *relative* values, so that a constant voltage is unnecessary. The current necessary for working a set of these telegraphs, as shown in figures, is two amperes at 80 volts. A permanent step, R R, is put in series with each ratio coil to prevent the current reaching too high a value. By means of switches these telegraphs

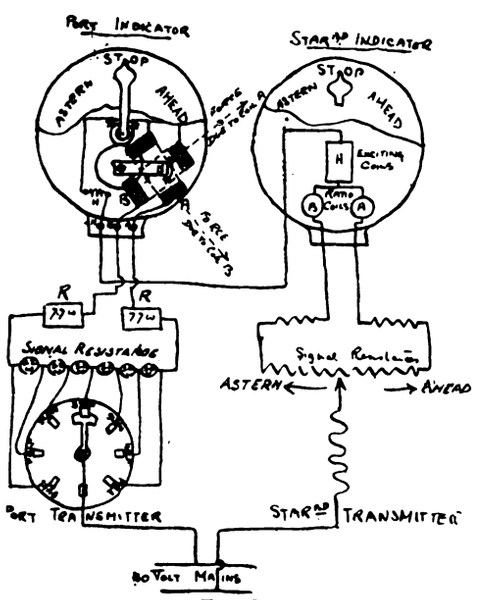

Fig. 2.

can be arranged to signal from any of several working positions—for example, bridges and conning towers. Transmitters will send orders from any of these stations to a common receiving instrument in the steerage flat. The above description, together with the sketches, will, I think, be sufficient to enable "P. T." to understand the working of this instrument.—T. Square.

Answer to No. 512 (*awarded* 7*s.* 6*d.*).—A good form of engine room telegraph equipment is shown in Figs. 1 and 2, also a wiring diagram for same (Fig. 3). The indicator (Fig. 1) is placed on the switchboard platform to be operated by the switchman, and Fig. 2 in the engine-room, so that it can be seen by the drivers. When it is requisite to give orders to the driver the switchman grips the handle, B, drawing the small lever close to it, which prevents the bottom part making contact with the stops as its passes over them to the required number of the engine. When this is reached he presses the small button at top of handle, which closes the circuit of a large bell fixed in the engine-room, and thus calls the attention of the driver. He then releases the handle and small lever, the bottom part of which makes contact with the live strip, C, and the stop opposite number of engine, lighting up lamp at back of number on switchboard and engine-room indicators. The switchman then operates handle, A, in the same manner, allowing it to rest on stop opposite order for driver, which lights up lamp behind order, such as "run up" in switchboard indicator and the corresponding order in

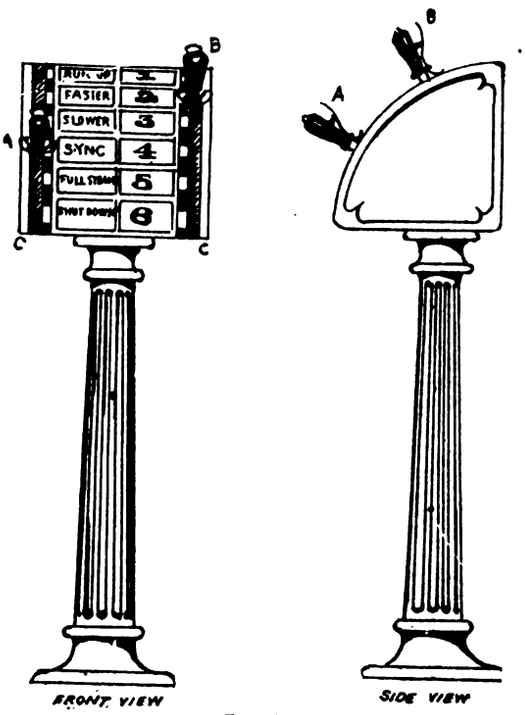

Fig. 1.

engine-room indicator. The indicators are divided up into small compartments and a lamp placed in each; by this means the required number or order only is illuminated,

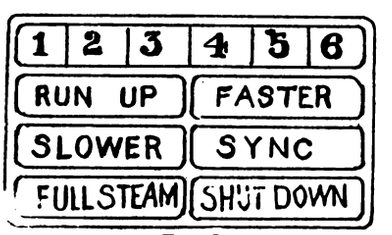

Fig. 2.

and the rest remain in darkness. Ground glass is used for front, the lettering is usually in deep black. The lamps are connected in series, so that in case of 100-volt supply

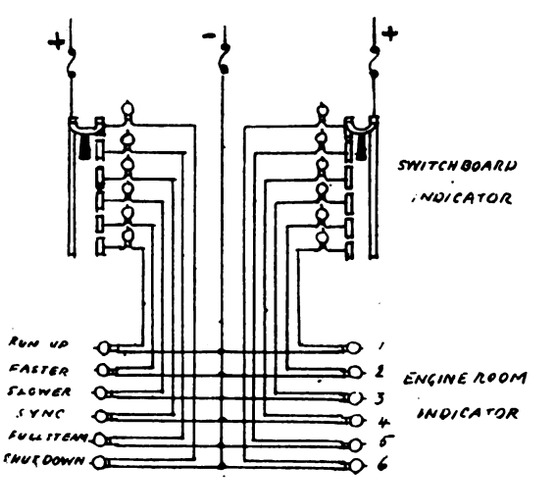

Fig. 3.

they will be 50-volt lamps; they are arranged in this manner so that the switchman can see if lamp burnt out or other electrical fault preventing order being delivered. In large stations a duplicate set of telegraphs could be installed

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so that engine-driver could signal back, and switchman would know that his order had been received. When all orders for the time being have been given, the handles, A and B, should be moved to top of indicator, then the bottom part of small levers rest on ebonite and, do not make any electrical connection.—A. C.

Answer to No. 512 (*awarded* 5*s.*).—Engine-room telegraphs electrically actuated may be divided into two classes: (*a*) those in which there is a good deal of mechanism, the electric circuit being only a small portion of the appliance; and (*b*) those in which there is very little mechanism, the appliance being almost wholly electrical.

In class (*a*) the current employed is small in comparison with that employed in class (*b*), but to class (*b*) belong the most reliable forms of ships' telegraph, since they are not so likely to be put out of order by shock or vibration, two factors rarely absent from a steamship. As an example of class (*b*) may be described Richards and Evershed's telegraph. The receiving portion of this appliance is really an ohmmeter, since it consists of two coils at right angles to one another, capable of acting upon an electromagnetic needle, which is free to take up a position depending on the direction of the resultant of the fields due to the two

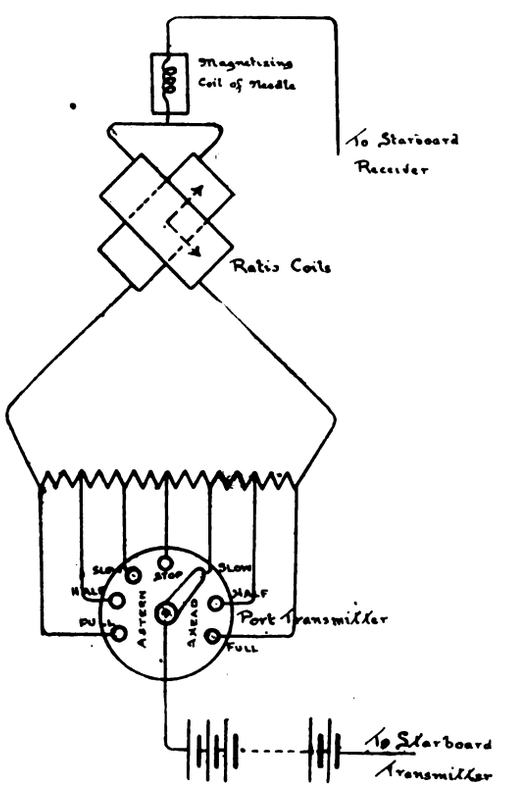

FIG. 1

coils. This needle is geared with the indicating pointer that moves over the receiver dial. The transmitter consists of a switch that alters the relative values of the currents in the two ratio coils, as they are called, by switching resistance (between three and four ohms per contact) out of the circuit of one coil into the circuit of the other coil, these two circuits being connected in parallel. This switch is actuated by the hand-lever of the transmitting telegraph. When the lever is in the "stop" position, the currents in the ratio coils are equal, and the needle assumes a mid-position corresponding with "stop" on the receiver dial. Fig. 1 shows the general arrangement of the circuits. The port and starboard transmitters and receivers are all in series, but each receiver is actuated only by its own transmitter. It should be noted that the position assumed by the needle depends simply on the relative, and not on the absolute, values of the currents in the two coils. Hence the position of the needle is independent of any variations in the supply voltage, and the telegraph may therefore be conveniently worked off the electric light mains if such are in use on board the ship. Separate generators or secondary batteries may also be used, but the latter have been found to give trouble. The particular type of electric telegraph described above requires a source of supply capable of giving two amperes at a pressure of about 80 volts.

In another type of telegraph—also belonging to class (*b*)—the circuit is arranged as in Fig. 2. In this case, current

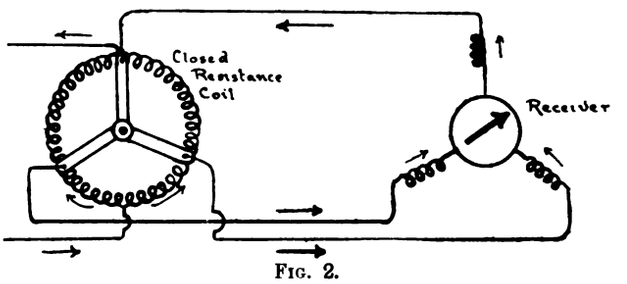

FIG. 2.

is supplied to two fixed points in a circular closed resistance coil divided into a number of sections of unequal resistance, the ends of which are connected to contacts, over which rotates an arm, having fixed to it three contacts spaced 120deg. apart. This arm is moved over the contacts to any required position by the hand-lever of the transmitter. The three moving contacts are respectively connected to three mains leading from the three coils of the receiver. When the transmitter arm is turned, the currents in the three coils of the receiver combine to produce a rotating field, which acts upon a magnet, causing it to turn, and at the same time move round the indicator over the dial of the receiver in synchronism with the movement of the transmitter. To render the indicator dead-beat, the oscillations of the magnet are damped by means of a copper cylinder. As with the apparatus previously described, the indications of this type of telegraph are independent of any variations in the supply voltage.—LL. R. L.

Answer to No. 512 (*awarded* 5*s.*).—The best, cheapest, simplest, and most effective engine-room telegraph can be made and operated as follows: A wooden box, say 5ft. by 2ft. 3in., or of larger or smaller dimensions to suit particular conditions, is made and divided into a number of cubicles, each containing an incandescent electric lamp of small candle-power, say 5 c.p. or 8 c.p. (see Fig. 1). This box has a hinged cover, also divided into compartments to coincide with Fig. 1. In each of these compartments is fitted a piece of glass, which has on it in clear

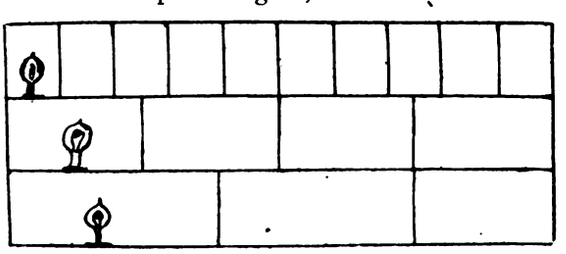

FIG. 1.

frosted letters the signals desired to be given. The margin is then painted an opaque colour, so that when the lamps are lighted the signal stands out in clear, bright letters, and is very distinct. The frosted letters are preferable, as they do not dazzle the eyes. The cover must be made hinged or to slide off, in order that the

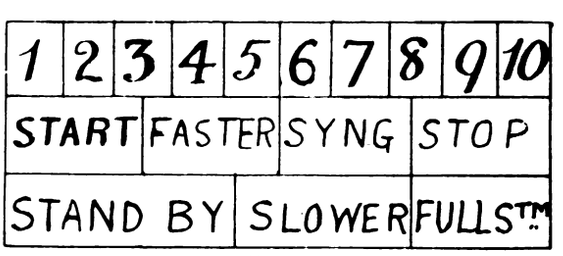

FIG. 2.

lamps may be renewed when necessary. Lamps of a slightly lower voltage than the supply are useful to prolong the life, as the signal will probably be placed in a somewhat inaccessible position. For cheapness the glass front could be made in one or two pieces, but this is not advisable if it will be subject to any vibration whatever. Fig. 2 will

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show the appearance of such a telegraph. On the switchboard, in a convenient position for the attendant to operate, is a switch to light the lamps in the combinations desired. Fig. 3 will explain this. Two switch-arms swing about a common point, X, making contact with a number of studs connected to the different lamps. Point X is connected to one wire from the source of supply, so that when switch is in position shown the current will pass through the switch-arms and light up the lamp in compartments 7, "Start." Two dead contacts at the end must be provided to extinguish signal, or a separate switch must be inserted at X.

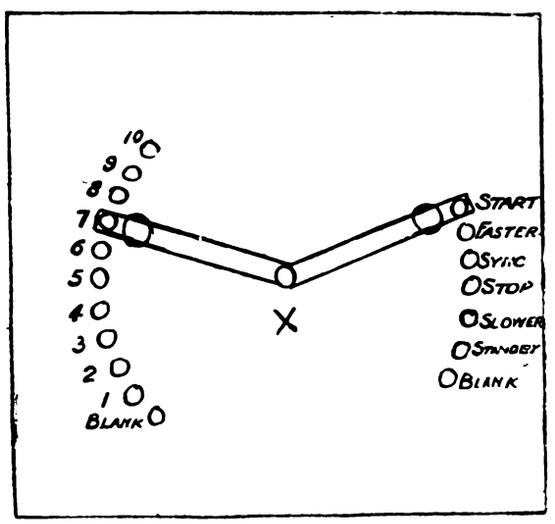

FIG. 3.

The engineman's attention is attracted by an electric bell, or, if the station is large, a ship's gong will be found necessary, or a good gong can be made out of a steel blank flange, or a piece of boiler-plate suspended by hooks so as not to deaden vibrations. If the switchboard is in such a position that each engineman can see it from his stop-valve—a very desirable condition, by the way—the telegraph should be placed over the board, but if this is not so, the most suitable place must be found, or a number of small signals operated in parallel must be dotted about the engine-room. The above system has, to the writer's knowledge, been in operation for many years with complete success in some of the largest electric supply stations in England.—F. P.

Answer to No. 512 (*awarded* 5*s.*).—The best form of engine-room telegraph for ship work is the system known as the Fiske. This system is operated on the Wheatstone bridge principle, the connection of which is illustrated in Figs. 1 and 2. Both the transmitter and receiver have equal resistances arranged in an arc of a circle, the zero position of each instrument being when the handle is vertical.

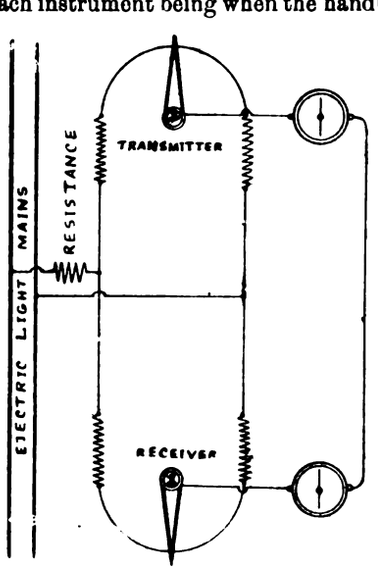

FIG. 1.

It follows, therefore, that if the transmitter handle be moved over a given arc it would be necessary, in order to balance the bridge, to move the receiver handle a corresponding amount. In series with the transmitter and

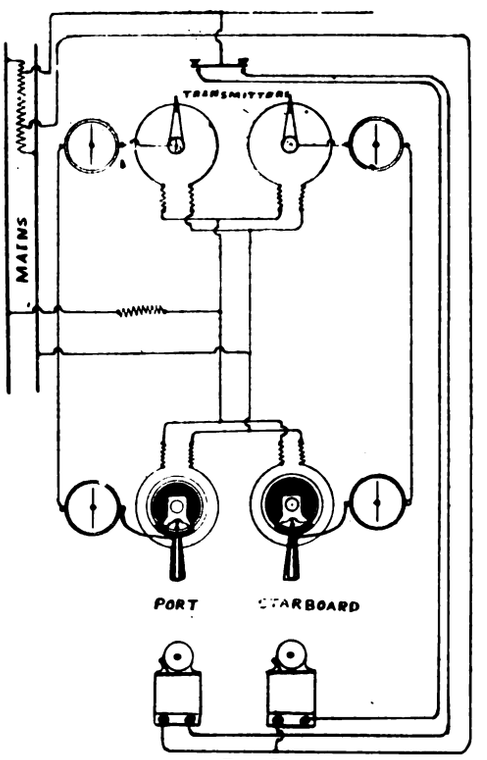

FIG. 2.

receiver are two galvanometers that serve as indicators, for when the transmitter handle has been thrown over, the

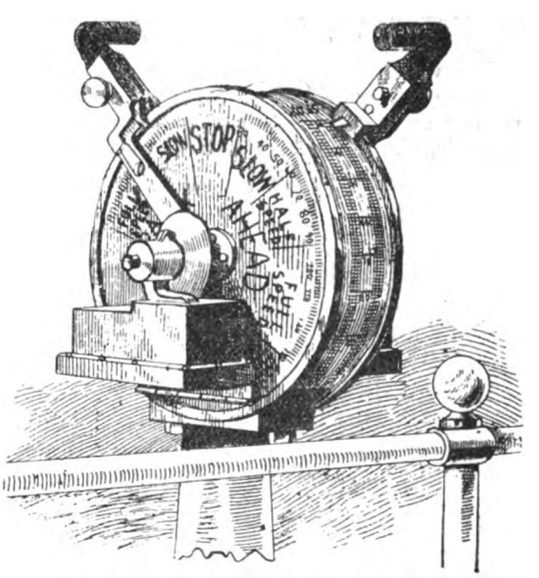

FIG. 3. Engine Telegraph Transmitter.

needles of both instruments will deflect, and will continue in that position until balanced by the receiver; thus the

FIG. 4.—Engine Telegraph Receiver.

person giving the command knows immediately if his order has been received. The attention of the engi-

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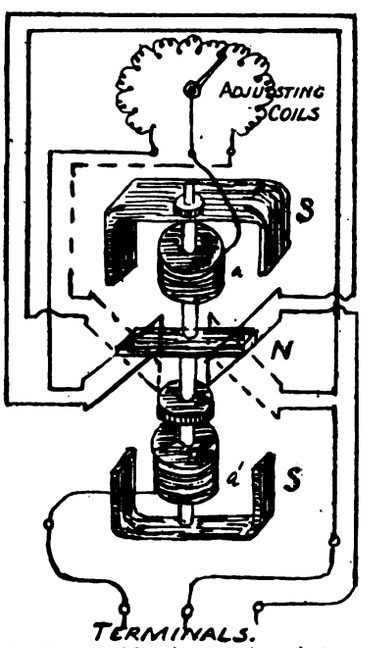
neer is attracted by the ringing of the bells, which are shown connected up in Fig. 2. These bells in actual practice are rung by a very small movement of the transmitter handle. The two sides of the transmitter are duplicated, and transmits the orders to both port and starboard engine-rooms. One of these duplicated instruments is shown in Fig. 3 Fig. 4 shows one of the receivers, and it will be seen that the deflection of the needle shows in what direction the engineer should work the handle in order to restore the balance, which point will be at the same position as that of the transmitter. The whole system is operated by taking the necessary drop across the lighting mains. It will also be noticed that the outside of the transmitter and the front of the receiver is graduated. These graduations are made to correspond to revolutions per minute of the shaft.—K.

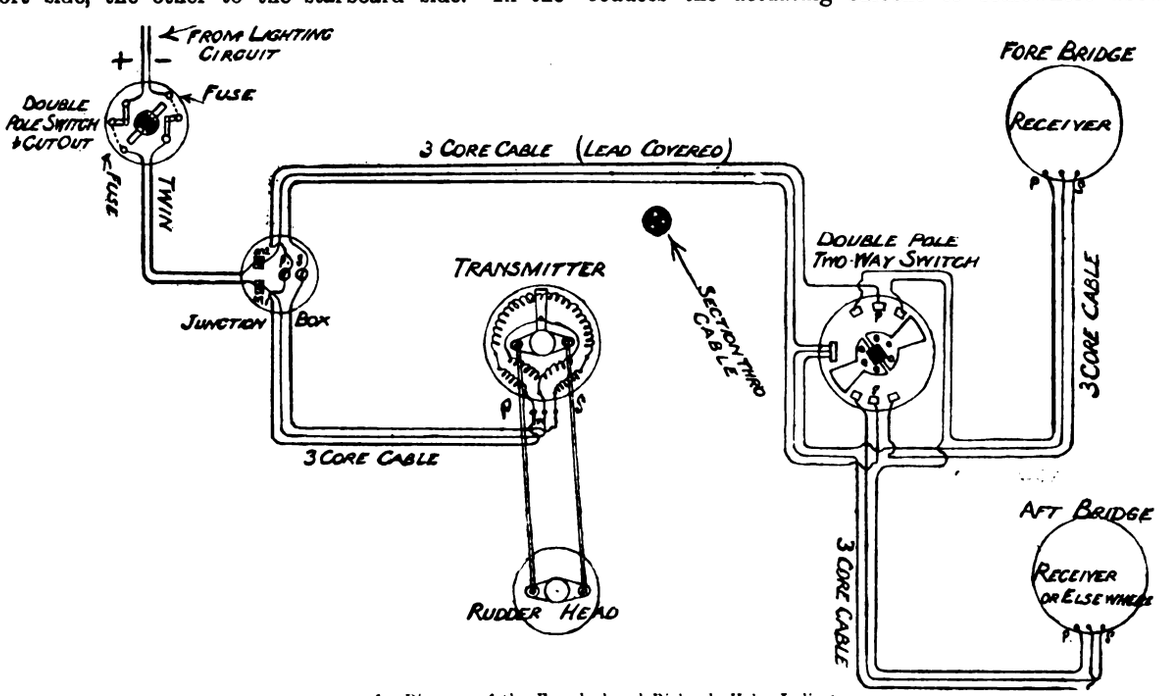
Question No. 513.—Describe some reliable form of electric helm indicator, and explain the method of fitting the same on board ship.

Answer to No. 513 (*awarded* 7*s.* 6*d.*).—One of the most reliable and more recent of electric helm indicators, and that now adopted by H.M. navy, is that patented by Evershed and Richards. The following is a description: The circuits in all cases are watertight, hence lead-covered twin and three-core cables are used for connecting up; also watertight instruments and fittings are employed. Current is brought to double-pole switch and cut-out as shown (sketch 1). To simplify matters let us follow the + current. After passing through the junction box (used for convenience and localising) we get to the switch-lever of transmitter. This is moved by rods fixed to rudder-head, the cross-bar to which they are secured having a set-bolt allowing for adjustment. As the rudder moves so the switch-arm moves, thus the position of switch depends upon position of rudder. The switch itself moves over resistance coils, and according to the position of switch more or less resistance is inserted on either side. After passing the rheostat in divided circuit, two wires conduct the current through a two-way switch to the receiver. One of these wires with its current tends to turn needle of indicator to the port side, the other to the starboard side. In the



SKETCH 2.—Diagram of Receiver. *a a'* are electromagnets.

pole switch and "home." If the port and starboard wires be traced from the transmitter this will be quite clear. If the rudder is midships, then the port and starboard currents are equal, consequently no movement takes place. As the rudder moves, one side (either port or starboard, as the case may be) offers less resistance, thus more current flows; while the other offers more resistance, causing less current to flow. This difference in the two currents causes electromagnet and pointer of receiver to move, as before stated. The double-pole two-way switch is to switch the port and starboard wires on to either of the receivers fixed in different positions, shown on diagram as fore bridge and after bridge. The resistance in the transmitter and receiver reduces the actuating current to somewhere about one



SKETCH 1.—Diagram of the Evershed and Richards Helm Indicator.

receiver are coils and electromagnets (as shown in sketch 2) which produce this result. To make instrument dead-beat, small magnetic poles are fixed round, and little distance from spindle, 7½deg. apart. On the spindle is fixed a small pole, and when the large magnet swings nearly into position it is locked by the smaller ones.

Both currents return to a "common" plate by means of common return from each receiver. This plate is shown in the double-pole two-way switch. From this plate they return to M^2 of junction box, thence to − side of double-

ampere, varying from 1 at midship to 1·05 when rudder is hard over. Convenient spacing on indicator dial is produced by multiplying effect, multiplying factor being 6. As regards fitting circuit through ship, the usual "deck-tubes" are used, and the cables—that is, their lead covering—is soldered to the casing of instruments.—W. BEARD.

Answer to No. 513 (*awarded* 7*s.* 6*d.*).—One of the most reliable forms of electric helm indicator is that which forms part of the Fiske system of ship's telegraph. It

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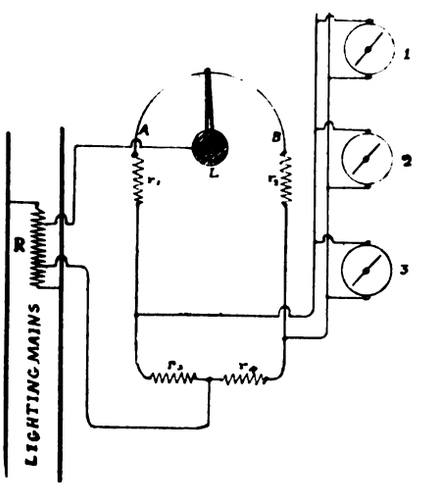
indicates the position of the helm at any instant in any place in which an instrument may be fixed. This consists of an ordinary astatic galvanometer, or better, an instrument of the type of Weston voltmeter, with the dial graduated in degrees so as to indicate the actual angle at which the helm stands at any time. The working principles of the apparatus are the same as those of the Wheatstone bridge, which will be seen from the diagram of connections.

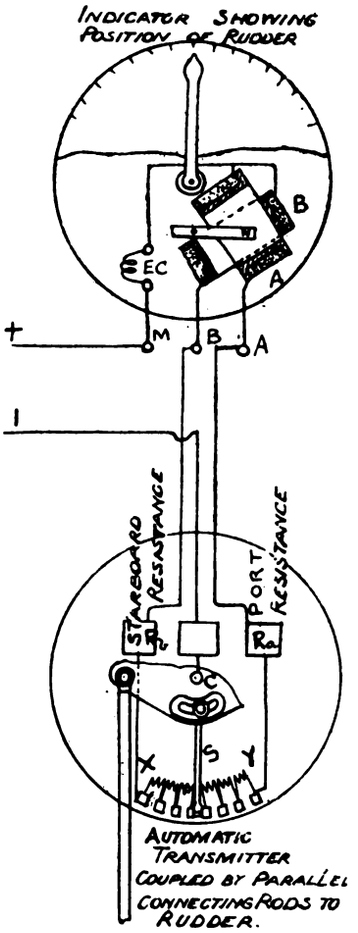


The lever, L, shown in the figure, is rotated with the helm, and forms a moving contact with the wire, A B, which is of high resistance; the resistances, r_1, r_2, r_3, and r_4 are so arranged that when the contact arm of the helm, L, is vertical the bridge connections are balanced and the needles of indicators Nos. 1, 2, 3 are not affected. But on the helm, and, therefore, the lever, L, being moved to either side, the instruments Nos. 1, 2, 3 will indicate the want of balance on either side. The current to work the apparatus is taken from the lighting mains by taking the difference of potential across the resistance, R. In the arrangement illustrated above it is immaterial whether the lever, L, or the wire, A B, is carried by the helm. In actual practice it is often the latter method that is adopted.—K.

Answer to No. 513 (*awarded* 5*s.*).—I presume what "J. S. B." wants is an indicator showing at any moment the exact position of the rudder at that instant. The following is a description of the best apparatus for this purpose: The indicator shown at the top of the sketch has a needle connected by gearing to the magnet, N, which is magnetised by coil, E C, in main circuit. This magnet, N, moves up or down according to the ratio that the current in coil A bears to that flowing in coil B. The automatic transmitter is fixed up somewhere near to the rudder, and the switch-arm is connected to the rudder stock by a connecting rod as shown in sketch. A resistance coil of about 3·2 ohms is connected between each stud, and from the two extreme studs, X and Y, wires are taken to two resistances having a resistance of 7·7 ohms each. The apparatus is arranged to work off an 80-volt circuit, and takes about two amperes. It is one of the good features of this apparatus that a steady voltage is not required, as the movement of the needle does not depend upon the strength of the current in the coils A B, but on the ratio the current in A bears to that in B.

Let us now see what happens when the rudder moves to the right as far as it can move. The switch-arm, S, will move to end block, Y, and starting at the negative pole for convenience, the current will pass along switch-arm to Y, from Y to R_a, R_a to terminal A, through coil A to M, completing the circuit. The current has an alternate path. When it reaches Y it can go through all the resistance coils to X, from there to R_b, R_b to B, thence to coil B, and from there to terminal, M, completing the circuit. Owing to the much greater resistance in the last path mentioned, a much greater current will flow through coil A than coil B, and the magnet will pull the needle round to indicate position of rudder. If the switch-arm is in position shown in sketch, then equal currents will flow through coils A and B, causing needle to point as shown.

I trust that the working of the apparatus is made sufficiently clear. This system was worked out by Messrs



Richards and Evershed many years ago, and is now largely used in the navy.—W. A. T.

COMPANIES' MEETINGS AND REPORTS.

CHLORIDE ELECTRICAL STORAGE.

The annual general meeting of the shareholders in this Company was held at the Company's Works, Clifton Junction, near Manchester, on Tuesday, the 16th inst.

Dr. Edward Hopkinson, having temporarily taken the chair, announced the resignation of Dr. Bowman, since the report was issued, of his position as director of the Company and chairman of the Board. Dr. Bowman's resignation had been accepted by his co-directors with great regret, he having held the office of chairman for some six years, and devoted himself with much ability to the interests of the shareholders Under the circumstances the Board had elected as chairman Mr. William Bannister, J.P., of Cork, who had been a director for some six years.

Mr. Bannister then took the chair.

The **Chairman** said, with reference to the balance-sheet, that as a shareholder he considered the figures to be eminently satisfactory in every way. The Company had never since its inception been in so strong a position, both in regard to the quality of the work done and the way in which it was turned out. Testimonials from experts in the position to express an opinion of the quality of storage batteries were being received, and were in every way satisfactory. The Company had now acquired such a high position, technically and financially, that although up to the present shares had been unsaleable there was now quite an enquiry for them He himself had been asked to sell a number of his shares at par, but he did not feel inclined to do so. He considered the Company was now in such a position that the shareholders might look to receiving a satisfactory return on their holdings. He hoped and anticipated that there were good times now in store, after the long period of depression through which the Company had passed. He moved the adoption of the report and accounts.

Mr. Harvey seconded, and the motion was carried unanimously.

A resolution declaring a dividend at the rate of 6 per cent. per annum on the preference shares, less income tax, and 8 per cent on the ordinary shares. free of income tax, from April 14, the date of the reduction of capital, to June 30, the end of the financial year, was then agreed to.

In conclusion, a motion was adopted by the shareholders expressing their regret that circumstances had compelled Dr. Bowman to resign his position as chairman of the Company, and recording their appreciation of the services he had rendered to the Company during the last six years.

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WILLANS AND ROBINSON, LIMITED.

The directors, in the seventeenth half-yearly report, to be submitted at the ordinary general meeting of the Company, to be held at the Victoria Works, Rugby, on Oct. 1, at 2.30 p.m., state that after writing off as depreciation from plant, etc., the sum of £4,804. 4s. 10d., and paying interest upon debenture stock, the balance to the credit of profit and loss account at the end of the half-year (including £7,035. 11s. 2d. brought forward) is £33,449. 13s. 9d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares and 10 per cent. per annum upon the ordinary shares, amounting in all to £26,666. 8s. The amount payable to directors in accordance with the articles of association, and with the resolution of Oct. 2, 1901, is £919. 7s. 2d., leaving an available balance of £5,863. 18s. 7d. From this the directors propose to carry £475 to the reserve fund, in accordance with Article 112 of the articles of association, leaving a balance of £5,388. 18s. 7d. to be carried forward. The directors are glad to state that since the date of their last report the Admiralty had ordered Niclausse boilers for two more first-class cruisers (H.M.S. "Carnarvon" and "Devonshire"), making four of this class in all, and more recently Niclausse boilers for a new battleship have been ordered, thus bearing out the previously expressed expectation that the merits of the boiler must soon receive fuller recognition. All these boilers, aggregating (with those of two small vessels not included in the above) about 100,000 h.p, are being constructed under license from this Company, pending the completion of the new boiler works at Queen's Ferry. In the directors' report, issued 12 months ago, it was pointed out that after certain writings off there remained in the share premiums account the sum of £3,991. 14s. 16d. Other later receipts from the same source raised the total sum disposable to £40,052. 14s. 10d. Of this £20,000 was carried to the reserve fund in the second half of 1901, and the following further accounts have been written off against the balance—viz., £7,431 14s., expenses of the late issues of shares and debenture stock, including the £5,000 given as a bonus on the old stock paid off, this being the condition of repayment; £193. 11s. 6d., a small amount standing against some old experiments in connection with the Niclausse boiler; £2,000, on account of experimental work upon gas-engines (which promises very favourable results); £1,650. 9s., the final charges in connection with the removal from Thames Ditton, which is now complete; £2,504. 5s. 5d., special exhibition expenses; and a sum of £1,961. 14s. 9d., being the cost to the Company of a very unusual and extraordinary accident in an electric light station, which caused the entire destruction of a valuable engine, an occurrence so unprecedented and exceptional as, in the opinion of the directors, to justify its being paid for out of the fund. A balance of £4,311. 0s. 2d. remains to be carried forward. The fire insurance fund of £25,000, required to be established by the new trust deed, which in the directors' opinion amply safeguards the Company against fire risks, has been formed from the old debenture sinking fund and fire insurance fund.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Rent, rates, and taxes	669	3	10
Interest on debenture stock	2,301	14	10
Salaries, including directors' remuneration	7,189	15	10
Contingent salaries to employés	1,488	6	3
Fire insurance	191	13	1
Fire insurance fund	400	0	0
Legal and professional charges	81	16	4
Advertising	549	9	6
Books, stationery, and printing	784	11	1
Postage and telegrams	323	12	5
Travelling, hotel, and general expenses	759	9	11
Auditors' fee and expenses	129	9	9
Subscription to benevolent fund, etc.	386	1	6
Depreciation of property and plant and machinery	4,804	4	10
Balance carried down	26,414	2	7
	46,473	11	9
Contingent share of profits to directors	919	7	2
Balance available for dividend or reserve	25,494	15	5
	£26,414	2	7

Cr.	£	s.	d.
Gross profit for the half-year	42,821	2	8
Royalties	1,108	7	0
Interest on investments, etc.	2,500	15	1
Transfer and registration fees	43	7	0
	£46,473	11	9
	£	s.	d.
Balance, profit (half-year) brought down	26,414	2	7
	£26,414	2	7

DICK, KERR.

The report of the directors for the 12 months ended June 30 last, to be submitted to the meeting on the 29th inst., states that the profits earned during the 12 months amount to £103,758. Out of this had to be paid debenture and loan interest and trustees' fees, and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These absorb £6,683, leaving a balance of £97,074, to which must be added the profits brought forward from last year—viz., £27,793—making a total of £124,868, which it is proposed to appropriate as follows: in payment of a dividend of 5 per cent. per annum on the preference share capital, £6,000 (the proportion of this dividend to Dec. 31, 1901, has already been paid); to carry one-fifth of the remaining profits to reserve fund as required by clause 24 of the trust deed securing the debentures, £18,215; further sum to this reserve, £21,785—making £40,000; to pay a dividend of 10 per cent. and a bonus of 20 per cent. on the ordinary share capital, which will be about £48,000; to carry forward the balance of £30,868. Since the last report important contracts have been carried out for the construction and equipment of several electric tramways both at home and abroad, and these various works have given satisfaction to the Company's clients. The resolutions for acquiring the shares of the English Electric Manufacturing Company, Limited, which were set out in the circular of July 21 last, were duly passed, and the exchange of the shares will be carried out in due course. Steps will be taken to acquire the few outstanding shares, and arrangements will be made with the debenture holders of both companies at an early date.

ELECTRIC LAMP REGENERATING.

On Friday the creditors and shareholders of the Electric Lamp Regenerating Company, Limited, met at the London Bankruptcy Court, under the compulsory winding-up order recently made on the petition of a creditor.

Mr. H. Brougham (official receiver) reported to the creditors that he had a sum in hand sufficient to pay the debts in full, and consequently the liquidation more closely affected the shareholders.

The **Chairman** reported to the shareholders that he was advised that it was open to creditors in both France and Spain to at once take steps to realise the property there for their own benefit, without regard to the claims of the British creditors, and negotiations were entered into with the view of at once disposing of these assets. As the result, an offer of £2,000 in cash for the whole of the Company's assets in France and Spain, the purchaser undertaking to discharge all liabilities of the Company in those two countries, was accepted, and had been completed. That practically provided sufficient to pay off all the Company's liabilities, and left the other assets, returned in the accounts at about £2,000, available for the shareholders.

Resolutions were passed for the official receiver to act as liquidator, with the assistance of a committee of inspection.

The account with the contributories discloses a total deficiency of £77,645.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Swindon.—The Corporation require tenders for wiring of consumers' premises by Oct. 7.

Grimsby.—The Corporation require tenders for the supply of continuous-current meters. Tenders by Oct. 3.

Huddersfield.—The Corporation invite tenders for high and low tension cable. Tenders by Sept. 30. See advertisement.

Wigan.—The Corporation invite tenders for 18 bogie cars, double-deck, four-motor equipment. Tenders by Oct. 20. See advertisement.

Manchester.—The Tramways Committee invite tenders for the supply of steel tramway poles. Tenders by Oct. 4. See advertisement.

Bury.—The Tramways Committee of the Corporation invite tenders for rails bonds and compressors. Tenders by Oct. 14. See advertisement.

Belfast.—The Gas and Electric Committee invite tenders for the supply of electric motors for a period of 12 months. Tenders by Oct. 10. See advertisement.

Tientsin (China).—Mr. A. W. Harvey Pellingham, secretary of the British Colony at Tientsin, China, invite tenders for installation and working of electricity works. Tenders by Nov. 30.

Wigan.—The Corporation invite tenders for the electrical equipment of a short length of new tramway and of a portion of their existing tramways. Tenders by Oct. 20. See advertisement.

Huescar (Spain).—The Municipality invite tenders for the installation and working for 20 years of the electric lighting of the town. Tenders to the Municipality, Province of Granada, by Oct. 6.

Batley.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Batley, Yorks, of 240 accumulator cells and accessories. Tenders by Oct. 10. See advertisement.

Wigan.—The Corporation invite tenders for the construction of a short length of new tramway and for the reconstruction of a portion of their existing tramways. Tenders by Oct. 20. See advertisement.

Burton-upon-Trent.—The Corporation invite tenders for the supply and laying of electric mains, conduits, junction boxes, etc., in connection with the tramways. Tenders by Sept. 30. See advertisement.

Bradford.—The Corporation invite tenders for the supply and delivery of electric motors (semi-enclosed type) of 4½, 7, and 10 h.p., for a period of 12 months, commencing Dec. 1, 1902. Tenders by Oct. 2. See advertisement.

Aviles.—The Company of the Asturian Coast, 38, Rue de Marques de Treverga at Aviles, Asturias, Spain, offer for sale their undertaking, composed of a 3ft. gauge line, five kilometres long, two Reve-Stuart locomotives, eight second-class and other wagons, and buildings. Tenders by Oct. 1.

Paris.—The French Government have decided to invite tenders for the supplying and laying of the following cables: (1) from Brest to Dakar; (2) from Tamatave to Réunion and from Réunion to St. Morice; (3) from Saigon to Pontianak, at Borneo. Tenders must be sent in by Oct. 21 next.

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Rotherham.—The Corporation invite tenders for steam pipes and valves, feed pipes and valves, feed pump and economiser, exhaust, water, and drain pipes and valves, and extension switchboard. Tenders by Oct. 16. See advertisement.

West Ham.—The Corporation invite tenders for the supply of 46 combined arc lighting and traction poles with side brackets. Specification and further particulars may be obtained from the borough electrical engineer, Mr. James K. Bock, Abbey Mills, West Ham. Tenders by 4 p.m. on Oct. 4.

Peterborough.—The Corporation invite tenders for the construction and seating of a Lancashire boiler, 28ft. by 7ft, at their electricity works. Specifications, etc., may be obtained at the office of Mr. John C. Gill, A.M.I.C.E., engineer, Municipal Offices, Peterborough. Tenders by Sept. 30.

Leicester.—The Tramways Committee invite tenders for the erection of an octagonal brick chimney shaft, 180ft. high, on the site of the new generating station, The Lero. Specification, etc., can be obtained at the office of Mr. E. George Mawbey, M.I.C.E., Town Hall, Leicester. Tenders by Sept. 30.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of two electric car traversers at certain of the Council's depôts in the south of London. Specification, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 21.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for Lancashire boilers, economisers, surface condenser, and pumps, etc., steam, feed, blow-off, and drain pipes, etc., and travelling crane. Specifications, etc., can be obtained from Mr. F. Schofield, clerk to the Board, Town Hall, Stalybridge. Tenders by Oct. 13.

Shanghai.—Messrs. Preece and Cardew are authorised to receive tenders for the supply and delivery c.i.f. of two 500-kw. steam alternators (the engines to be enclosed double-acting type and alternators to have stationary armatures, pressure 2,100 volts, periodicity 100), switchboards, and two condensers and circulating water pumps. Tenders by Oct. 30. See advertisement.

Bexleyheath (Kent).—The Electric Lighting and Traction Committee of the Urban District Council invite tenders for transformers and transformer pillars; condenser, air-pump, and water softener; feed pumps and pipework; and travelling crane. Specification, etc., may be obtained from the engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders by Sept. 30.

Ilford.—The Urban District Council invite tenders for the supply and erection of dry-back, semi-marine type boiler (15,000lb evaporation per hour), superheater and accessories, and motor feed pump; steam, feed, and blow-off pipes, and feed filter; surface condenser, cooling tower, motor pumps, hot-well, grease extractor, exhaust, steam, and water pipes. Tenders by Oct. 6. See advertisement

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Swindon, Wilts, of all the materials, fittings, and accessories for a complete installation of the electric light and wiring to the motors on the works, and also for the supply and delivery at the electricity works of testing instruments and engine-room accessories. Tenders by Oct. 4. See advertisement.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines hitherto by horse traction, with electrical power, and the construction, of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

South Benfleet (Essex).—The Rochford Rural District Council invite tenders for supply, delivery, erection, and maintenance for one month of electrical transmitting and recording instruments, and about 1¼ miles of overhead wire, poles, etc., for communication between the water-tower and engine-house at South Benfleet, Essex. Specification, etc., can be obtained at the office of the engineers, Messrs. James Mansergh and Sons, 5, Victoria-street, Westminster. Tenders by 10 a.m. on 30th inst.

Madrid.—The Postal Telegraph Department invite tenders for laying of 71 miles of submarine cable between Santa Isabel (Fernando Po) and King Bell's Town (Cameroons). The maximum subvention will be 8,400 pesetas per mile. A building is to be erected at the landing point; the contractors must furnish trial apparatus and pay 75 pesetas per day to each member of the commission of inspection, which has been appointed by the Government, until acceptance of the cable. A provisional deposit of 30,000 pesetas and a final deposit of 10 per cent. of the value of the contract will be required. Tenders by Sept. 30, which are to be addressed to the above authorities, from whom further information may be obtained.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

London, N.—The Light Railways Committee of the Middlesex County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction bridge work, etc.), of the following light railways—viz.: (Contract No. 1) railway No. 1—a line of double track (with cross-overs, contingent works, etc.) to be laid along Lordship-lane and Bruce-grove, in the districts of Wood Green and Tottenham, in the county of Middlesex, having a length of 1 mile 7 furlongs 6·8 chains or thereabouts; (No. 3) railway No 3—a line of double track (with cross-overs, contingent works, etc.) to be laid along the Archway and Great North roads, from Highgate Archway to Whetstone, in the districts of Hornsey and Finchley, in the county of Middlesex, having a length of 4 miles 6 furlongs 1·5 chains or thereabouts; (No. 5) railway No. 5—a line of double track (with cross-overs, contingent works, etc.) to be laid along the Edgware-road, from Cricklewood to Edgware, Hendon, Kingsbury, and Hendon Rural, in the county of Middlesex, having a length of 4 miles 6 furlongs 8 chains or thereabouts. Specification, etc., for each contract may be seen and schedule of quantities obtained on application at the office of Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster, S.W Tenders by Oct. 7.

RESULTS OF TENDERS.

Japanese Navy.—The tender of Belliss and Morcom has been accepted for one 385-h.p. engine.

South Wales.—The South Wales Power Company have decided to instal two Bruce Peebles dynamos for direct coupling to 360-h.p. Willans engines.

Coventry. — The City Council have accepted the tender of T. Reynolds for wiring and fitting the two old pavilions at the city hospital for the electric light, at £40.

Hampstead.—The Borough Council have accepted the offer of T. Parker and Co., of Wolverhampton, for a dynamo for direct coupling to a 100-h.p. Willans engine.

South Africa.—The Ayrshire Gold Mine and Lomagunda Railway Company, Limited, have accepted the tender of Belliss and Morcom for the supply of three 400-h.p. engines.

Harrogate.—The Corporation have accepted the tender of J. Walsh, Limited, High-street, Sheffield, at £749, for the wiring and supply of fittings for the electric lighting at the kursaal, Harrogate.

Bexley (Kent).—The Urban District Council have accepted the tender of the Hart Accumulator Company, Stratford, E., for the supply of storage battery at their electric lighting and power station.

Glasgow.—Browett, Lindley, and Co. have been successful in booking an order for three 400-kw. sets for the Scottish Co-operative Wholesale Society, Glasgow, and have sublet the dynamo portion to Crompton and Co, Chelmsford.

Ilford.—The Urban District Council have accepted the tender of the British Electrical Car Company, Oxford-court, Cannon-street, London, E.C., at £800, for a combined track watering and sweeping car on maximum traction truck with complete electrical equipment.

Watford.—The School Board have received the following tenders for lighting the Victoria Boys' School with electricity. Alternative estimates for casing the conductors in steel tubes and best whitewood:

Steel tubes

Ridout	£166	0	0
Waterford Engineering Works	139	0	0
Firth and Son	138	0	0
H. Downer	125	12	6
Rogers and Gowlett (accepted)	113	10	0

Best whitewood.

Ridout	166	0	0
Watford Engineering Works	132	1	0
Firth and Son	134	0	0
H. Downer	119	10	0
Rogers and Gowlett (accepted)	93	5	0

APPOINTMENTS VACANT.

Shift Engineer, Canterbury, 30s. per week, Oct. 6.

Junior Assistant Engineer, Hanley Town Council, £100 per annum, Oct. 10.

Shift Engineer, Southport Corporation electricity works, 45s per week, Oct. 7. See advertisement.

Junior Engineer, National Electric Supply Company, Preston, £5 per month. See advertisement.

Improver to act as switchboard attendant, Coventry Corporation Electricity Works, £50 per annum, Oct. 1. See advertisement.

Various Appointments are vacant at the Cleckheaton Urban District Council Electricity Works by Sept. 29. See advertisement.

Engineer-in-Charge, Wimbledon Urban District Council's electricity department, £78, rising to £104 per annum, Oct. 2. See advertisement.

Demonstrator and Assistant Lecturer in the electrical engineering department of the Heriot-Watt College, Edinburgh, £100 per annum, Oct. 4. See advertisement.

Switchboard Attendants, Eccles Corporation Electricity Works, £62 per annum, Sept. 31. Particulars may be obtained from the Town Clerk, Town Hall, Eccles. Kendal, Oct. 4.

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BUSINESS NOTES.

TRACTION.

Vienna.—This place is proposing to institute a service of electric omnibuses.

Gorton.—The tram fares on the Hyde-road section of the tramways are shortly to be reduced.

Norwich.—It is proposed to erect a shelter for passengers at the tram centre, Oxford-place.

Merthyr.—A fine of 40s. and costs has been inflicted on a driver of one of the electric tramcars for excessive speed.

Blackpool.—Next Wednesday the Tramways Committee will introduce a tariff of reduced fares on the tramcars.

Chichester.—Mr. E. Rotter has been appointed consulting engineer to the Corporation in connection with the tramway scheme.

Warrington.—Everything is now in readiness for the Board of Trade inspection of the Wilderspool route of the tramway system.

Dundee.—The Constitution-road route of the electric tramway system is expected to be opened for traffic in the beginning of next month.

Ossett.—Steps are being taken with a view to taking a poll of the ratepayers on the question of the introduction of tramways into the district.

Woodbridge.—Yesterday the Light Railway Commissioners opened an enquiry into the scheme for a light railway from Woodbridge to Bawdsey.

Rochester.—The Corporation have appointed Mr. E. Rotter, consulting engineer to the Portsmouth Town Council, to advise them on their tramway scheme.

Glossop.—The tramway scheme, which is being carried out by the Edmundsons' Electricity Corporation, will probably be completed by the end of March next year.

Sunderland.—The work of laying the track of the Fulwell tramway was commenced on Monday, and it is expected the section will be ready for traffic by December.

Bradford.—The tramway employés are agitating for better terms of engagement. The Tramways Committee are now considering what can be done to meet the demands of the men.

Tyldesley.—The Tramways Committee have refused permission to the South Lancs. Tramways Company to run cars in Tyldesley until the whole of the widenings have been completed.

Answorth.—The Parish Council have passed a resolution calling upon the Bury, Rochdale, and Oldham Tramway Company to sell to them so much of their undertaking as is within the parish.

Leeds Accident.—Owing to the trolley of an electric car coming off the overhead wire on Wednesday, the metal standard on the roof received a wrench which brought it down. Two persons were injured.

Walthamstow.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order for the construction of light railways in Walthamstow, Leyton, and Chingford.

Anglo-Argentine Tramways.—The directors have declared an interim dividend of 2s. per share, free of income tax. The existing 260,007 shares will become 5 per cent. cumulative preference shares as from Jan. 1, 1903.

Stirling.—It is proposed to form a local company for the purpose of constructing and working a tramway from the foot of King-street to the further end of Bannockburn on the overhead trolley system. The scheme is receiving the support of the Corporation.

Clydebank.—The negotiations between the Glasgow Tramway Committee and the Clydebank Town Council with respect to the acquisition by Glasgow of the burgh tramway provisional order have resulted in the conclusion of an agreement between the parties.

Leigh.—A trial run over the South Lancashire Tramway Company's lines in this district took place on Tuesday. The run was successful, the only delays being through wheel bearings getting overheated. The public service will commence running in about three weeks.

Hull.—The city of Hull tramways carried 411,366 passengers during the week ended Sept. 20, the total receipts amounting to £1,714. 0s. 6d., comparing favourably with the corresponding week last year, when 397,959 passengers were carried, and £1,658. 3s. 3d were the total receipts.

Madras.—Mr. T. Namberumall Chetty's scheme for the construction of tramways on the monorail system in the environs of the city of Madras, outside municipal limits, only waits for a technical difficulty with the Madras Electric Tramways Company before being put in hand.—*Indian Engineering.*

Leyton.—At a special meeting of the Council a resolution was passed that, subject to the approval of the Board of Trade, the Council give notice to the Lea Bridge, Leyton, and Walthamstow Tramways Company to acquire from them that portion of their undertaking within the urban district of Leyton.

Collision.—Another accident occurred on the Glasgow electric tramway system on Saturday. The driver of a car proceeding down West Nile-street gradient lost control through, it is said, the brake failing to act, and the vehicle collided with a cart and two lorries. The driver of the cart was slightly injured.

Manchester-Liverpool Monorail.—Considerable progress is said to have been made in the matter of providing capital for the Manchester and Liverpool Electric Express Railway, and it may be expected that before long an official announcement will be made as to when the construction of the new railway will be commenced.

Newcastle.—Plans of the proposed new car-shed on the Wingrove Estate have been approved, and tenders will shortly be invited for the construction of the building. The cattle market tramway is to be connected with Clayton-street. It is expected that about the middle of October the electric cars will be running to Walker.

Bournemouth.—The surveyor has received instructions to report on a scheme for an extension of the tramway system, to include a line from Lansdowne to the pier, and from the pier to the square *viâ* Exeter-park or Exeter-lane, and any other additions he thinks desirable. It is proposed to proceed by provisional order.

Guiseley.—Messrs Le Maitre and Parker, of Leeds, are proposing to construct tramways through Horsforth, Rawdon, Yeadon, and Guiseley. It is intended eventually to connect the Leeds city boundary with Bradford. The Guiseley, Yeadon, and Rawdon Councils have passed resolutions of sympathy with the scheme.

Dudley.—The Town Council have adopted a resolution of a committee of the whole Council agreeing as to the expediency of purchasing the whole of the tramways within the borough under the conditions set forth in the agreements with the Dudley and Stourbridge Tramways Company and the British Electric Traction Company.

Blackburn.—During the week ending Sept. 12 passengers carried on the Corporation tramways numbered 155,848, and the receipts amounted to £903. 12s. 9½d., compared with 140,529 passengers and £807. 13s. 5½d. receipts in the corresponding period of the previous year, an increase of 15,319 passengers and £95. 19s. 4d. receipts.

Chester.—Application is to be made to the Local Government Board to borrow £5,924 for purposes connected with the supply of electrical energy for the tramways In the construction of the tramways the Board of Trade have written the Town Council recommending a rail groove of 1in. in preference to the 1⅛in. groove proposed.

Dumfries.—The Town Council have delayed till after the November election consideration of a proposal to take the necessary steps to apply in April next for an order in Parliament giving powers to construct a tramway to Glencaple, with the assistance of Messrs. Kirkland and Capper, electrical engineers, London, as advisers only.

Southampton.—The Tramways Committee are recommending the Council to extend the tramways from the Portswood depôt to a site near the Brook Inn. The borough engineer and the electrical engineer will be asked to submit their estimates for carrying out the work. The suggested extension to Highfield is postponed for the time being.

Huddersfield.—The Corporation have decided to waive their powers to lay down tramways to Brighouse and Mirfield, and have invited the British Electric Traction Company to negotiate direct with the authorities of those towns with a view to taking the scheme in hand. A proposal to introduce ½d. fares on the trams has been defeated.

Camberwell.—The Borough Council have referred back to committee a proposal to support the application of the Crystal Palace Light Railways Company for the construction of a light railway, commencing at Lordship-lane near Crystal Palace-road, thence along Lordship-lane, Sydenham-hill, and the Crystal Palace-parade to Anerley-road.

London United Electric Railway.—The Chelsea Borough Council have been asked by the promoters of this scheme to authorise some of their members to give evidence before the Commons Committee which sits in October in favour of the line, one portion of which—*i.e.*, that from Clapham Junction to the Marble Arch—runs through this borough from Chelsea Bridge to the top of Sloane-street.

Manchester.—The secretaries of the Manchester branches of the Amalgamated Association of Tramway Employés met last week to consider the protest of the Manchester Corporation tramways employés against the conditions under which they have to carry on their employment. After a conference of several hours' duration, a statement was drawn up setting forth the demands of the men.

Automobile Corps.—The Automobile Volunteer Corps, which Mr. Mark Mayhew is raising with the approval of the War Office, wil have its headquarters in King's-road, Chelsea. The premises comprise a large drill hall, garage for 100 cars, offices and storerooms, etc., and are provided with a complete set of the most recent machine tools with a repairing staff. The premises are lighted by electricity.

Macclesfield.—The Council have passed a resolution approving in principle the introduction of electric tramways into the district. It is proposed to form a company to acquire the necessary powers from Parliament and to carry out the undertaking. In the event of the Corporation deciding to lay down an electric lighting plant, the company will take current for the tramways from that source.

Shipley.—A conference has been held between the Shipley District Council and the Bradford town clerk with regard to the coming arbitration to determine the conditions and terms for the running of the tramways within the Shipley district. The object of the conference was to clear the ground for the arbitration proceedings on the 29th inst., but beyond one or two minor points nothing was settled.

Bridlington.—A special meeting of the Rural District Council was held on Saturday, at which the proposed application of the promoters of the Flamborough and Bridlington light railway for a further extension of the provisional order of 1897 by 12 months was considered. It was decided to oppose the application. It was stated that the order had for some time stood in the way of certain road improvements in the district being carried out.

Deptford.—The Borough Council have agreed to contribute £3,510 towards the cost (estimated at £25,000) of the street widenings in connection with the London County Council tramway scheme. The Council have received a memorial urging them to take steps to carry into effect at the earliest possible date a scheme of electric trams connecting the districts of Deptford, New Cross, Forest Hill, and Sydenham, *viâ* Brockley and Crofton Park.

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Nidd Valley Light Railway.—It is stated that the Power and Traction Company, who some months ago obtained an order, under the Light Railways Act, to construct a light railway from Pateley Bridge to Lofthouse, have entered into a preliminary contract for the construction of the line, subject to satisfactory arrangements being made with the various landowners for the acquisition of the necessary land at agricultural value, to be paid in shares in the undertaking.

Hove.—The proposal of the Town Council to introduce electric tramways into the leading thoroughfares of the town is having a mixed reception locally. The ratepayers have not been consulted in the matter, and a Ratepayers' Defence Committee has just been formed for the purpose of resisting the proposals of the Council, and to compel that body to obtain the approval of the ratepayers before proceeding further. The committee is being very generally supported by the ratepayers.

South Shields.—A special meeting of the Town Council have adopted the recommendation of the Tramways Committee, noted last week, and have authorised the Parliamentary Committee to prepare a Bill for a new system of tramways in the borough. The cost is estimated at £213,360, based on the overhead trolley system, but the adoption of the overhead or any system has been deferred to allow the borough engineer to obtain further information from other towns.

Wolverhampton.—The Molineux section of the municipal tramways, which has been equipped for electric traction on the Lorain surface-contact system, will soon be opened for traffic. A trial trip on the section has shown it to be ready for the official inspection. Wolverhampton and Bilston are now linked together by an electric tramway. On Tuesday a trial took place of the new line from Ettingshall-road to Stow Heath-lane, and everything was pronounced satisfactory. The line was opened for traffic the following day.

Cardiff.—The project of a light railway from Cardiff to Penarth has been revived by the formation of a company, which, it is said, will be registered shortly with the object of obtaining powers for the construction of an electric tramway. It is expected that vigorous opposition will be offered to the scheme by the Corporation. The Tramways Committee have now agreed to offer to the tramways company £22,000 for the depôts and other buildings. The company are holding out for £25,000, and in the event of their refusing to accept the above offer the matter will go to arbitration.

London County Council Tramways.—With reference to the proposal for the construction of a tramway from Battersea Park-road to Buckingham Palace-road, the London County Council have resolved that, subject to the Battersea and Chelsea Councils, and the Council of the city of Westminster, consenting to the proposed tramway, and subject to the Battersea Council agreeing to contribute one-third of the net cost of the necessary street widenings, which will be entirely within that borough, to apply to Parliament in the session of 1903 for powers to widen Battersea Bridge-road, in general accordance with the plan approved by the Improvements Committee on May 7, 1902.

South Lancashire.—It is stated that the Corporation of Liverpool have entered into an arrangement with the Cheshire Lines Committee and the South Lancashire Tramways Company for direct communication by electric car and rail between St. Helens and Southport. The South Lancashire Company will convey passengers by car from St. Helens to the Knotty Ash terminus of the Liverpool Corporation electric car system, the Corporation will convey them similarly to the Knotty Ash Station of the Cheshire Lines Committee, and they will then be taken by rail to Southport, and *vice versâ*. At present passengers between St. Helens and Southport have to take a roundabout journey. The new arrangement, which comes into force almost at once, will be quicker and cheaper than the old.

Wallasey.—At a meeting of the Gas and Electricity Committee held yesterday week, the engineer, Mr. J. H. Crowther, presented a report recommending that the charges for energy be reduced for tramway purposes from 2¼d. to 1⅝d. This has been made retrospective from April 1, 1902. A report was also presented by the engineer as to charges for repairs to cars, overhead work, etc., showing that the Electricity Committee could not help losing money under the present arrangement, whereby they receive 10s. on repairs to cover management, current for motors, driving tools, fan, etc. ; also interest and sinking fund on works and tools. A joint committee meeting has been held to consider the proportion of plant required by the Tramways Committee under the engineer's scheme to spend £50,000 over the next seven years, which was referred back at the last Council meeting.

Bakewell.—A conference between representatives of the various local authorities interested in certain proposals to connect Sheffield and Bakewell by means of light railways was held on the 11th inst. The conference was called at the instance of the Bakewell Urban District Council, who decided some months ago that it would be well, before sanctioning any scheme for a new company to put down a light railway within their district, to approach the Midland Railway directors with a view of ascertaining whether they were prepared to carry out a project suggested some years ago to make a loop line between Hassop and Grindleford, which would afford all the facilities now required in this neighbourhood, and, in fact, be preferable in many respects to the suggested light railways. The following resolution was passed : "That as many of the representatives of the various local authorities as can shall form a deputation to wait upon Mr. Mathieson, the general manager of the Midland Railway Company, to discuss the matter."

Liverpool.—Mr. C. R. Bellamy, the tramways manager, reports that in the fortnight ended 6th inst. the electric cars in the city traversed 455,735 miles, that the passengers carried numbered 4,527,617, and that the financial receipts were £21,283. 6s. 7d. Touching by way of comparison the corresponding fortnight of the previous year, the figures are as follows : mileage, 443,510 ; passengers, 4,125,625 ; and receipts, £19,287. 16s. The Tramways Committee have decided to increase the wages of the electric car drivers who have been in the service over two years by ¼d. per hour, and over three years by ½d. per hour. This will have the effect of immediately augmenting the wages of 435 men to the extent of 2s. 6d. per week, and of 116 men 1s. 6d. per week. An attempt has been made to revert to the old system of charging higher fares inside the tramcars than to "outside" passengers. The proposal has, happily for the citizens of Liverpool, been overthrown in committee, and no alteration will be made in the present system.

Exeter.—At a special meeting yesterday the City Council received a report from the Electric Traction Committee recommending that, in addition to the routes previously approved, tramway No. 1 be continued along Polsoe-road, so as to form a junction with the existing terminus at Livery Dole. The committee were unable to recommend the construction of a tramway in Bonhay-road at present, and they also withdrew their recommendation as to Okehampton-road and Okehampton-street, as well as their recommendations as to tramways in South-street and College-road. The committee further recommended an additional tramway, commencing with junction No. 1 in High-street, through Bedford-street, Bedford-circus (crossing Southernhay), Barnfield, Denmark-road, Spicer-road (crossing Magdalen-road), St. Leonard's-road, terminating at Topsham-road. The whole of the tramways now recommended will be of a length of nearly 8 miles single track and a street mileage of 6·90 miles. The committee further adhered to their estimate that the cost of constructing the tramways, including overhead equipment, will be £6,500 a mile.

Leeds.—Several proposals were submitted to the Tramways Committee at their last meeting by the general manager, Mr. J. B. Hamilton, for the construction of a number of new tramways, and for the extension of certain of the existing routes to the city boundary. It was decided to apply for powers to construct new lines from Park-lane by way of Belle Vue-road and Moorland-road to Hyde Park, and from the Stanningley-road tramway at Bramley through Bramley township to Rodley. The former line is to be 1 mile 220 yards in length and the latter 2¼ miles. It was also decided to apply for powers to construct the following extensions : from the present terminus in York-road to the city boundary, a distance of 1,700 yards ; from the Elland-road tramway *via* Holbeck Top Moor Side and Domestic-street to Sydenham-road, a distance of half a mile ; and a short length of line (a quarter of a mile) along Great Wilson-street connecting the Hunslet-road tramway with the projected Victoria-road tramway. In reply to an enquiry from the Board of Trade, the committee formulated an answer to the effect that the consensus of opinion in Leeds was in favour of the carrying of extra passengers on the trams.

West Bromwich.—A hitch is said to have arisen between the West Bromwich Town Council and the Handsworth District Council in regard to the tramways. The first-named authority have purchased the tramways in the borough, and have been engaged some months in the work of reconstructing for the overhead trolley system. The West Bromwich boundary in the direction of Birmingham is opposite the West Bromwich football ground, and as the cable trams only go as far as the New Inns at Handsworth, it was thought there would be no difficulty with the Handsworth Council for continuing the electric system to where the steam trams at present run. Quite recently, however, the Handsworth Council have decided to municipalise the whole of the tramways within their district, and they say there are legal reasons why they should not consent to West Bromwich continuing their system to the New Inns. Moreover, it is said the Handsworth Council object to the centre poles which West Bromwich propose to erect between the two sets of rails on account of the heavy traffic which passes along the road. Although the system would occupy but a short distance in the Handsworth district, it is sufficient to prevent the linking up of the system. As this would be disastrous to the arrangements made, the British Electric Traction Company propose continuing the cable system to the West Bromwich boundary at the Albion ground.

Tramways in the Midlands.—Tramway municipalisation has provided a much-needed topic of discussion in the Midland counties during the past two or three weeks. The question arises in connection with the proposal of the Birmingham City Council and the surrounding district authorities to municipalise the tramways within their areas. Many meetings have been held, and resolutions both for and against have been passed. The Press also has taken up the subject with considerable zest, and daily there appear leading articles and letters in the columns of the local papers dealing with the subject. Among the latter is one from Mr. Arthur Chamberlain to Mr. A. J. Lecson, hon. secretary of the Birmingham and District Trades and Property Association. In the course of his letter, Mr. Chamberlain says he is opposed to the acquisition and working by the City Council of the tramways. He does not consider that the constitution or mode of election of city council's was intended to lend itself, or, as a matter of fact, does lend itself to the effective management of commercial undertakings. City councils, considered as profit-earning bodies, suffered from two radical defects. In one direction their powers were too limited for the effective control of great businesses, and in another direction their personal responsibility was too vague to bring home to them the results of financial mistakes. The Council had it in their power to propose to any company of undertakers their own (reasonable) terms, and it was only if such negotiations failed that they would be justified in taking the risks themselves. The Council was by its constitution much better fitted to conduct such negotiations to a successful issue than to supervise the daily and hourly details of a great business, and there was no reason to suppose that negotiations honestly and skilfully conducted would not result in getting all that tramway municipalisation, if successful, could give them, and avoiding all the burdens that, if unsuccessful, it would impose on them.

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LIGHTING AND GENERAL.

Gillingham.—The Council will join Chatham and Rochester in applying for a telephone license.

Chester.—Distributing mains for public and private lighting are to be extended at an estimated cost of £142.

Hythe.—The Town Council have sealed an agreement for the introduction of electric light into the borough.

Amble.—The Urban District Council have allowed the National Telephone Company to erect poles in various roads.

Brussels.—It appears that the inauguration of the Brussels-London telephone will not take place before February or March, 1903.

Amble.—The Urban District Council have given the National Telephone Company notice to remove certain poles which have been erected.

Londonderry.—Mr. P. C. Cowan will hold an enquiry on Oct. 9 next. Among other loans, the Corporation will apply for £35,000 for electric light purposes.

Maidstone.—The Urban District Council have received numerous applications for current, and mains are to be laid in St. Luke's-road and St. Luke's-avenue.

Radcliffe.—Tenders will shortly be issued for machinery at the electricity works. The buildings are fast approaching completion, and the chimney is finished.

Faversham.—Colonel A. G. Durnford has held an enquiry into the Town Council's application for sanction to borrow £24,190 for the purpose of electric light.

Llanelly Dock.—What is reported as a very successful installation of electric light has just been laid down at the Llanelly new dock by Messrs. Alger, of Newport.

Eastern Extension, Australasia, and China Telegraph Co — The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share.

Llandudno.—The Urban District Council are petitioning the General Post Office to provide additional telephone trunk wires between Llandudno and the English cities.

East Cowes.—The electric light and power company have given notice of intention to lay mains, cables, and boxes to supply electricity in the principal thoroughfares of the town.

Wolsingham.—An electric light company are making enquiries as to the probable requirements of Wolsingham so as to judge the advisability of constructing a power station.

Direct Spanish Telegraph Co.—The directors have declared an interim dividend at the rate of 4 per cent. per annum for the half-year ended June 30 last, payable on the 1st prox.

Folkestone Electricity Supply Co.—The directors declare an interim dividend at the rate of 4 per cent. per annum on the ordinary shares in respect of the half-year ended June 30 last, payable Oct. 1.

Croydon.—We understand that the post of the principal of the electrical department of the Croydon County Polytechnic will shortly become vacant, and that the secretary of the institution is open to receive applications.

Sale of Plant.—The Urban District Council of Shipley invite offers for the purchase of one 45-i.h.p. compound engine, direct-coupled to a 25-kw. compound dynamo. Further particulars may be seen in our advertisement columns.

Hawick.—The Urban Electric Supply Company are offering to fit up small houses in the town on the free-wiring system. The current is to be supplied through a 1s.-in-the-slot meter at the rate of 6d. per unit, this charge to meet the whole cost of fitting and rent.

Stock Exchange.—The Stock Exchange Committee has appointed Oct. 1 as a special settling day for Isle of Thanet Electric Tramways and Lighting Company's £150,000 4 per cent. debenture stock, and have ordered the said securities to be quoted in the official list.

New Company.—Burn's Patent Tramcar Lifeguard Syndicate, Limited, has been registered, with a capital of £2,000, the object being to acquire and work all patents obtained by or on behalf of R. S. Burn in respect of a safety guard for electric tramcars and the like, etc.

Lux Meters.—We are informed that Mr. G. Braulik, 217 and 218, Upper Thames-street, E.C., has taken over the sole agency for the United Kingdom of the Lux electricity meters, which are largely used on the Continent, and which are sold at a comparatively very low price.

Edinburgh.—It has been remitted to the Electric Lighting Committee to consider and report on the disposal of the declared surplus of £10,295. 11s. on last year's account of the electric lighting undertaking, and report on the charges to be made for electric energy for light and power during the current year.

Dundee.—It is reported that Mr. George Balfour, of Messrs. Lowden Bros. and Co., Dundee, at present consulting engineer for the electric lighting of Broughty Ferry, has been offered, and has accepted, an appointment with an eminent firm of electrical, mechanical, and civil engineers in London, at a salary of £1,000 per annum.

Camborne.—The electric light company have been asked to supply King's-road with electric light of the same power as the present gas lamps. A long correspondence between the Camborne Electric Light Company and the Board of Trade respecting the supplying of houses in the district with electric energy has been forwarded to the Council.

East Africa.—The telegraph line from Dar-es-Salaam to Kilimatinder is shortly to be extended to Ujiji, where it will connect with the British Transcontinental line. At Dar-es-Salaam Messrs. Howaldt and Co., of Kiel, recently built a new dock at a cost of £30,000, which is lighted by electricity and supplied with electric motors.

Cardiff.—There is a curious trouble brewing, apparently, on account of the action of the Cardiff Railway Company, who have refused to lay the Corporation wires on their land, while it seems they are willing to grant the privilege to the South Wales Electrical Distribution Company. The latter claim the right to supply in this case, as they would be on private land all along.

Preston.—At the last meeting of the Guardians an opinion was expressed to the effect that the Boilers Committee had made a good bargain in securing the superintendence of a qualified electrical engineer for the sum of £5. 5s. a year. It would be money well spent, for reports would be received monthly and advice given in case of emergency. It could not by any means be called an exorbitant fee.

Tunbridge Wells.—At the Wednesday's meeting of the Tunbridge Wells Ratepayers' Association, a question was asked whether there was any intention on the part of the Corporation to sell or lease the telephones to the National Telephone Company. Councillor Nicholson, as chairman of the committee, said the success of the borough system disposed of any idea of handing over a valuable scheme to the company.

Falkirk.—The Town Council will borrow £10,000 for electric lighting before getting a permanent loan. About £25,000 is required. The Grahamston and Bainsford Co-operative Society have decided to light their Falkirk premises with electric light. They will require 72 lights altogether; the fitting up of these is estimated to cost £95. To light the fleshing department will cost £81, and the central premises £110.

St. Albans.—At a recent meeting of the Urban and General Purposes Committee of the Council the electric lighting question was discussed, with the result that the committee have decided to recommend the Council to accept the offer of the North Metropolitan Electric Supply Company for their undertaking, the terms of the company being practically accepted *en bloc*. The matter is to be finally decided upon at the next meeting of the Council.

South Africa.—We note from a paragraph which appeared in *Electricity of New York* that manufacturers are invited to furnish to John Denham, electrical engineer of the Cape Government Railways, Cape Town, South Africa, catalogues with prices, discounts, etc., of steam, oil, and gas engines, pumps, steam piping, electrical fittings, cables and wires, arc and incandescent lamps, switchboards, measuring instruments, etc. Where prices are subject to fluctuations an approximate amount should be stated. We have great pleasure in reproducing this information, as we see no reason why English manufacturers should not also avail themselves of the opportunity offered; in fact, we would have much preferred, and had a right to expect, that manufacturers in the United Kingdom would receive considerable preference in South Africa.

Anglo-French Telephone.—The convention regulating the telephone service between Great Britain and France has just been published. The convention was signed at Paris on July 29. The unit adopted both for the collection of charges and for the duration of communications is a conversation of three minutes. For this period a charge of 4s. will be made for conversations originating in, or destined to, telephone centres situated in England proper, including Wales (first zone); 6s. will be charged for conversations originating in, or destined to, telephonic centres situated in Scotland and in Ireland. In France two zones and two similar prices obtain. These rates include the share of each administration in respect of the transit of submarine cables. The two administrations are to determine, by mutual agreement, the allocation of each of the circuits through which international communication shall be established, the towns admitted to the service, and the hours during which the service shall be authorised. The rates provided for are to be reduced by one-half for conversations exchanged during the night by subscription. Intending users of the lines may as well note that the minimum duration of each conversation by subscription is to be twice the unit of conversation.

Plymouth.—The Corporation are circulating a pamphlet by Mr. E. G. Okell, the borough electrical engineer, entitled "Notes Relating to the Electricity Supply within the Borough." The contents are brief and to the point, and give all the information required by consumers in the streets where supply is available. It states, *i.a.*, that the supply is given at a pressure at either 100 or 200 volts, alternating current of a frequency of 50 periods per second, and is suitable for incandescent lighting, arc lighting, heating, cooking, ventilating, and for general power purposes. All electricity supplied is charged for by meter, and at the following rates: for lighting, etc., 4½d. per unit; for motors, 4½d. per unit, or 8d. for first hour daily and 3d. after. There are no meter rents or other charges, the supply cables being brought into consumers' premises, and meters fixed free. The Corporation, however, reserve the right to determine the position in which the meter shall be fixed. When the point of entry into a consumer's premises is more than 60ft. from the nearest main, or if any distance has to be run within consumer's premises, the Corporation, at their discretion, may exercise their right to make a charge on account of the extra cable required. One unit of electricity, costing 4½d., will light one 8-c.p. lamp for 33 hours, one 16-c.p. lamp for 16½ hours, and one 32-c.p. lamp for 8¼ hours. The current supply is well suited for small alternating motors up to, say, 12 h.p., which are most adapted in the district referred to, as motors of this type have no commutators or brushes, and, therefore, do not require neither skilled attention nor special foundations. In addition, they occupy very little space. The charge for electricity supplied to motors is either 4½d. per unit for all power supplied, or 8d. for the first hour's daily use and 3d. after on the maximum demand indicator principle. The latter rate of charge will be found the cheaper in all cases where motors are used for more than three hours daily. The price per unit under this system of charging works out as follows on a constant load: one hour's use daily, 8d. per unit; three hours, 4⅔d.; five hours, 4d.; six hours, 3⅔d.; eight hours, 3⅝d.; ten hours, 3½d.

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Maidenhead.—The engineer is of opinion that everything will be ready for the light to be switched on in the middle of November. Applications for the light are coming in very well.

Bridgwater.—The Town Council have sealed an agreement with the National Telephone Company, Limited, for the provision of telephonic communication with the pumping station at Ashford.

Calcutta Electric Supply Corporation, Limited.—The directors have declared an interim dividend for the half-year ended June 30 last at the rate of 6 per cent. per annum, payable on Nov. 15 next.

Finsbury.—The County of London and Brush Provincial Electric Lighting Company intend to lay electrical conduits along both sides of Lever-street, from the east side of Goswell-road to the west side of Central-street.

London Gazette.—A supplemental dividend of 11s. 8½d per £ has been declared in the estate of G. H. Bentley, 8, Grafton-street, Earlestown, Lincs., payable from Sept. 25 at official receiver's offices, Byrom-street, Manchester.

Radstock.—The Somerset and District Electric Syndicate intend to apply to Parliament for a Bill in November. They propose to erect a main generating station upon the Somersetshire coalfields in the neighbourhood of Radstock.

Rotherham.—The Sheffield Corporation have asked the Council to co-operate with them in the provision of municipal telephones within the Sheffield area. Further particulars are to be obtained before the Council will commit itself by any resolution on the subject.

Chelsea.—Notices have been received from the London Electric Supply Corporation of their intention to lay mains along Sloane-street, Knightsbridge, King's-road, Church-street, Elm Park-road, Elm Park-gardens, Flood-street, Cheyne-walk, and Chelsea-embankment.

Warkworth.—At the annual meeting of the Harbour Commissioners last week the chairman reported that the carrying out of the work of the electric lighting was progressing satisfactorily, and he hoped that in the course of a month the installation would be completed.

Poplar.—At the last meeting of the Guardians exception was taken to certain recommendations of the Engineering Works Committee, especially of the recommendation to provide and fix iron ladders and gratings in the deep-well pumps, and to fit and connect an electric lamp to each well.

Benwell.—The District Council's surveyor has been instructed to obtain information from persons in the district willing to take a supply of electricity from the Council at a price equivalent to the price charged for gas, and report to the Council at their next meeting the quantity likely to be required.

Shildon.—The electric light company have been negotiating for some considerable time for the purchase of land on which to erect a destructor and electric works. They have arranged the various contracts for cables, etc., and are making such progress that they hope to start supplying current early in the coming year.

Lanchester.—The Rural District Council have accepted an offer of the owners of the Hamsteels Colliery to affix six poles and the necessary plant for lighting the road at Wilk's Hill by electricity at a cost of £40, with the addition of 45s. per lamp per season for lighting and attention, the illuminating power being 32 candles.

Colchester.—The Town Council have signed an agreement with the National Telephone Company, Limited, for (*a*) telephone instrument at and telephone line from Fire Brigade Lieutenant Jarman's residence to the police station; and (*b*) fire alarm bell at and electric line from each of the 21 firemen's houses to the police station.

Removal.—Messrs. Baxter and Caunter, the London agents for the Newton Electrical Works, Limited, the Electric and Ordnance Accessories Company, Limited, the Premier Electric Lamp Company, and the British Insulated Wire Company, Limited, have removed from 5, Macclesfield-street, Shaftesbury-avenue, to 86, Charing Cross-road.

Morecambe.—Mr. Carleton has presented a report upon the recent breakdown of the arc lamps, which was said to be caused by a subsidence of earth brought about by the exceptionally high tide, and the consequent snapping of the cable. The cable makers' along with a report as to the mains will be presented at the next meeting of the Urban District Council.

Wallasey.—At a meeting of the Gas and Electricity Committee held on 18th inst., the engineer, Mr. J. H. Crowther, presented a report recommending that the charges for energy be reduced from 6d. for first 2½ units on each 8 c.p. in any quarter, all other units at 4d., to 6d. for first two units on each 8 c.p. and 3d. for all further units consumed in each quarter; motors from 3½d. to 3d. per unit.

New Steamer.—The "Schleswig," trading between Southampton and Monte Video and Buenos Ayres, is a twin-screw steamer of 7,000 tons, owned by the North German Lloyd Company. The ship, which is 467ft. in length, is an entirely new type of steamer in the River Plate trade. Electricity plays many parts on the ship, from warming and ventilating the state rooms to the heating of curling-irons for lady passengers and the kneading of dough in the bakery.

Aston.—The stonelaying ceremony of the electrical power station, now in course of erection in Chester-street, is to take place on Tuesday next. The chairman of the Tramways and Electric Light Committee (Mr. J. J. Gittings) has issued invitations for the ceremony, and also for a dinner at the Albert Hall, Witton-road, subsequently. It is expected that the building will be completed by March or April. About three-parts of the street cables for the electric lighting under the present scheme have already been laid.

Garston.—The Electric Power and Lighting Committee of the Liverpool Corporation have received from the city lighting engineer a report as to the lighting of the Garston district, which has recently been brought within the city boundaries. From this it appeared that while with regard to gas the illuminating power would be increased by 150 per cent., the annual charge would be diminished by £220 per annum. The committee decided to reduce the price charged for electricity from 5d. to 3½d., the price of current in Liverpool.

Wirksworth. The Derby and Notts Electric Power Company propose to erect a generating station near Matlock early next year for the Matlock and Wirksworth districts. Three stations are in course of erection in the two counties, and the company has also another station near Ilkeston for supplying electricity for the tramway and general lighting. Their charge will be 1½d. for 250,000 units, the mains to be put in by the Council at an average cost of about 7s. 6d. per yard. No decision has been arrived at by the Council pending the receipt of table of charges, etc.

Brighton.—According to Mr. Bennett's revised estimate for the construction of the proposed municipal telephone system, excluding from the scheme the cost of all works in the borough of Hove, application will be made for sanction to borrow £42,000 in lieu of £45,000 previously applied for. The Lighting Committee have resolved to ask the Councils of Portslade, Southwick, and Shoreham whether they are willing that the Corporation should supply electricity within their districts, and whether in that case they would be willing to support an application by the Corporation to Parliament for the necessary powers.

Heckmondwike.—Good progress is being made with the large extensions which are being made at the District Council's electricity works in anticipation of supplying electrical energy to the British Electric Traction Company for the running of the proposed trams. The old electricity plant is working satisfactorily, and the output is steadily increasing. At the end of August the Council had 5,961 8-c.p. lamps connected, and 57 consumers. Since then nine other consumers have been obtained, thus bringing the total up to 66. It is estimated that there will be fully 6,000 lights and 70 consumers by the end of the present month.

Canterbury.—The electric light is to be installed at the sanatorium, and tenders will be invited for wiring the institution. The work is to be carried out under the supervision of the electrical engineer, Mr. Blascheck. The estimated cost of carrying the cable from the asylum to the sanatorium is £350. This will be a charge upon the capital of the Lighting Committee. The wiring is estimated to cost about £65, and the connection of the houses with the cable about £30. The probable number of lamps required is 166, and to these 10 to 15 lamps for the new blocks will be added; estimated cost, about £55.

Huddersfield.—The following is the text of a motion agreed to last week: "(1) that all former resolutions be rescinded, or varied so far as may be necessary, for the purpose of passing this motion; (2) that the interests of the borough imperatively demand an underground and modernised system of telephonic communication; (3) that an agreement be entered into with the National Telephone Company, Limited, for placing their wires and cables underground within the borough for a period not exceeding 25 years, subject to satisfactory terms being arranged; and that it is desirable that the negotiations which have already been commenced should be continued and completed."

Fulham.—The borough electrical engineer on Wednesday reported that from July 14 to Sept. 8, 1902, applications equivalent to 2,558 8-c.p. lamps had been received, making in all a total of 36,808 8-c.p. lamps; 510 services had been connected to the mains, representing an equivalent of 21,000 8-c.p. lamps. During the eight weeks ended Sept. 6, 1902, the refuse destroyed and clinker disposed of amounted to 2,640 loads of refuse, weighing 3,735 tons 7cwt. 2qr., at 2s. 3d. per ton, and 53 loads of trade refuse cremated at 1s. 6d. per load. There were barged away 1,756 tons 9cwt., and carted away 270 tons, making 2,026 tons 9cwt. at 6d. per ton, giving net receipts of £274. 10s.; as against wages, £370. 11s 3d.; 10 per cent. salaries and management, £37. 1s. 1d., thus leaving a debit balance of £133. 1s. 8d.

Bermondsey.—A resolution to the effect that application be made to the Board of Trade for a provisional order authorising the Council to supply electricity for public and private purposes within the parishes of St. John and St. Olave and St. Thomas has been referred to the Finance Committee of the Borough Council, so that proper estimates of the cost of the application might be framed. A special meeting will be held on Oct. 21 to consider the matter and pass statutory resolutions requisite. The total number of lamps applied for in the borough up to date is 8,325, irrespective of public lighting. Of these 2,887 8-c.p. lamps were applied for since the previous meeting of the committee. As regards power, many large firms have at least one motor, and one firm alone has agreed to take 100,000 units per annum.

Coventry.—We learn that the Corporation electricity department is now in a position to loan out electric motors to consumers on extremely advantageous terms. Current for power purposes is being supplied at 1½d. per unit, and therefore any works or manufacturing process cannot fail to benefit by the adoption of electrical driving. The following rates are being charged for hired motors: ½ h.p., £1. 13s. 6d. per annum; 1 h.p., £2. 5s; 2 h.p., £2. 12s. 6d.; 3 h.p., £3. 5s.; 4 h.p., £3. 17s. 6d.; 6 h.p., £4. 7s. 6d.; 9 h.p., £5. 17s. 6d.; 10 h.p., £6. 15s.; 12 h p., £7. 10s; 16 h.p., £9; 20 h.p., £10. 10s.; 25 h.p., £11. 17s. 6d.; 35 h.p., £14; 50 h.p., £25. Intermediate sizes are charged *pro rata*. These rates do not include fixing or wiring motors, which has to be done by the hirer. The department is anticipating increased business from this departure.

Sunderland.—On the invitation of the chairman of the Electricity and Lighting Committee of the Sunderland Corporation (Alderman W. Bruce), the members of the Town Council and others paid a visit of inspection to the new electric lighting station constructed in Hylton-road last week. The site, which cost £6,000, measures four acres, three of which have been used for electrical supply purposes, while the

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remainder has been allocated to the Tramways Committee for the erection of additional car-sheds. The cost of the new station up to date, including land, buildings, and plant, has been £60,000. There are installed two 250-h.p. and three 500-h.p. steam dynamos, with five Lancashire boilers. The output from the new station—which is being used at present merely as an auxiliary to the other station in Dunning-street—was from Oct. 31, 1901, to March 31, 1902, 107,489 units.

Swansea.—A clerk of the works for the new municipal telephone exchange, which is being erected in Pier-street, has just been appointed in the person of Mr. David Jones, of Swansea. The Corporation have secured a larger number of subscribers than was necessary to start the scheme. Mr. A. R. Bennett's revised estimate, based upon the tenders for the apparatus, etc., required for the carrying out of the municipal telephones scheme, reduces the original estimate of £18,900 to complete the necessary equipment by £900. The Council will apply for sanction to a loan of an additional £1,400 for the establishment of an exchange. Reference to another column will show that the contract has been let, and the subscribers are promised connection by January next. A question raised at the last meeting as to the inadvisability of proceeding with the building before the Local Government Board had sanctioned the loan was over-ruled by the Council, who have secured the Postmaster-General's license. The minutes of the Electric Lighting Committee were adopted stating that the foundations for the new plant were almost completed. With reference to the proposed trial of the Kingsland surface-contact system for the extensions, other firms were also sending in applications. A sub-committee will deal with the matter and report.

Macclesfield.—A sub-committee of the Electricity Committee have under consideration an offer from Messrs. Medhurst, Page, and Lloyd with regard to establishing an electricity supply undertaking on the following lines: (1) the contract for all buildings, plant, mains, etc., to be placed with one firm, the Council raising the money and paying cash for the installation in the usual way on their certificates; (2) the successful contractors to take a lease of the whole undertaking from the Council immediately on completion of the works, paying to the Council a rental equivalent to the amount of the interest and sinking fund that the Council would have to pay on loan, the contractors paying in addition all working expenses, and taking, of course, all revenue during the continuance of the lease; (3) inasmuch as the Council will be permitted by the Local Government Board to borrow this capital for a period of 25 years, the lease to be a 25 years' lease, with the option to the Council of terminating the lease by paying a premium of 15 per cent. on the capital expenditure at the expiration of seven years, 10 per cent. on the capital expenditure at the expiration of 10 years, and no premium whatever at the expiration of 14 years, with a further option of terminating the lease at any time after 14 years by giving six months' notice to the contractors.

Ashton-under-Lyne.—Major Stewart has held an enquiry into the application of the Corporation to borrow £30,000 for electric lighting purposes in connection with the borough, and for proposed extensions in connection with the Corporation electricity works. The Town Clerk (Mr. F. W. Bromley) said he was instructed by the Town Council to ask for sanction to borrow £30,000, being the amount necessary for defraying the costs, charges, and expenses incurred, or proposed to be incurred, in the extension of the Corporation electricity works, plant, and mains, owing to increased demand for current by the Oldham, Ashton, and Hyde Electric Tramways Company and by ordinary customers for lighting purposes. Colonel Eaton, C.B., gave evidence dealing with the erection of the works carried out under his supervision and the preparation of the plans. The original estimate for the building, he said, was £4,743, for iron roofing £707, for wiring £174. 18s.—total, £5,624. The actual cost was £7,463. 0s 2d., so that there was an excess of extras of £1,838 2s. 2d. Colonel Eaton explained the various items which had caused the excess, the largest of which was £313 for plumbing and glazing work, and which was, he said, unforeseen. Mr. N. Appelbee, the electrical engineer, explained the reason of the excess of £2,522 in the cost of the machinery, the estimate for which was £16,000.

Hamsteels (Durham).—The oil lamp, which has long been associated with Hamsteels, Quebec, and Esh Village as the only means to light up the main turnpike and streets, has given way to the electric light. The Owners of Hamsteels Collieries supply the power, and the lights were switched on for the first time on Thursday evening. The generating plant at the Hamsteels Colliery consists of two 40-h.p. vertical steam-engines, supplied with steam from colliery boilers, driving two multipolar Morley dynamos capable of supplying current for 480 lights each at a pressure of 240 volts, these being compound-wound, so that the variation in the number of lights does not affect the voltage. The switchboard is mounted in a teak frame surmounted by a clock, and is divided into four panels, the two inner being the distribution panels for district, colliery, and private lighting, and the two outer the dynamo panels. This also contains shunt regulators for 300 16-c.p. lamps for colliery and private lighting, four 2,000-c.p. arc lamps for lighting heapsteads, and 61 32-c.p. lamps for street-lighting. The latter covers over five miles, extending from Springwell in a westerly direction to Low Esh in an easterly direction, and the boundaries of Esh Winning in a southerly direction. In this work over 160 poles and nearly five tons of copper wire have been used. The plant has been supplied by the Morley Electrical and Engineering Company, Limited, Morley, Leeds, and its erection has been superintended by Mr. Frank Wall.

Stirling.—The Lighting Committee have received the following reports from Mr. A. C. Hanson: "In accordance with your instructions, I have prepared the following statement on the progress of the electric light undertaking for four weeks ending Aug. 9, 1902: units generated, week ending July 19, 1902, 1,386 (1901, 737); week ending July 26, 1,420 (795); week ending Aug. 2, 1,570 (829); week ending Aug. 9, 1,711 (900)—total, 6,087 (3,261). Fifty-six equivalent 8-c.p. lamps have been applied for during this period, and 244 have been connected, making a total of 8,111 equivalent 8-c.p. lamps connected for private lighting and motors, and 8,989 connected to the mains for all purposes, as compared with 6,180 at the same period last year. Public lighting.—The cable for the Snowdon-place extension has been laid, and most of the lamps are connected. The whole of the material, with the exception of the switch and fuse box, has arrived, and if this box arrives within the course of the next few days the extension should be complete by the 15th inst. Units generated: week ending Aug. 16, 1902, 1,808 (1901, 1,108); week ending Aug. 23, 2,389 (1,138); week ending Aug. 30, 2,303 (1,373); week ending Sept. 6, 2,612 (1,476)—total, 9,112 (5,095). Twenty equivalent 8-c.p. lamps have been applied for during this period, and 370 have been connected, making a total of 8,423 equivalent 8-c.p. lamps connected for private lighting and motors, and 9,359 connected to the mains for all purposes, as compared with 6,310 at the same period of last year. The Snowdon-place extension is completed and has been running satisfactorily. The engineer was instructed to take in estimates for the supply of coal for six months. Two Nernst lamps are to be erected at the corn exchange."

Broughty Ferry.—The inauguration of the electric light took place on the 24th inst. Miss Lena Kidd, the daughter of the electric light convener, switched on the light first in the Council-chambers, and afterwards the public lamps were lit. The front portion of the station consists of a staffroom and storeroom on the ground floor, the battery-room occupying the upper front, which contains an E.P.S. battery of 136 cells of 220 amperes each. The switchboard is fitted with instruments, switches, and connections for 230 volts continuous-current supply for the two dynamos. The dynamos—one 60-kw. and one 30-kw., constructed by Messrs. Parker, Wolverhampton—are coupled direct to the engines by Messrs. Belliss and Morcom's engines of the enclosed high-speed compound type, the larger being capable of developing 112 h.p and the smaller 56 h.p. The larger has 450 revolutions per minute and the smaller 550. The battery is charged with one of Parker's boosters, capable of an output of 20 kw. An atmospheric evaporating condenser, built by Messrs. Cooper and Greig, Dundee, is placed above the engine-house. The boilers were constructed by Messrs. Babcock and Wilcox, work at a pressure of 160lb., and are fitted with blast for burning riddlings from coke. The cables are on the two-wire system, with provision for changing to a three-wire system should occasion arise. The cables (on the solid method) are placed in wooden troughs, supported with small bridges to keep them clear, and run in with bitumen. Above the wooden troughs tiles are placed, and a tube for a third wire is laid between the troughs. Twelve Brockie-Pell arc lamps are fixed upon pillars by Messrs. Walter Macfarlane and Co., Glasgow. Each lamp pillar is also fitted with two brackets for incandescent 16-c.p. lamps, which will be lit after 12 o'clock in place of the arc lamps.

Cardiff.—The change over to continuous current was inaugurated last Friday, when Alderman Carey, the chairman of the Lighting and Electrical Committee, manipulated the switch which supplies current throughout the centre of the town and the Docks district, outside, of course, the private property of the Cardiff Railway Company. At the present moment the committee are supplying 57,000 8-c.p. lamps in Cardiff. Mr. Ellis explained that directly the continuous current was set going the committee would supply the Mount Stuart Dry Docks, and other works could be connected both for lighting and power. Subsequently he stated that the Mount Stuart Company were supplied at 1d. per unit, which left a good margin of profit. The Lighting and Electrical Committee have decided to light Bute-street by electricity before the winter. The material has been ordered, and the work will be proceeded with as soon as the lamps and brackets are delivered. A similar application in regard to Cathays is to be considered shortly. At the last Council meeting it was resolved that Penarth-road, Corporation-road, Walker-road, Portmanmoor-road, Tudor-road, Neville-street, and Clare-street be electrically lighted in the same way as proposed for Bute-street and St. Mary-street. It was also resolved that Windsor-place be lighted by electricity. A letter has been received from the Local Government Board refusing to sanction the loan of £107,611 for extensions to the Roath power station, from which fact it appears that there must be some friction between the Board and the Board of Trade, who have given their sanction. Up to the present time £48,750 out of the £107,611 have been expended, and the demand for light and power is increasing at such a rate that the committee will be in a fix unless the extensions are made. The Local Government Board object to the expenditure upon the continuous-current supply on account of the plant having been put down at the power station. Mr. Ellis has suggested that the Tramway Committee should obtain the sanction of the Board of Trade and sell the energy to the Lighting Committee. A committee is dealing with the matter.

PROVISIONAL PATENTS, 1902.

SEPT. 15.

20097. Improvements in storage batteries. Walter Osmond Rooper, Congreve Manor, Penkridge, Staffordshire.

20112. A method of winding electric machines. Harry Rottenburg, 38, Seymore-grove, Old Trafford, Manchester.

SEPT. 16.

20168. Improvements in or relating to electrical induction or sparking coils. Frederick Harold Hall and Constance Hall, 24, Temple-row, Birmingham.

20199. Improvements in or connected with the construction of electric arc lamps. James Brockie, 33, Chancery-lane, London.

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20206. Improvements in switches for starting and controlling electric motors. Justus Eck, 5, Priory-road, Chiswick, London.

20236. Improvements in electric switch signals. Charles P. Bass and Thomas B. West, 322, High Holborn, London. (Complete specification.)

20237. Improvements in selective calls for telephones and telegraphs. William Palmer, jun., and Acheson McClintock, 53, Chancery-lane, London.

20240. Improvements in electric conduit railways or tramways. Robert Abbott Hadfield and David Galbraith, 46, Lincoln's-inn-fields, London.

SEPT. 17.

20265. Improvements in or applicable to trolley poles of electrically-propelled vehicles. Albert Lumbers, 9, Tempest Hey, Liverpool.

20280. Electrical insulator. Morton Harloe, 214, Mears-building, Scranton, Lackawanna, Pennsylvania, United States. (Complete specification.)

20289. Improvements in telephone systems. Donald Macadie, 111, Hatton-garden, London. (Complete specification.)

20323. Improvements in and relating to electric switches. Llewellyn Burbank Codd, Standard Works, Dame Agnes-street, Nottingham.

SEPT. 18.

20324. Improvements in protecting irons for electric cables. Louis Mannstaedt, 221, Alleestrasse, Barmen, Germany. (Complete specification.)

20340. Improvements in the form and construction of wire used for the transmission of electrical energy. Isaac Hopkinson, 698, Wakefield-road, Bradford.

20355. Improvements in telegraphs with automatic disengagement. Eugène Ducretet, 100, Wellington-street, Glasgow. (Complete specification.)

20376. An improvement in telephonic microphone transmitters. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Waleryan Ernest Knorr, Brazil.)

20398. Improvements in electric telegraphy. Frederick Edward Hesse, 24, Southampton-buildings, Chancery-lane, London. (Ernest Sydney Heurtley, Singapore.)

SEPT. 19.

20425. Improvements in or in connection with cut-outs for overhead electric traction or trolley wires. William Towler, 30, Park-row, Leeds.

20426. Improved portable testing and comparing instrument for electric incandescent lamps. Albert McCandlish, 78, George-lane, Bredbury, near Stockport.

20428. An electrical motion transmitting and speed gear for application between a mechanically-operated driving-shaft spindle or part and a driven shaft spindle, or part, particularly adapted for use on motorcars and such like. Tom Hawkins and Ernest Greenhalgh, 11, Burlington-chambers, New-street, Birmingham.

20438. Improvements in electric car trolleys. John William Knowles, Sunbridge-chambers, Bradford.

20445. Improvements in terminals for electric wires. The Wolseley Tool and Motorcar Company, Limited, and Herbert Austin, Prince's-chambers, Wolverhampton.

20456. Quick-break chopper switch for high-voltage currents with automatic spark extinguisher. Otto Volkmann, 94, Sophie Charlotten Strasse, Charlottenberg, near Berlin. (Complete specification.)

20461. Improvements in detachable connections for use in electric lighting and heating. Andreas Peter Lundberg and Gustaf Charles Lundberg, 18, Fulham-place, Paddington, London. (Complete specification.)

20483. Improvements in electric safety fuses. Oliver Leopold Peard and Frederick Dew, 24, Southampton-buildings, Chancery-lane, London.

20502. Automatically operated points and cable connections for main junctions of electric tramways and the like. Charles George Goord, 77, Chancery-lane, London.

SEPT. 20.

20522. An improved method of and means for generating electric current for certain purposes. Frederick Harold Hall and Constance Hall, 24, Temple-row, Birmingham.

20552. Improvements in electric switches. Isaac George Waterman, 111, Hatton-garden, London. (Complete specification.)

20553. Improvements in electromagnetic valve-controlling apparatus. Isaac George Waterman, 111, Hatton-garden, London. (Complete specification.)

20555. Improvements in electromagnets. Isaac George Waterman, 36, Chancery-lane, London. (Complete specification.)

20556. Improvements in electromagnetic valve-controlling apparatus. Isaac George Waterman, 36, Chancery-lane, London. (Complete specification.)

20557. Improvements in the electrical control of water-supply lavatories, bath tubs, shower baths, and bowls. Isaac George Waterman, 36, Chancery-lane, London. (Complete specification.)

20571. Improvements in and connected with alternate-current motors. Valere Alfred Fyn, 70, Chancery-lane, London.

20572. Improvements in or connected with alternate-current motors. Valere Alfred Fyn, 70, Chancery-lane. London.

20573. Improvements in or connected with electromagnetic clutches or couplings. Valere Alfred Fyn, 70, Chancery-lane, London.

20587. Improvements in safety arrangements for use in electric motor and other circuits. The Johnson-Lundell Electric Traction Company, Limited, 45, Southampton-buildings, Chancery-lane, London. (Robert Lundell, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 9.

1901.

18256. Electrical batteries. Colietas. (Date applied for under International Convention, Feb. 12, 1901.)

18258. Combined electric logs and speed recorders. Denison, Graham, and Dearlove.

18330. Electric motor control systems. British Thomson-Houston Company, Limited. (Case.)

18502. Electric arc lamps. Froment. (Date applied for under International Convention, Feb. 16, 1901.)

13577. Push button controlled electric lift. Bush and Medway.

18895. Electric switches. De Ferranti.

19230. Electric arc lamps. British Thomson-Houston Company, Limited. (Fish.)

21031. Supporting standard and trolley arm used in overhead electric traction schemes. Ross.

21292. Electric heaters. Danilevsky.

21328. Waterproof cone, cap, or cover for protecting the holders of electric glow lamps. Miller.

21665. Construction and production of the terminals of electric glow lamp sockets and their fittings to and insulation from the casing of the said sockets. Hopkins.

22000. Insulating composition for electrical purposes, and method of applying the same. Sankey.

23600. Shunts for electrical measuring instruments. Eckstein and Panter.

24175. Conduits for laying electric cables. Brooke.

25076. Insulators for high-potential currents. Gaertner.

25265. Electric arc lamps. British Thomson-Houston Company, Limited. (Fish.)

26346. Control of electric automobile vehicles. British Thomson-Houston Company, Limited. (Lemp.)

1902.

11499. Electric low-water alarms for steam-boilers. Marks. (Fuller.)

14228. Electromagnetic friction clutches. Schuster and Ast.

14387. Electrolytical manufacture of chlorates and perchlorates. Lederlin. (Date applied for under International Convention, Jan. 8, 1902.)

15952. Systems of electric motor control. Andrews. (Date applied for under International Conventions, July 25, 1901.)

16232. Regulating devices for electric arc lamps. Thorin.

16293. Electric switches. Lake. (General Electric Company.)

16294. Electromagnetic switches. Lake. (General Electric Company.)

17253. Waterproof, acid-resisting, and electrically non-conducting gloves. Eckert.

17867. Moisture and waterproof fixture and guard for electrical attachments, such as incandescent lamps, plug attachments, and the like. Hauss.

17913. Arc electric lamps. Green.

17953. Marine electric light fixtures. Martin.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7½-7¾
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	103-106
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1¾
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15½-16¼
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2¼-3
—— 5 per cent. Debentures	100 ..	101-106 p.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼-⅜
—— "A" Shares, 01-017,139	5 ..	14-24
—— 5 per cent. Debentures	100 ..	78-83
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	100-103
W. T. Henley's Telegraph Works, Ordinary	5	16-17
—— 4½ per cent. Preference	5	5½-5⅝
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21¼
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12½-13⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12½-13
—— 5 per cent. Perpetual Debenture Stock	100	125-128
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅛-1⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100	104-107
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4¾-5⅛
—— 4 per cent. 1st Mortgage Debentures	100	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11½-12⅝
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	96-99
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4⅜ xd
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref. } Within	10	11¼-12
—— " " " " } 1-82,500	5	8⅞-9¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	108-110
—— " " Prov. Crts.	50	82-84
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅜
—— 5 per cent. Cum. Pref.	10	11½-12⅜
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8½-9⅜
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £251,132 6 per cent. Preference	14s.	¾
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	70 p.c.	70 p.c

Electric Railways.—

Central London, Ordinary	100	103-106
—— 4 per cent. Pref.	100	105-108
—— " deferred	100	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	72-74
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	90 93

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	103-106
Bournemouth and Poole, Ordinary	10	12-13
—— 4½ per cent. Cum. Pref.	10	9½-10⅛
—— Debenture Stock, Red.	100	102-105
Brompton and Kensington, Ordinary	5	10¼-10⅜
—— 7 per cent. Preference	5	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7½-8⅛
—— Nos. 20,001-30,000	5	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " £10 Ord.	6	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	105-108
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5¼-5⅜
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	9-10
—— 6 per cent. Cumulative Pref.	10	12½-13½
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London and Brush Provincial, Ordinary	10	8¼-8½
—— 6 per cent. Cum. Pref.	10	11½-12⅝
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	111-114
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5⅜-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10¾-11⅛
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	105-108
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10½
London Electric, Ordinary	3	1⅜-2¼
—— 6 per cent. Pref.	5	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	110-115
—— 3½ per cent. Mortgage Debenture, Red.	100	98-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6⅜
Notting Hill Electric Lighting	10	13½-14½
Oriental, 1879	1	—
—— £5 Shares	5	7-7½
—— £1¼ Shares, New	4½	6¼-6⅜
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6 xd
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1⅜-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5	15-16
—— 7 per cent. Pref.	5	8¼-8½
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	2¼-3⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	2¼-3⅛
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	6 6¼

Telephones.—

National Telephone, Preferred	100	93-95
—— Deferred Stock	100	55-57
—— 6 per cent. Cum. First Pref.	10	12-13
—— 6 per cent. Cum. Second Pref.	10	11-12
—— 5 per cent. Non-Cum. Third Pref.	5	4⅞-5⅛
—— ¾ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent. Deb. Stock, Red.	100	102-106
[illegible] Telephone and Electric Company	1	⅛-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sept 20	1,003	753	+ 249	+ 4,539	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	" 20	4,930	4,916	+ 36	+12,880	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	22½	—	—	—	—	1,140,000	—	—	—	—
Blackburn Corporation	" 19	755	752	+ 3	+ 3,744	24	—	—	—	26,064	—	—	11·86	1,035	—
Blackpool Corporation	" 18	1,611	1,573	+ 38	— 267	16½	—	Mar. 31	41,818	5,809,190	753,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	" 20	1,144	1,008	+ 136	— 536	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 21	1,631	1,502	+ 129	+ 2,585	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	" 21	3,359	1,235	+2,124	+72,040	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57*
Bristol Tramways Company	" 19	4,820	4,129	+ 691	—	51½	49	Dec. 31	210,112	35,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	" 20	195	180	+ 15	+ 450	—	—	" 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	" 20	6,324	5,873	+ 451	+ 6,246*h*	12	12	" 31	535,086	41,188,389	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	" 21	2,851	2,040	+ 811	+10,345	12½	9½	" 31	62,631*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	" 18	820	564	+ 256	+ 4,000	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	" 20	251	256	— 5	+ 131	4½	—	" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 22	132	99	+ 33	— 11*h*	6¼	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	" 19	3,793	3,686	+ 107	} —	46	46	" 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	" 19	912	883	+ 29											
Dundee City Tramways	" 17	787	689	+ 98	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	" 20	12,935	15,958	- 3,022	—	104	95	" 31	532,146*e*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	" 10	1,439	1,201	+ 229	+ 2,047	27¾	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	" 20	1,112	958	+ 154	—	—	—	" 31	49,011	7,624,865	1,001,033	1·54	11·7	—	13·90
Hull Corporation, E. S.	" 20	1,714	1,658	+ 55	+ 1,908	19	9½	" 31	72,331	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	" 13	10,430	9,650	+ 780	+28,990	93	78	Dec. 31	87,707	21,065,999	2,218,695	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	" 21	1,514	1,565	— 51	— 1,199	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	" 20	1,831	1,003	+ 828	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	" 21	4,237	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	" 11	1,199	959	+ 240	—	11	—	" 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	" 21	1,120	1,134	+ 14	—	19	17	" 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *h* Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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NOTES.

The Pacific Cable.—Operations in connection with the laying of the British Pacific cable have now been commenced at Bamfield Creek, on the west coast of Vancouver Island. The ss. *Colonia*, which sailed from Liverpool some time ago, has just reached there with the cable on board. Bamfield Creek will be the terminus of the line, which is likely to be in operation by the end of the year.

Book Received.—Messrs. Whittaker and Co, of Paternoster-square, have just published a new work by Mr. S. R. Bottone, entitled "Galvanic Batteries: their History, Construction, and Use." The book deals with all classes of galvanic batteries, including primary, single and double fluid cells, secondary, and gas batteries, and is well illustrated throughout. The published price of the work is 5s.

Electro-Harmonic Society.—The seventeenth season of the Electro-Harmonic Society will open on Friday evening, the 10th inst., with a smoking concert in the Crown Room of the Holborn Restaurant. We are informed that all the society's concerts are to be held at the Holborn Restaurant this season, instead of at the St. James's Restaurant as heretofore, the change being necessitated by rebuilding operations at the St. James's Restaurant.

Ventilation on the Tube.—We gather from an unofficial source that the attempts to improve the atmospheric conditions on the Central London Railway have not so far proved successful. The experiment has consisted in drawing air from the tube by means of a huge fan placed in the Bond-street station. A new attempt is to be made on the opposite principle of forcing fresh air into the tubes rather than of drawing the vitiated air out from them. We gather that the supply of fresh air is to be distributed throughout the length of the tube, and controlled by means of valves in the air-pipes.

Finsbury Technical College.—In the evening courses for the ensuing session at the Finsbury Technical College, the Monday evening lectures (advanced course) begin on Oct. 6. Prof. Silvanus Thompson will lecture on three-phase currents, and later on dynamo design. Mr. Simmons will take part in the lectures after Christmas. On the Wednesday evenings, beginning Oct. 8, Mr. Darling will lecture on electrical instruments, etc., and later Prof. Thompson will lecture on magnetism and electromagnetic apparatus. Mr. Darling and Prof. Thompson will share the heat and light lectures on Friday nights, commencing Oct. 10.

Scientific Research in India.—We understand that the Government of India have decided to appoint a board of scientific advice, to meet ordinarily twice a year. Its function will be that of a central authority in relation to the various scientific departments which are growing up in connection with the Revenue and Agricultural Departments. Among the duties of the board will be to ensure that the work of scientific research in India is distributed to the best advantage, to see that each investigator confines his researches to the subject with which he is most capable of dealing, and that energy is not dissipated by useless duplication of enquiries, or misdirected by lack of inter-departmental co-operation. Its duties will also include such supervision as will enable it to see that the claims of abstract science are not given undue precedence over those of the more immediately important demands of economic or applied science.

An Electric Drying Oven.—For the benefit of chemists and others who desire a more convenient apparatus than the gas-heated air-bath commonly in use for drying precipitates, Mr. E. S. Smith, in the *Scientific American*, describes a simple and easily constructed oven, in which electricity is the heating agent. Ordinary electric incandescent lamps are used. In the illustration before us the bath is eqipped with two 110-volt 20-c.p. lamps, one of which will heat the oven to 150deg. F., while the two are capable of giving a temperature of 230deg. F. It is obvious that a range of temperature may readily be obtained by using lamps of higher candle-power or by increasing their number. The bath itself is constructed of galvanised iron, lined with asbestos. Its dimensions are 7½in. by 6½in., the material being cut and shaped in one piece. The lamps are fixed horizontally at the bottom of the oven. We understand that Mr. Smith has found the arrangement very successful and practical.

The Goubet Submarines.—It is stated that an English company has acquired the patent rights for manufacture in this country of the Goubet submarine boats, which are to be built under the personal supervision of Mr. Claude Goubet, the inventor. These boats are small in size compared to those which have been built at Barrow-in-Furness, and it is proposed that they shall be carried on the warship, and only put overboard for use just before going into an engagement. The length of the boat, 26ft., and the diameter, 5ft. 6in., give an idea of the smallness of the craft, which, however, are said to carry enough battery power for 5½ hours' actual work. A maximum speed of from 7 to 8 knots an hour is to be obtained. A system of compressed-air tanks and pumps for expelling the vitiated air is provided for a week's submergence if any crew could be got to stay under the water for that length of time. The boats will be armed with Whitehead torpedoes carried in two horizontal keels, one on each side, which are said to increase the stability of the vessel.

Application of Legrange's Equations.—In the September number of the *Physical Review* Mr. Wm. S. Day describes an experiment relating to the application of Legrange's equations of motion to electric currents, which is analogous to one made by Maxwell. The latter investigated whether or not any part of the kinetic energy of an electric current could be expressed by a term depending on the product of an ordinary velocity and an electric current. The velocity, he considered, was a velocity of the wires carrying the current in the direction of its length, and Legrange's equations of motion show that if the term referred to exist, then whenever a current is started or stopped in a wire, there would be an impulse acting on the wire in this direction. Maxwell could not discover any evidence of such an effect. The present author has made an experiment for a similar purpose, but in his experiment the mechanical co-ordinate considered is one whose velocity means a rotation of the wire around its axis, the corresponding impulse when the current is suddenly started or stopped being an impulsion torque, if the term in question exists. But no evidence of the existence of such an effect was discovered in spite of most careful experiments.

Cables in Wartime.—The Institute of International Law, at Brussels, has passed certain important resolutions with regard to the attitude of the Powers respecting submarine cables in wartime. As given by the Brussels correspondent of the *Morning Post* they are as follows: First, the submarine cable connecting two neutral territories is inviolable. Second, the cable connecting the territories of two belligerents, or two portions of the territory of one of the belligerents, may be cut anywhere except in the territorial sea, or in the neutralised water dependent on a neutral territory (neutralised by treaty or by declaration conformable with Article 4 of the resolution

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of Paris, 1894). Third, the cable connecting a neutral territory with the territory of one of the belligerents may in no case be cut in the territorial or neutralised sea dependent on a neutral territory. In the open sea such a cable may only be cut if there is an effective blockade and in the limits of the line of blockade. This cable may always be cut in the territory and in the territorial sea of the enemy up to a distance of four sea miles from the "laisse" of the low tide; and fourth, the liberty given to a neutral State to transmit telegrams may not degenerate into a disloyal and manifest assistance of war given to one of the belligerent parties.

An Antiseptic Attachment for Telephones.—An arrangement which serves to minimise the danger of the spread of disease by the promiscuous use of telephones has been devised by Messrs. Henry C. Smith and M. H. Woolsey, of the States. It consists of an antiseptic attachment for telephone mouthpieces, which is calculated to destroy any disease germs which may be lodged within the mouthpiece, and at the same time to protect the mouthpiece and connected parts from the ingress of dust or foreign matter. The essential feature of the arrangement is a cap, adapted to close over the mouth of the telephone, and which carries within it any suitable absorbent material. This material is properly saturated with a sterilising or antiseptic substance, so that when the cap is closed over the mouthpiece the material forms contact around the periphery, and thus cleans and sterilises the mouthpiece, besides forming a closure to prevent the rapid access of dust. It also serves by closing to prevent the rapid evaporation and loss of sterilising substance and to maintain the vapour or fumes, if any such arise, within the instrument, where such vapour or fumes will be of the most service. The cap is held normally closed over the mouthpiece, and may be easily released by a light pressure when it is desired to open the device for use.

Future of Engineering.—Mr. J. D. Cormack, professor of engineering, on Tuesday delivered the introductory lecture at University College on the reopening of the building for the winter session. In the course of his address he remarked that the value of a thorough scientific and technical training was not even yet properly appreciated. Referring to the many important and varied works for which the engineer was responsible, Prof. Cormack drew attention to the great strides that had been made in the locomotion of the world, not excepting the tube railway, the electric tram, and the motorcar. He also mentioned the telephone and the telegraph as among the greatest feats accomplished by the engineer. As regards the education of the engineer, it was at this moment a question of supreme national interest, and until it was on a more satisfactory and rational basis England could not hope to compete successfully with the United States, Germany, and those other countries which challenged her industrial supremacy. We appeared to be on the eve of a thorough awakening, and, he asked, what part was the University of London to play? It was to the public they must look to supply in the university a well-equipped, well-endowed, and well-staffed institution, providing advanced technological courses and furnishing young men trained, not only in scientific principles and methods, but also in the application of science to particular industrial processes. There were two chief obstacles to overcome—the want of money and the want of a scheme. The public must supply the first want and the university the other.

Motorcar Trials.—The official results now published of the reliability trials held at the beginning of last month by the Automobile Club show that they were of a remarkably successful character. They have demonstrated that the average car is a highly reliable vehicle; they have shown that the English car need not fear comparison with its foreign rival. Altogether 61 cars took part in the trials, of which 35 were of English manufacture and 26 of Continental or American origin. Considering, first, the trials as a whole, of the first 20 cars in the total marking, 12 were of English and eight of foreign make. Then, in the non-stop runs, 11 of the leading 20 cars were English and nine foreign. These results tend to show that the motorcar as turned out in England is at least ahead of the foreign vehicle in point of efficiency. In the hill-climbing test the cars performed very well. The condition of the cars at the end of the trial was an important feature, and it is satisfactory to find that 14 vehicles scored full marks. In the judges' remarks there is a comment to the effect that in three foreign cars and one English the gear was inaccessible. These, however, were the only exceptions to the general practice of making every part as accessible as possible. While it is gratifying to note that only in five cases were marks deducted for faulty steering gear, the results of the brake trials were not so satisfactory. That is to say, that while in most cases the brakes would have held on ordinary roads, they were not all equal to the work they were called upon to do under the conditions of the competition. The judges have not yet awarded the medals, but they are shortly expected to do so.

High-Speed Electric Locomotive.—Mr. Reichel has a well-illustrated article in *Elek. Zeit.* on an electric locomotive built for high-speed railways by Messrs. Siemens and Halske. The engine has four axles and two geared motors. It is operated directly on 10,000 volts, so that no step-down transformers have to be carried on the train, and the weight of the locomotive is thereby considerably decreased. The primary winding is placed on the stator, and to obtain a large cooling surface rather deep slots were chosen. The rotor has a radius of 34cm. and is 30cm. broad. The stator has 72 open slots and 67 wires per slot, star connection being used. The rotor winding is placed in 90 half-closed slots, and consists of single copper bars, four bars in each slot. The accessories are, with the exception of the rheostats, of the same design as used on the high-speed experimental motorcars in the Berlin-Zossen trials. Starting and speed regulation is accomplished, as usual, by inserting resistance in the secondary circuit, the rheostat having 24 stops. The rheostat consists of kruppin wire spirals, connected in parallel. The locomotive has been tested at a voltage of 6,000 to 11,000. The highest speed obtained was 63 miles, as had been the intention. If for high-speed railroads it is intended to use a speed of 96 miles at a frequency of 35 and a pressure of 8,000 volts, a car equipped with those motors, together with a trailer of 42 tons weight, including passengers, can carry 100 passengers, and there are 1,200 kg. total weight per passenger. The author says that the corresponding figures for steam traction would be 1,800 kg., so that there is an advantage in favour of electric traction.

The Electrical Industry of Austria.—Information to hand concerning the electrical industry of Austria shows that the trade in that country is largely monopolised by German firms. For example, the electric tramways in Vienna are being constructed by the Siemens and Halske Company, of Berlin, which is also investigating the question of converting the Vienna Metropolitan Railway to electric traction. Again, the Schuckert Company, which is completing the municipal electricity works in the Austrian capital, now proposes the construction of a high-speed electric railway between Vienna and Baden. Other German firms engaged in this work in Austria include the

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United Company, which is installing hydro-electric works of 2,000 h.p. at Lebring, and the Union Company, which, in addition to various electric tramway systems, is establishing power plants in numerous works and mines. As far as the export trade is concerned, this is practically controlled by the German companies, who, in truth, are the founders of most of the Austrian concerns. At the present time the capital invested in Austria-Hungary aggregates five millions sterling, of which the former country is responsible for about 75 per cent. In Vienna there are three companies running electric lighting works. These have now to compete with the municipal supply, which has just been commenced. The present position of the manufacturing electrical concerns in Austria is described as not being of a very brilliant character. This is attributed partly to the uncertainty in regard to the economic relations of Austria and Hungary, and partly to the effects of the German crisis as experienced in Austria.

Electricity Supply at Northampton.—In a few months' time the Corporation of Northampton will require a supply of electricity for running the electric tramways they are laying down in the town. Naturally, the Northampton Light and Power Company, which commenced its supply in the year 1891, is anxious for the Corporation to take current from its generating station for this purpose, but it seems that the Corporation are not yet convinced that it would not pay them better to put down their own generating plant. We have received a pamphlet from the company, which affords some idea of the relations existing between it and the Town Council. It seems that the company is offering to supply the tramways with power at 1¼d. per unit, and in this pamphlet it endeavours to show that if the Corporation accept the offer in preference to putting down their own plant, they will effect a saving of £1,100 per annum. We gather that the Corporation at one time had the option of buying current from the company at 1⅛d. per unit, which, on the company's figures, would have increased the saving to £1,339. The company has now been carrying on its undertaking for over 10 years, and the purchase of the business by the Corporation is almost certain to take place sooner or later. Thus, it is pointed out that in these circumstances the Corporation will be in a much better position to carry it on successfully if they are free to combine the lighting and traction than if they are hampered by the possession of a separate power station for the tramways. In coming to a decision in the matter, the Corporation have not much time to lose, for if they finally reject the offer of the company they will have to erect a generating station of their own in order to get a supply of energy by the time the tramways are ready for running.

The Electrochemical Industry in the States.—The first journalistic exponent of electrochemical science and its various applications, to be devoted entirely to this object in America, is a new monthly publication received by the last mail from Philadelphia. Its title is *Electrochemical Industry*, and it promises to fill a vacancy in the scientific periodical literature of America, which has been created by the rapid growth of the electrochemical industries in that country, and especially in the neighbourhood of the Niagara Falls. The first number of our new contemporary is an exceedingly interesting production. It has several original contributions by well-known authorities in the electrochemical world, the one which particularly attracts our attention being an able exposition of the electrochemical industries of Niagara Falls by Mr. Joseph W. Richards, president of the American Electrochemical Society. By the end of the present year the Niagara Falls Power Company will be developing 60,000 h.p., 45,000 h.p. of which, or exactly three-fourths, will be used in electrochemical work. Several electro-chemical processes now being worked at Niagara are described by the author, and he mentions an experimenting company which has been formed to discover and develop new processes and bring them to the point of commercial application. Among the processes so far developed by this company are: the method of fusing bauxite to produce artificial corundum, the method of treating barite to produce barium hydrate, the method of producing acid from nitrogen and oxygen, and the method of producing camphor from turpentine. Besides these, the company is working on the production of cyanides by the fixation of the nitrogen in producer gas, the production of artificial rubber, the production of new fertilisers, and the manufacture of several new silicides.

Electrolysis of Alkali Salt Vapours. — This question is discussed by Wilson in the *Philosophical Magazine*, to which he contributes an account of an experimental investigation of the passage of electricity through the flames containing salt vapours. Former experiments have shown conclusively that conduction through salt vapours is accomplished by means of ions of some kind, and is, therefore, to this extent at least analogous to conductions through solutions. The experiments described by the author show that above 1,300deg. C. there is a very close analogy between salt vapours and liquid electrolytes; Faraday's laws of electrolysis are strictly applicable to salt vapours, just as to salt solutions. He shows that a salt in the state of vapour gives rise to the same number of ions carrying the same charges as a salt in an aqueous solution, and describes in detail the arrangement of his experiments, giving in a diagram curves showing how the current with a constant E.M.F. (840 volts) varies with the temperature when solutions of 1 grm. in a litre are sprayed. The nearly constant value of the current above 1,300deg. seems to represent the maximum current which the amount of salt passing through the tube can carry, for it is affected very little by increasing either the temperature or E.M.F. This current he calls the "saturation" current for the particular salt used. The values of this maximum current are given for various salts in a table. From this table the writer proves that Faraday's laws of electrolysis apply also to the saturation current carried by a salt vapour. The amount of salt per second of electro-chemical equivalent unity which would correspond to a current of one ampere is 0·0101 milligramme. Now, one ampere-second liberates in electrolysis 0·0104 milligramme of hydrogen, so it appears that the factor of proportionality is nearly the same for salt vapours as for electrolytes.

Electric Lighting Rights.—The Cardiff Lighting Committee have been refused permission to lay mains on the property of the Cardiff Railway Company in order that they may supply tenants of that company with power and light. From the reports which have reached us the committee are exceedingly indignant at the refusal, particularly so as they understand that the South Wales Electric Power Distribution Company will be able to obtain those customers which the committee cannot reach with the public mains. The town clerk has been instructed to report on the question of the powers of the Corporation and of the electric supply company at the next meeting of the committee, and we are afraid that his report will give no consolation to the Committee. The electric lighting orders do not vest their owners with power to confiscate private rights, but simply give them permission to open up public streets in order to lay mains. It has been proved in London that where the local authorities have unduly opposed the laying of trunk mains through their streets by companies not holding provisional orders, this

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consent has been dispensed with by making agreements with railway and canal companies running through the areas in question. It seems, therefore, that the only chance which the Cardiff Committee has of supplying these consumers must result from pressure brought to bear on the railway company by the tenants. It is certain that if these tenants find the municipal supply more convenient and more reasonable in price than that given by the power company, they will soon be able to force the ground landlords to give their consent to the laying of the mains. It will come as a shock to extreme municipalists to find that their electric lighting orders do not prevent private individuals supplying electrical energy within their district so long as they can keep their mains on private property.

Alternating Current for an American Railroad.—According to our American contemporaries, the Westinghouse Company, of Pittsburg, are about to equip an inter-urban railroad between Washington and Baltimore for electric traction with alternating-current apparatus throughout. This will mark an entirely new departure from American practice, which heretofore has always been on the side of the direct-current system. As a rule, for long-distance roads, alternating currents are generated at high pressures of from 10,000 to 30,000 volts which are reduced down to from 500 to 650 volts by means of transformers and rotary converters and supplied to the motors on the cars at this potential. The new system of the Westinghouse Company, particulars of which are not yet available, is said to avoid the present limitations of the induction motor and the disadvantages of the multiplicity of overhead conductors. For the road now being constructed between Washington and Baltimore, single-phase alternating current will be generated in a main power-house by three 1,500-kw. single-phase generators delivering current at 15,000 volts. At this voltage it will be distributed to transformer stations located at suitable intervals along the line, from which current will be fed to a single trolley wire at 1,000 volts. This pressure of 1,000 volts for the trolley line is not part of the new system, as a much higher voltage could be used if deemed advisable by the engineers of the railway. The cars are to be equipped with four motors, each of 100 h.p., and it is expected that a normal speed of from 40 to 45 miles an hour will be obtained, and a speed of 60 miles if required. The motor, which is said to be the novel part of the equipment and the key to the entire system, is a variable-speed motor, having characteristics adapted to railway service. It is claimed that in all respects it is quite equal to the present-day direct-current railway motor.

Lightning Above and Below Water.—Prof. J. Trowbridge, in a recent publication, describes experiments which lead him to the conclusion that lightning never strikes the surface of the sea. When a lightning discharge seems to do so, it really passes from one region of the air to another, and it is only perspective which leads one to suppose that it strikes the water. The author has often endeavoured to pass powerful sparks to the surface of water, in order to obtain a strong spectrum of water vapour, but in every case the sparks—6in. in length, and resembling lightning discharges as far as possible—refused to strike the level surface of the water and pass to the edges of the containing vessel. In a vacuum tube with water terminals and exhausted to the vapour tension of water, no discharge could be made to pass from one water surface to the other. It is also very difficult to pass powerful sparks from one stream of water to another, and the author thinks it improbable that lightning discharges pass through regions in the air of heavy rainfall. In his endeavours to obtain a good water-vapour spectrum, the author set himself to produce an electric spark under water. Using distilled water, it was necessary to use platinum wires sealed in glass tubes, and emerging not more than half an inch. If the terminals are dipped to a depth of 2in. in the water, the containing tube, if not more than 2in. in diameter, is shattered by the sparks. If the terminals are only dipped to a small depth in the water, a spark passes giving a very brilliant light resembling that of an enclosed arc lamp, but having no lines in its spectrum. This spectrum is probably due to water vapour, and the different spectra of lightning obtained by different observers are due to different amounts of water vapour in the air. Zigzag lightning occurs in the lower regions of the atmosphere, certainly below 1,000ft.; above 1,000ft. it loses its zigzag character, and can be of great length with the same voltage as in lower altitudes. At still higher regions we have the aurora. Water vapour plays a controlling part in all these phases of lightning.

Depreciation.—In every argument concerning the faults of municipal trading and the advantage of public works being carried on as private enterprises, the question of depreciation always attracts great attention. In the articles now appearing regularly in the *Times* the views of the companies are expressed, and because they are repeated over and over again, the general public is apt to consider that these views are correct. The fact remains, however, that an electric lighting undertaking or a tramways scheme worked by a corporation is in a much better position than if owned by a company. The real difference lies in the length of life of the undertaking, which in the case of a company is only of a limited duration. With a corporation, on the other hand, the right to provide electric lighting and power or to run tramways is for all time. Consequently, if these corporation undertakings are maintained in efficient order out of the revenue, the need for further depreciation is extremely problematical. In spite of this, the corporations have to depreciate their undertakings, because they are bound to repay within a limited period the money they have borrowed. Our views on this point have been so often expressed that we need hardly reiterate them here. It is interesting to note, however, that Mr. Chas. Hawkesley, the president of the Institution of Civil Engineers, expressed exactly the same opinion in a discussion in the Engineering Section of the British Association at Belfast. He said that when the life of an undertaking was not limited, and the works maintained in efficient working order out of revenue, there was, in his opinion, no need to write off annually any sums for depreciation. It will be urged by the company's experts that Mr. Hawkesley is used to dealing with civil engineering works of a more enduring character than electrical undertakings. On the other hand, these experts unduly exaggerate the changes which are to be expected in the electrical engineering profession. If the best advice is obtained and acted upon at the present time, there is no reason why the machinery installed should not have a life at least equal to the period for which corporations obtain their loans. If this is done the error, if any, is on the right side.

Wireless Telegraphy in Germany.—Mr. Marconi, who has just returned to England from Italy, has been talking with a representative of the daily Press on wireless telegraphy in general and the proposed International Convention in particular. This convention was suggested on the initiative of Germany, and Mr. Marconi describes it as "neither more nor less than another attack by Germany upon British industry," it probably being thought in that country that as matters stand wireless telegraphy is at present too much in favour of England. According to the

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Daily Chronicle, Mr. Marconi is responsible for the following criticism with regard to Germany and Prof. Slaby's system of wireless telegraphy: "Prof. Slaby came to England and was introduced to me by the British Post Office authorities. He came at the instance of the German Government to study my system of wireless telegraphy. He received every facility from me in doing this. He went back to Germany. He lectured there declaring that he himself had attempted experiments in wireless telegraphy which had proved unsuccessful. He had seen what Marconi was doing, which represented a real invention, and he admitted that whatever he did in the future would be due to Marconi, his master. He adopted the essential features of my system, vertical wire for transmitting and receiving, for instance. These are the main features of his system. He introduced some other variations which I consider detrimental—indeed, experiment proves them to be so. He has established a so-called system of his own by which he has telegraphed one-twentieth of the distance I have covered. The German manufacturers, who have no inventor's royalties to pay, are prepared to sell their inferior apparatus for a small manufacturing profit. It is the desire of the German Emperor, I presume, to support them in this undertaking, and this it is which has inspired the demand for the convention. I think that a convention might at the proper time be a good thing, but the time is not ripe for international consideration. It is better to let fair competition work out its natural results." It is stated that most of the Powers have provisionally agreed to appoint delegates to attend the conference, and that the authorities at Berlin are now engaged in drawing up the programme.

Silver for Electromobile Batteries.—In an article published in the *Electrical World* for the 13th inst. Prof. A. Z. Marsh suggests that silver might be made to replace lead in a storage battery were it not for the first cost. While it is true that the first cost of a silver battery would be high, yet if a silver battery could be made light, efficient, and reliable, it is quite conceivable that it might supersede the lead battery for automobile purposes. In the lead cell the active material of the positive is only about half the weight of the entire plate, so the weight of silver oxide required in the silver cell would correspond to the weight of lead peroxide, and not to the whole electrode. The other materials used would be inexpensive—nickel or steel for the positive grid, and probably iron for both negative grid and active material. Experiments indicate that a silver battery, giving the same power as a lead automobile battery weighing about 550lb., would require only about 70lb. of silver oxide, and perhaps less. In the writer's view it would not take a very extraordinary reduction in the price of silver nitrate to make the silver cell practical from a financial standpoint, and for the reasons given above such a cell could be made to have a comparatively long life and high efficiency, and would require but little attention to keep it in working order. Discussing the principal defects which tend to shorten the life of a battery of the lead type, Prof. Marsh holds that the lead cell has not received enough attention from its chemical and physical side, most manufacturers having paid more attention to mechanical details, and this has given the battery a rather unbalanced development. He, however, expects to see in the near future a considerable improvement in lead cells in the way of longer life and greater reliability. Future investigations should be directed to methods for securing greater porosity and firmness in the active material of the positive electrode, and to improving the electrolyte so as to prevent the formation of lead sulphate, or at least to render it insoluble in all densities of the acid solution, so that it remains in place and can be restored to the proper condition. Other metals will undoubtedly come into competition with, and may displace, lead batteries for traction work, but as an auxiliary in electric light and power stations lead cells will probably hold their own for some time to come.

Tramway Municipalisation at Birmingham.—The attention of all who are interested in this important question will at the present time undoubtedly be centred on the turn events have taken at Birmingham within the past few weeks. The fight there is really between the Corporation and the British Electric Traction Company, which already holds very large interests in practically all the local tramway companies, and which is now anxious to turn the whole of the steam and horse tramways in the district into electric lines. The position of the Corporation in the matter is this. The first lease falls in at the end of next year, four others expire in 1906, and the remaining three in 1911. Last year the Corporation promoted a Bill in Parliament to confer tramway powers upon them, but, as our readers know, the measure was defeated, owing principally to the organised opposition of certain rich residents in the better parts of the city. True, the Bill is being promoted again this year, but if the Corporation should again fail to obtain the required powers the companies will be in a position to secure the tramways of the city practically on their own terms. This then is the serious position which has to be faced by the Corporation. Local opposition to the proposed municipalisation of the tramways seems to be growing, and in addition to the Property Owners' Association another body, known as the Birmingham and District Trades and Property Association, has taken up the cudgels in favour of the companies. The Bill which the Corporation are promoting will, in all probability, be subjected to a poll of the ratepayers next month, and if the poll should prove adverse to the measure, it only remains for the Corporation to accept the inevitable and allow the companies, or rather the British Electric Traction Company, to remain in possession of the field. The Birmingham Corporation, however, are not the only authority in the district who are occupied with the question of the municipalisation of the tramways, and on Friday an important conference of representatives of the various outside local authorities concerned was held to determine the attitude to be adopted towards the companies. The proceedings were held in private, but we understand that three courses of action were suggested for the consideration of the conference—*i.e.*, first, that each authority on acquiring the lines in their district should work the same themselves; second, that all the tramways running into Birmingham should be worked or controlled by the City Council on terms to be agreed upon; and, third, that the city and the surrounding authorities should agree to let the British Electric Traction Company control and work the tramways on terms. We are not in a position to say which of these three proposals found most favour with the conference, but the feeling generally expressed was that it would be unwise, at any rate, for each of the outside authorities to work their tramways independently of the others. We presume, therefore, that the conference inclined towards the second suggestion—*i.e.*, that the Birmingham Corporation should work and control the lines running into the city under arrangements with the surrounding authorities. At least, there is no dissention in the ranks of the municipalists, for it was determined at Friday's conference that the authorities outside Birmingham should combine for the purpose of dealing with the question.

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THE TYNESIDE TRAMWAYS AND TRAMROADS.

On Monday last, the official inauguration of the first lines of the Tyneside Tramways and Tramroads Company took place, in the presence of a distinguished company of those interested in the commercial development of the districts through which these lines pass. This district is of great industrial importance, as some of the principal shipbuilding yards and engine works in the country are situated along the route, there being, besides, a large resident population. The map (Fig. 1) shows clearly the nature of the district and the relative positions of the various manufactories and the residential quarters; also lines, which are now completed, through Gosforth, Wallsend, and Willington Quay to North Shields. The map further shows that when the Newcastle Corporation have completed the extension in Walker which they have in hand, direct tramway communication will be afforded along the whole length of the north bank of the River Tyne from Newcastle to North Shields. It would, perhaps, be convenient at the outset to draw attention to the distinction between tramways and tramroads, a tramroad being the name applied to a tramway when laid on any ground other than public roads. In the Tyneside system the tramroad, which runs from the residential quarter of Gosforth to Wallsend, is constructed on land owned by the company, and as there is no other traffic higher speeds are attainable than prevail in ordinary tramway practice. It is also found that even allowing for the cost of the land the capital expenditure is lower than in the case of a tramway, since it is possible to dispense with a concrete foundation and stone paving. A point of local interest in connection with this tramroad is that it follows the route of an old colliery wagon way, formerly used for conveying coal from Coxlodge Pit to the river.

The visitors for the opening ceremony proceeded by rail to Gosforth, where a number of decorated cars were waiting to take them over the line. Mrs. W. A. Watson Armstrong started the first car, and declared the line open. After passing through a small portion of the tramway in Gosforth, the cars ran on to the tramroad which follows the Coxlodge wagon way for 2¾ miles. The whole of this portion of the line runs through green fields, which are available for residential buildings, and which formed a wonderful contrast to the surroundings of the other portion of the system. In fact, from Wallsend to Gosforth there are vast opportunities of building workmen's and other residences with the most healthy and pleasant surroundings. The other portion of the lines from Wallsend to Tynemouth pass through purely business surroundings, and by workmen's dwellings which are squalid and distinctly out of date. It remains to be seen how quickly the men living in these unpleasant surroundings can be transferred to the vacant spaces between Wallsend and Gosforth, but without the tramway system inaugurated on Monday such a transfer was impossible. Quite apart, however, from this traffic, which has to be created by the erection of workmen's houses, there is a continual movement of men up and down the north bank of the Tyne which will be greatly facilitated by the tramways, while the completion of the Newcastle-upon-Tyne Corporation tramways in the Walker district will place the Newcastle markets within easy reach of the working population down the Tyne.

The inaugural run over the system clearly showed the advantage of a tramway company owning the ground over which it runs. The portion of the track from Gosforth to Wallsend was straight, and enabled high speeds to be maintained. After leaving Wallsend on the way to North Shields, the public roads were used, and these roads, in the first instance, were not designed by an engineer. In consequence, the grades and curves are exceedingly trying, and it is not to be wondered at that horse tramways have not been run along them. With the powerful Westinghouse motor equipments, there was no difficulty in climbing the steep hill at Willington with a grade of 11 per cent. The sharpest curves have about 40ft. radius, and these have been successfully designed, as the heavy bogie cars took the awkward corners without the slightest trouble and without that grinding on the track which is often heard on new tramways at such places. The tramway as at present constructed from Wallsend to North Shields is especially useful to the various works along the banks of the Tyne, but is not quite so suitable for a through traffic, as the surroundings are not attractive. We should not be surprised to find that the company will in the near future get parliamentary powers to add other routes which will give a more direct access to the seaside resorts of Tynemouth, Cullercoats, and Whitley.

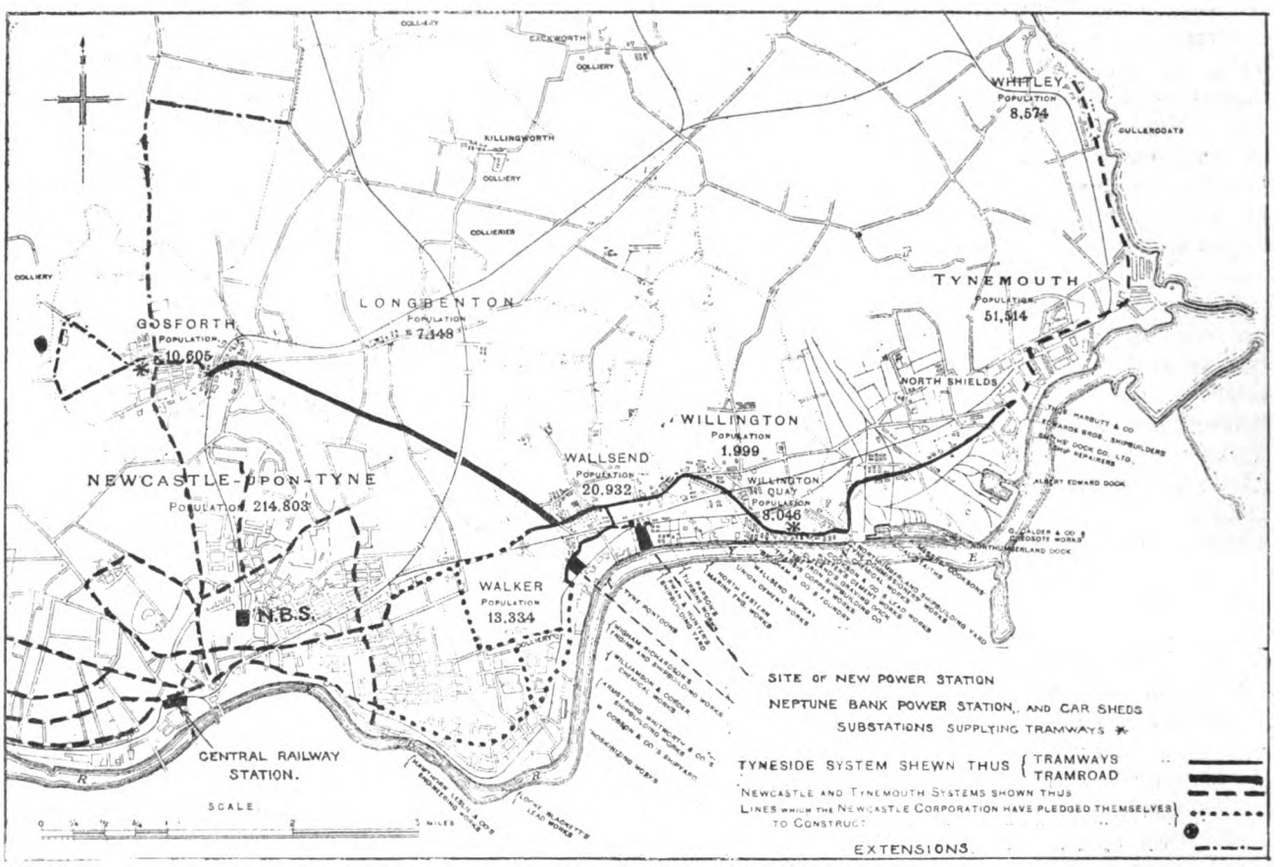

FIG. 1. Map of the Tyne, showing the Tyneside Tramway and Tramroad Company's System and adjacent Railways and Tramways.

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To revert to the engineering side of the system, we show in Fig. 2 the special form of grooved girder rail adopted for the tramroad on the Coxlodge wagon way. It will be seen that the check is $\frac{3}{8}$in. higher than the tread. This was made so to give a greater security at the high speeds which are permissible on this portion of the system. These rails are laid on wooden sleepers, as shown in Fig. 3, and then filled up with rough ballast in order to meet the Board of Trade requirements. In Fig. 4 is shown a single ballasted

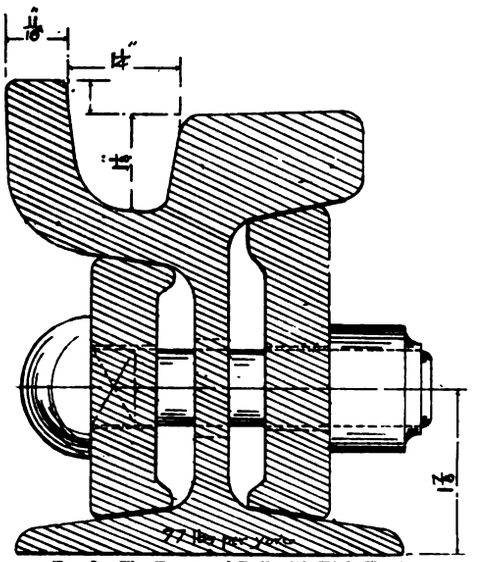

FIG. 2.—The Tramroad Rail with High Cheek

track in the cutting at Gosforth, where the tramroad and tramway join. Only a single line is shown in the photograph, but the second one was added and ballasted at the time of our visit last Monday. A good portion of this tramroad is of single track; thus, while the length of the route is about $2\frac{3}{4}$ miles, the equivalent of single track is just under three miles. The passing places along the single line are fairly frequent, and the straightness of the route enables the drivers to see well ahead. These passing places are located where the line crosses a public road, or

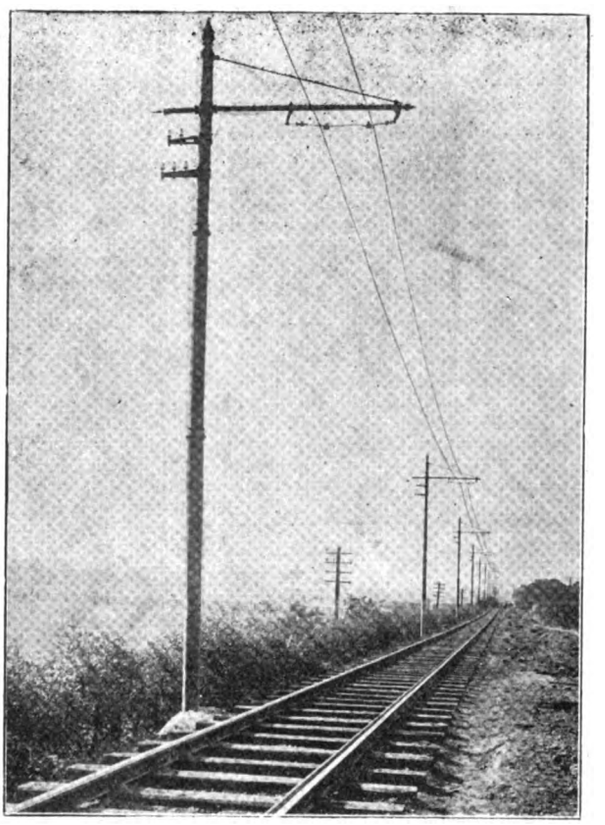

FIG. 3.—Tramroad Track before Ballasting.

miles of equivalent single track. Fig. 5 shows a section of the 95lb. girder rail employed on the tramway. The jointing of these rails has received the careful attention of the consulting engineers. Besides the ordinary fishplates, soleplates are provided at the joints, which renders the running smoother than usual. The gauge employed is 4ft. 8½in., which is the same as that of the Newcastle Corporation lines. The distance between the centres of the

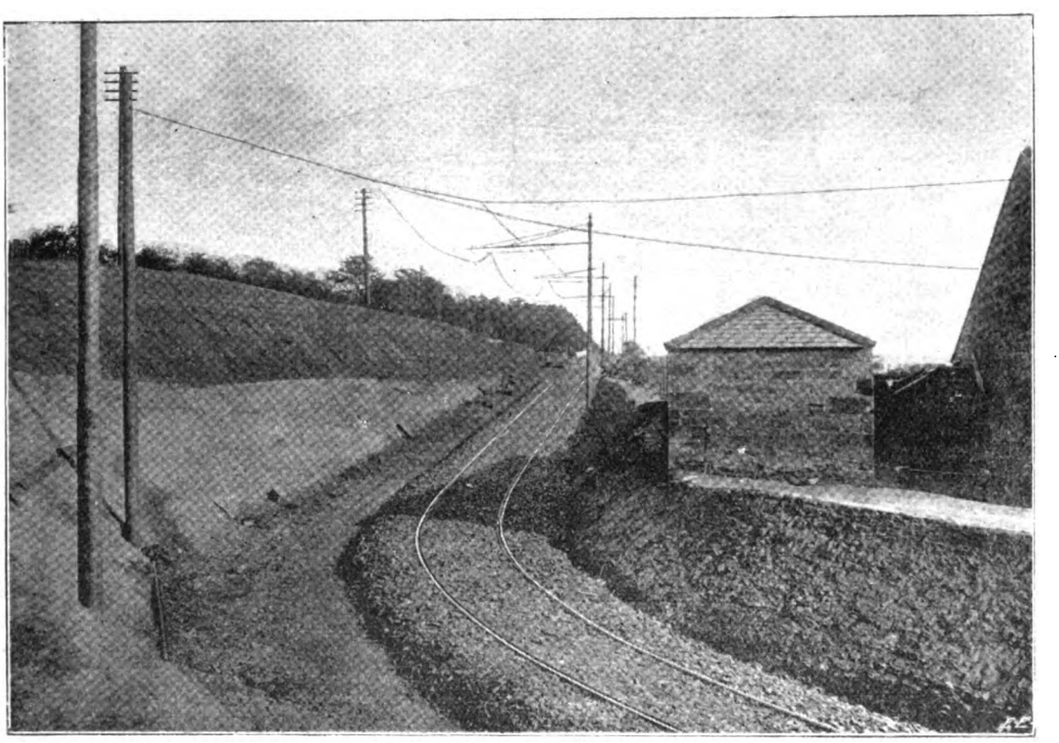

FIG. 4.—The Gosforth Cutting with one Line of Tramroad Track Ballasted.

at other points where the speed would in any case have to be reduced, with the result that the cars are able to make exceedingly good running time over the tramroad. The tramway between Wallsend and North Shields, and in Gosforth, is of double track in many places, thus the whole length of system now completed is $8\frac{1}{2}$ miles of route, with $12\frac{1}{4}$ tracks is 8ft. 4in. The overhead trolley wire is equivalent in section to a round wire of 00 S.W.G. It is of the special form illustrated in Fig. 6, which also shows the type of mechanical ear employed on the whole of the route except at curves where ordinary soldered ears are used. The perfect continuity of the lower surface of the wire

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obtained by this system of suspension enables the trolley to run much more smoothly than with soldered ears. The whole of the track and overhead equipment has been constructed by Messrs. Dick, Kerr, and Co., Limited. The special work is of Messrs. Hadfield's manufacture, their manganese steel being used throughout.

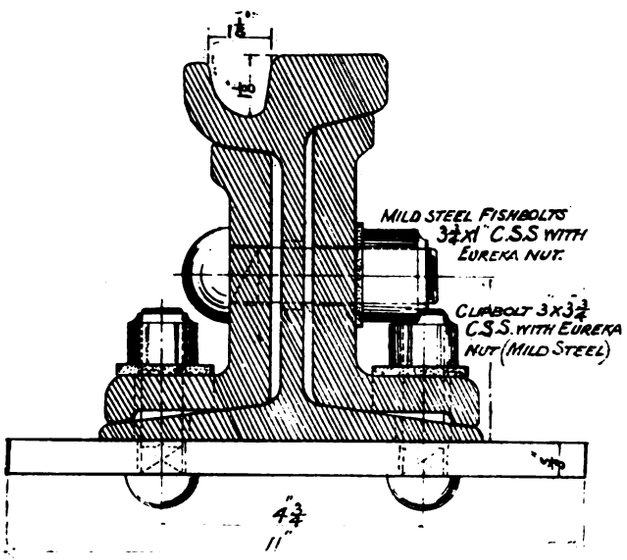

FIG. 5.—Section of the Tramway Rail, showing Soleplate and Fishplates at Joint.

The rolling-stock at present consists of four bogie cars each carrying 112 passengers and 14 single-truck cars having a capacity for 80 passengers. They are all of the double-deck type with completely enclosed vestibule at each end. The bogie cars are provided inside with combined longitudinal and transverse seats, the four-wheel cars having longitudinal seats only. All cars are fitted with Tidswell's lifeguards and both hand and electric brakes, the latter being of the Newell magnetic type, the resistance in connection with which is used in winter as a car heater. The great power of the brakes is demonstrated in the ease with which the heavy cars can be pulled up on the gradient of 1 in 11 at Church Bank, near Wallsend. The bogie cars are provided with a four-motor equipment, each motor rated at 30 h.p. when running with a line pressure of 500 volts. The wheel base of the bogies is 4ft. with 12ft. 6in. between bogie centres and the single-truck cars have a wheel base of 6ft. 6in. Steel-tyred wheels are used throughout. The car contact has been carried out by Messrs. the British Westinghouse Electric and Manufacturing Company, the bodies having been supplied by Messrs. Geo. F. Milnes.

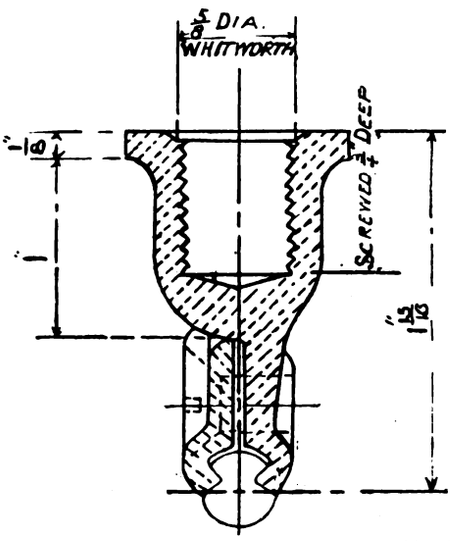

FIG. 6.—Full-size Cross-Section of Grooved Trolley Wire and Mechanical Ear.

The Tyneside Tramway and Tramroads Company have not found it necessary to build generating works, but have secured the power for working the line at most reasonable terms. The bulk of the current will be taken from the Newcastle-on-Tyne Electric Supply Company's works at Neptune Bank, Wallsend; while the Tynemouth Corporation will supply that portion of the line within their boundary, which commences at the point marked "Northumberland Shipbuilding Yard" in the map (Fig. 1). The two stars on this map indicate the sub-stations, from which the rest of the route is supplied. We did not see the Gosforth sub-station on Monday last, but Fig. 7 shows a photograph of the same, and Fig. 8 is a diagram of the connection employed. The other sub-station at Willington Quay was opened for inspection, as being the nearer to the

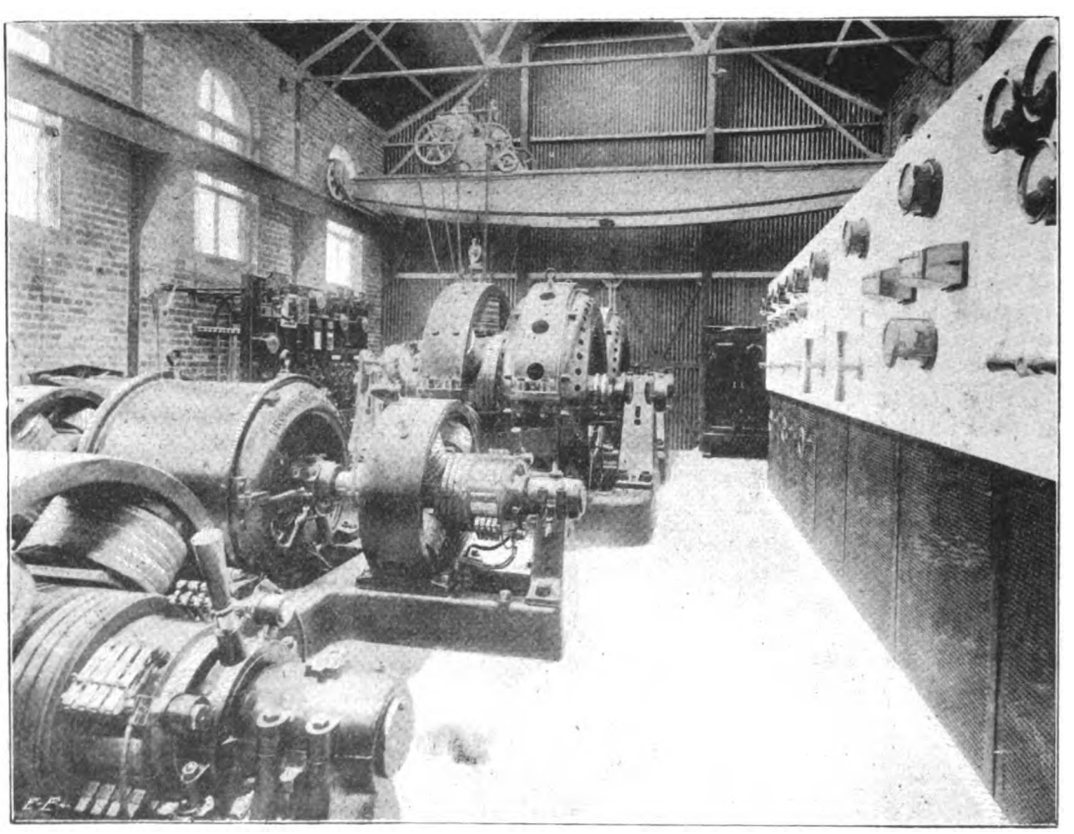

FIG. 7.—The Gosforth Sub-Station.

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route. These sub-stations were not built for tramway purposes only, but also supply electrical energy for light and power. Thus in Fig. 7 of the Gosforth sub-

two larger machines are at present used for traction purposes only, although when the lighting load increases they will be used for this also, and further sets will be

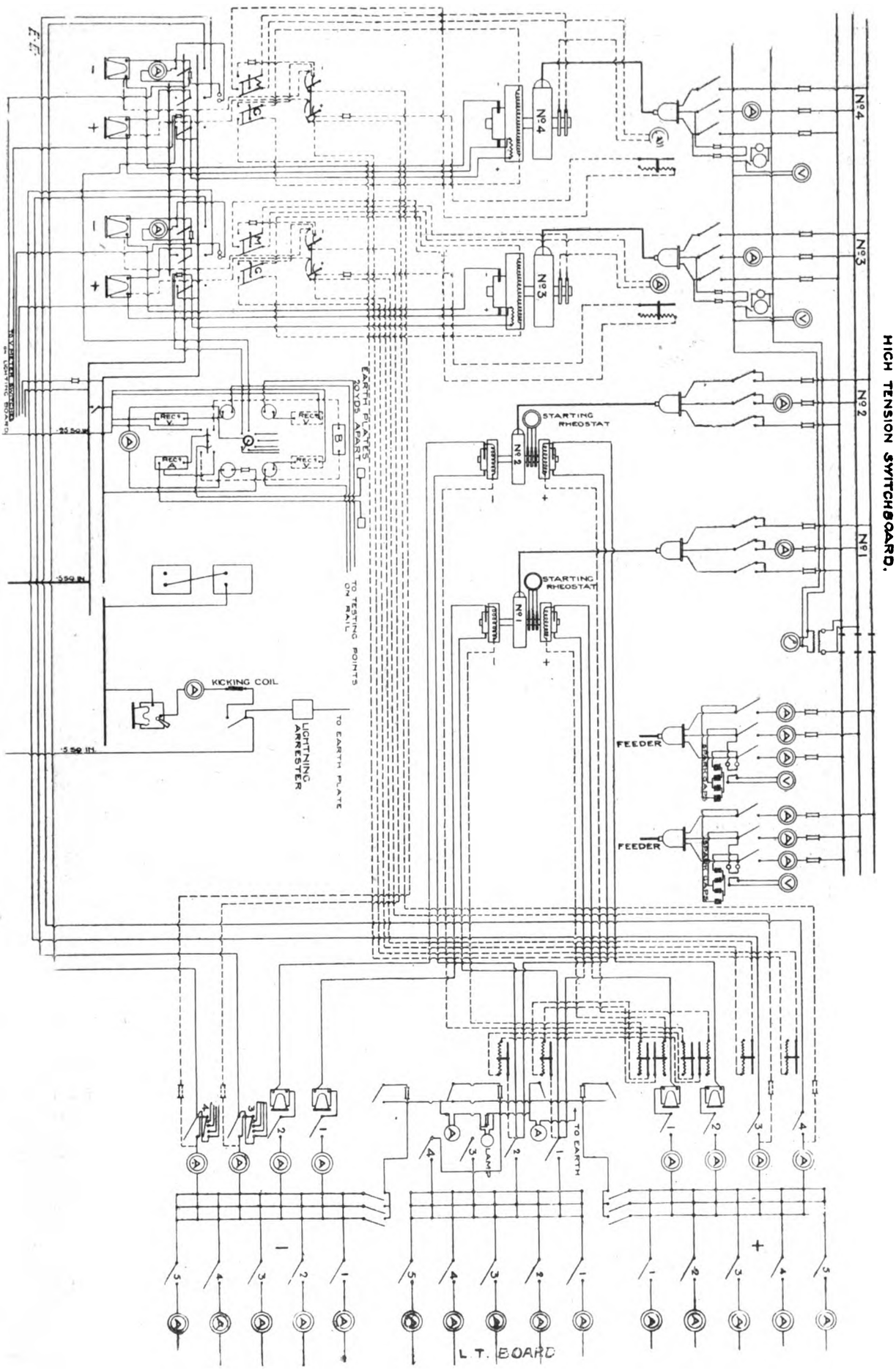

Fig. 8.—The Diagram of Connections of the Gosforth Sub-Station for supplying Light, Power, and Tramway Load from the same Motor-Generators.

station, the two small machines in the foreground are each of 75 kw. capacity, and are double-ended, supplying a 480-volt, three-wire, continuous network. The

installed to supply the tramways. The capacity of each of these traction motor-generators is 500 kw. The synchronous motor is supplied direct with three-phase

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current at 6,000 volts, and runs at 300 revolutions per minute. The continuous-current generator is compound-wound for 500 volts at no load to 550 volts at full load. In these sub-stations the motor-generators and high-tension switchgear have been supplied by Messrs. Richardsons-Westgarth, of Hartlepool, and are of the Brown-Boveri type. The low-tension switchgear was made by Messrs. A. Reyrolle and Co., of Hebburn-on-Tyne. The wisdom of this combination—by which from the one station at Wallsend a lighting, a traction, and a power load are supplied simultaneously—will be obvious to all electrical engineers. The proof of it lies in the fact that the charge for electrical energy to the tramways is to be 1¼d. per unit for all energy up to 200,000 units and 1d above this quantity. Consumers having a better power factor get a lower average rate; thus in one works, where the motors are used almost continuously, the charge for power is down to 0·97d. per unit. Also, in consequence of the combination, the power factor of the Neptune Bank works is in the neighbourhood of 40 per cent., and the cost per unit at the works is as low as 0·34d. This figure is likely to be still further reduced with the combination of the lighting load from Newcastle this winter with that of the power consumers. While on the subject of the power station, it is interesting to note that the Neptune Bank works are only looked upon by its owners as a step towards much larger works, which are to be situated near Swan and Hunter's shipbuilding yard. These works will have a river frontage which will reduce coal cost, and also improve on the condensing facilities now enjoyed at Wallsend. The output of the present works is limited to about 5,000 kw., while it is not improbable that units of 4,000 kw. each will be employed in the new station. Another interesting fact is that the success of the Parsons steam-turbine at Neptune Bank had resulted in steam-turbines being proposed as sole prime movers for the larger undertaking. This decision has been arrived at not from steam consumption considerations only, but because of the reduced charges for oil, attendance, and repairs. The indirect saving in boiler repairs alone in consequence of there being no oil in the condensed water is very considerable. These larger works are justified by the growth of the undertaking, and by the imminent prospect of supplying the suburban lines of the North-Eastern Railway after they have been converted for electric power. It must also be remembered that the area of the company's work was much extended by the Bill passed last session, by which the district was increased up to western boundaries of the Newburn and Castleward Rural District Councils and to the northern boundaries of the Morpeth Rural District Council.

After the cars had gone over the routes on Monday last the company adjourned to the car-shed (Fig. 9) at the Neptune Bank works for lunch. Mr. W. A. Watson-Armstrong presided.

After the usual loyal toasts, the CHAIRMAN, in proposing the health of "The Local Authorities," thanked them for their assistance to the company in the promotion of this important scheme. He went on to say that up to the present they could congratulate themselves that the history of the company was a short one. The Royal consent to the construction of the first portion of their scheme—that portion they had traversed that morning—was only obtained in the middle of August, 1901. By the end of November, 1901, contracts had been let for the whole of the tramway, for the cars and the car-sheds, and arrangements were at once entered into with the Newcastle Electric Supply Company, with the Walker and Wallsend Union Gas Company, and the Tynemouth Corporation for the supply of electricity to the company. The negotiations for the purchase of land between Gosforth and Wallsend necessarily took up a good deal of time, while the non-completion of the work of the widening of Willington Gut Bridge threatened to seriously delay the opening of the first portion of their system. This widening, as they saw, was not yet completed, and would not be for another month or so, but the line between Wallsend and Shields was opened for public traffic on Sept. 4, and they had since been running a regular service of cars over the route crossing the bridge on a single line. Everything was in an initial, undeveloped stage, yet their receipts so far had been very satisfactory. The greater portion of these receipts were derived at present from the traffic between Willington Quay and North Shields. Now, owing to the gap between their system and that of the Newcastle Corporation, they afforded no facilities for any residents of Willington Quay and Wallsend wishing to go to Newcastle. This gap between the two systems would be filled up within 12 months, and as the results of their receipts between Willington Quay and Shields, they felt convinced that the Newcastle Cor-

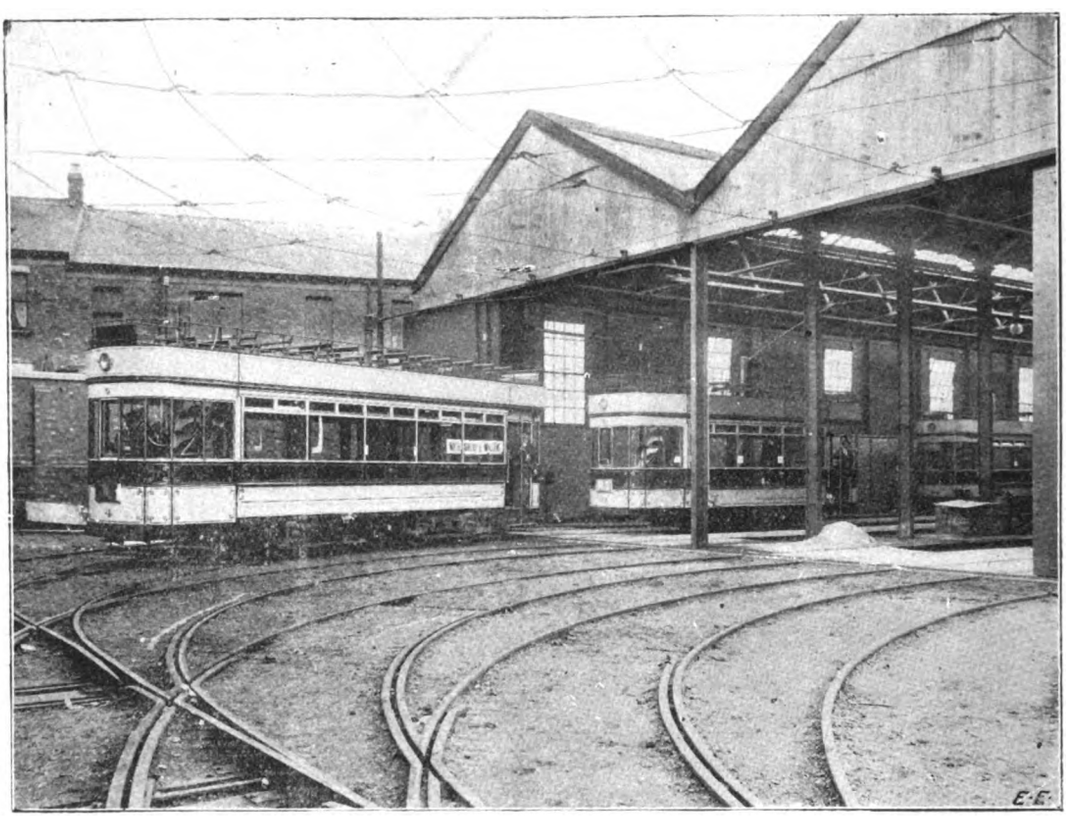

FIG. 9.—The Neptune Bank Car Shed, showing Bogie Car.

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poration would at once see the financial desirability of establishing mutual running powers, so that in the near future a through service to Newcastle would become an accomplished fact. They had in the meantime entered into negotiations with the Tynemouth and District Tramway Company—whose line was unfortunately of a different gauge—for an arrangement of cheap transfer tickets available to either system. The prineiple had already been agreed upon. In again thanking the local authorities for their help, he mentioned that the tramways had been completed within eight months of the opening up of the ground, and the tramroad within four months of the completion of the purchase of the land. He paid a great tribute to Mr. W. McLellan, the consulting engineer under Messrs. Chas. H. Merz, for this expedition.

Mr. W. BOYD, the Mayor of Wallsend, replied, and proposed the toast of "Success of the Tyneside Tramways and Tramroads Company."

Mr. J. SUMMERS HUNTER, replying, said the enterprise with which they were associated that day in connection with the adjoining works for the supply of electric traction, light, and power was one of the most remarkable, not only in the history of Northumberland, but of the whole country. They had received the hearty support of all the local manufacturers and of the local authorities, but having regard to future developments, he was only surprised they had not been received with open arms.

Dr. SPENCE WATSON, in proposing the health of Mr. and Mrs Watson-Armstrong, and coupling that with a vote of thanks to them for the part they had played in the day's proceedings, remarked that they had travelled through what was once a beautiful country, a landscape which roused the poet to sing—

> "Tyneside seems clad wiv bonny ha's
> And fornaces se dunny;
> Thi isure mun be what Bible ca's
> A land of milk and honey."

Its character had changed, but the manufacturers had made it in a permanent sense useful to the whole nation. In the country they had passed through, he proceeded, they could see land that was waiting for the houses for the working-men, and they had also seen working-men's houses which were capable of great reform. They had also had an opportunity of examining that power station, which was pre-eminent as the first of its kind in Great Britain in which electrical energy had been produced on a great scale at moderate prices for all purposes of power, traction, and light.

The toast having been accorded musical honours, Mrs. WATSON-ARMSTRONG and the CHAIRMAN replied, and the proceedings terminated, the guests afterwards proceeding to the inspection of the Neptune Bank power station.

In conclusion, it is permissible to say that the usefulness of this undertaking is fully vindicated by the patronage that has been accorded it by the travelling public since its inauguration. Mr. W. L. Phillips acted as clerk of works for the construction of the line; Mr. F. C. Kidman being resident engineer and traffic manager; while Mr. W. McLellan, on behalf of the firm of Chas. H. Merz, acted as consulting engineer.

ELECTRIC LIGHTING AND TRAMWAYS AT WEST BROMWICH.

The following account of the electricity works and tramways of West Bromwich is abstracted from an able paper by Mr. Albert D. Greatorex, A.M.I.C.E., read before the Incorporated Association of Municipal and County Engineers at West Bromwich on the 27th ult. In the introduction, the author refers to the various public institutions with which the town is so well supplied—such as the town hall, law court, free library and institute, art schools, etc. Proceeding to deal with the electric lighting scheme, Mr. Greatorex states that in 1898 the Corporation obtained a provisional order for the establishment of an electric lighting undertaking. A committee was appointed, and after they had visited several installations two engineers were requested to submit reports and schemes for their consideration, and in due course Mr. Robert C. Quin, M.I.Mech.E., M.I.E.E., was appointed consulting engineer. The compulsory area is the main street from the works to Roebuck-street, a distance of 1¾ miles, with several short streets adjoining the town hall. The system of supply adopted is that known as the continuous-current three-wire system, with an electric pressure of 460 volts between the outer conductors, each dynamo having a series winding in addition to its shunt winding, so as to enable it to develop electric pressure up

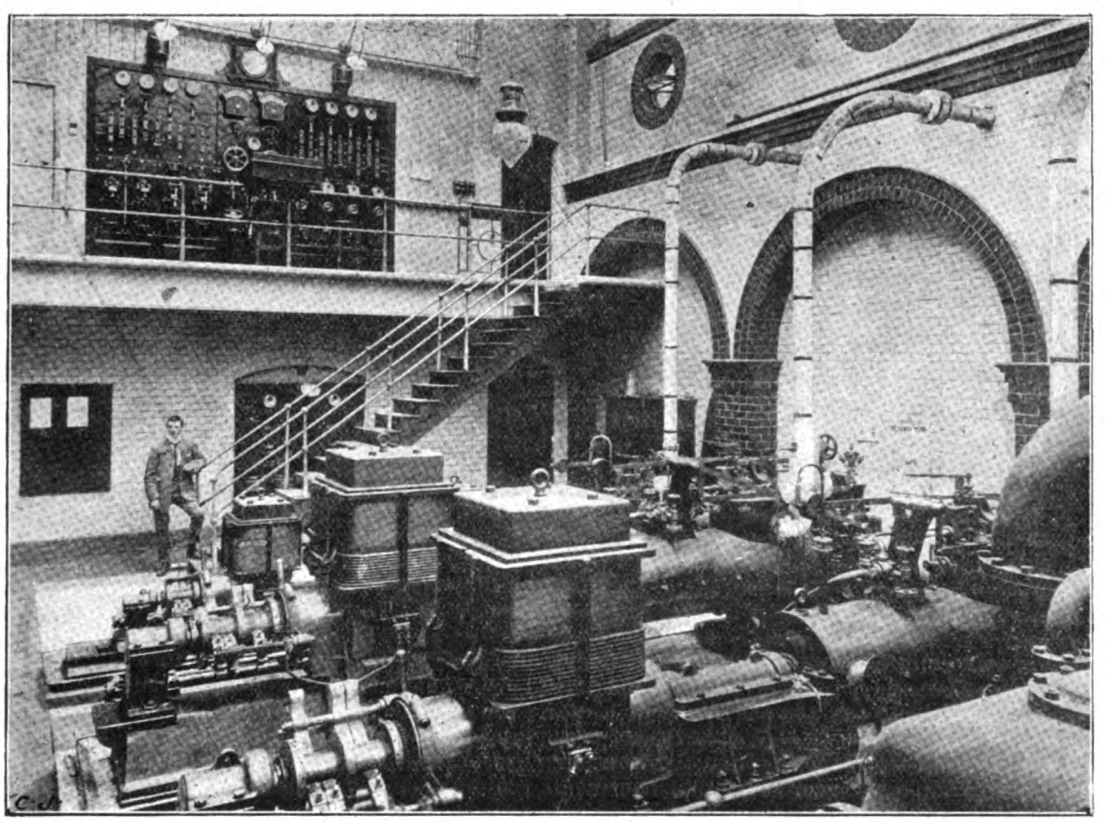

FIG. 1.—Engine Room, Electricity Works, West Bromwich.

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to 560 volts for power purposes. The generating station is at Black Lake, about the centre of the borough, where five acres of land have been purchased by the Corporation, adjoining the canal.

The buildings, which have been designed and erected under the supervision of the author to the requirements laid down by the consulting engineer, consist of boiler-house, with central stack, engine-room, accumulator-room testing-room, and offices. The chimney stack is situate in the north-east side of the boiler-house, and is 120ft. from floor level, and built on a concrete foundation, which is 20ft. 6in. square by 6ft. 6in. deep; the internal diameter is 5ft. 6in., with square base, the base being 3ft. thick and finishing 9in. on top; from the floor level to 20ft. up it is lined with 9in. firebrick, and 20ft. above this 4½in. firebrick lining; the flues are arched out of the square base in firebrick; the outside batter of the circular part of the shaft is 1 in 40, and it is capped by a cast-iron cap weighing 3½ tons, bolted down with holding-down bolts and plates, and has a lightning conductor on top. The boiler-house is 41ft. by 61ft., and accommodates four boilers and pumps. The roof on the south-west side is carried on cast-iron columns; the principals are iron, and the roof is slated and glazed with patent glazing. The engine-room (Fig. 1) is built in two bays, each 25ft. wide by 62ft. long; the wall adjoining boiler-house is 9in. thick, with piers at intervals, arched over and carrying on spandril a wall 14in thick, with a bed-stone for travelling crane. The engine-room is divided by brick piers, 2ft. 6in. by 2ft. 3in., 10ft. apart, having arches supporting bed stones for travelling cranes in each section of the building, and the north-east wall is composed of piers of the same thickness, the arches being temporarily filled in with 9in. work. The walls of the engine-house, which are per-

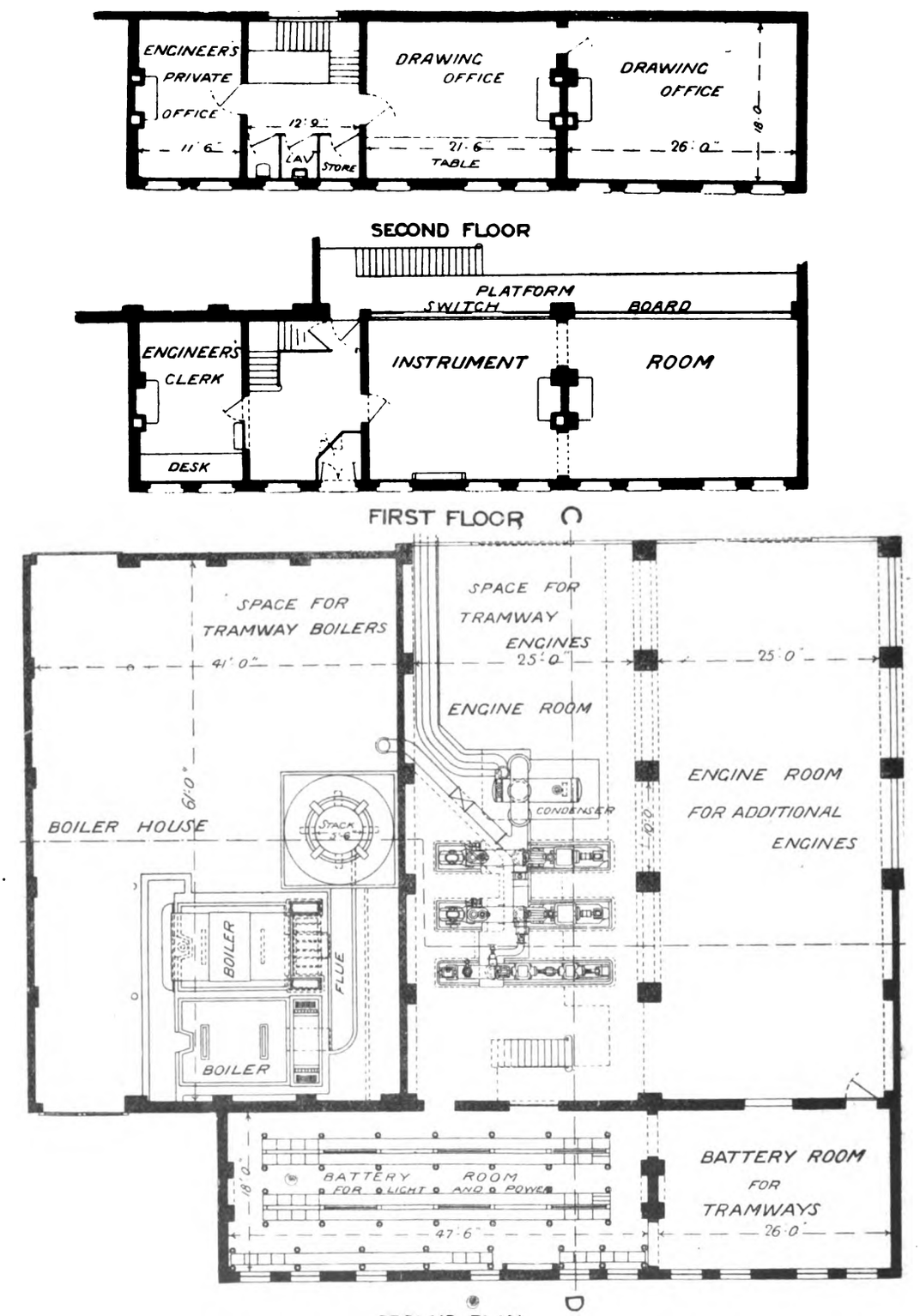

FIG. 2.—Plan of Electricity Works, West Bromwich

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manent, are lined throughout with best cream glazed bricks; the piers and arches are built of best chocolate glazed bricks; the roof principals are iron, and the roofs are match-boarded and slated The building is well lit from the roof by patent glazing. The end of the engine-house is temporarily filled in with boarding and corrugated iron. The accumulator-room communicates direct with the engine-room, and is 75ft. long by 18ft. wide, means of a balcony and iron staircase, the main switchboard being fixed in the side next the engine-room. The offices are in the first and second floors, and ample accommodation is provided for the present staff, together with lavatory. The buildings (Figs. 2, 3, and 4) are of a plain but substantial character; the front elevation (Fig 5) is faced with King's pressed red bricks, stone sills and heads to windows; the other brickwork is best common of

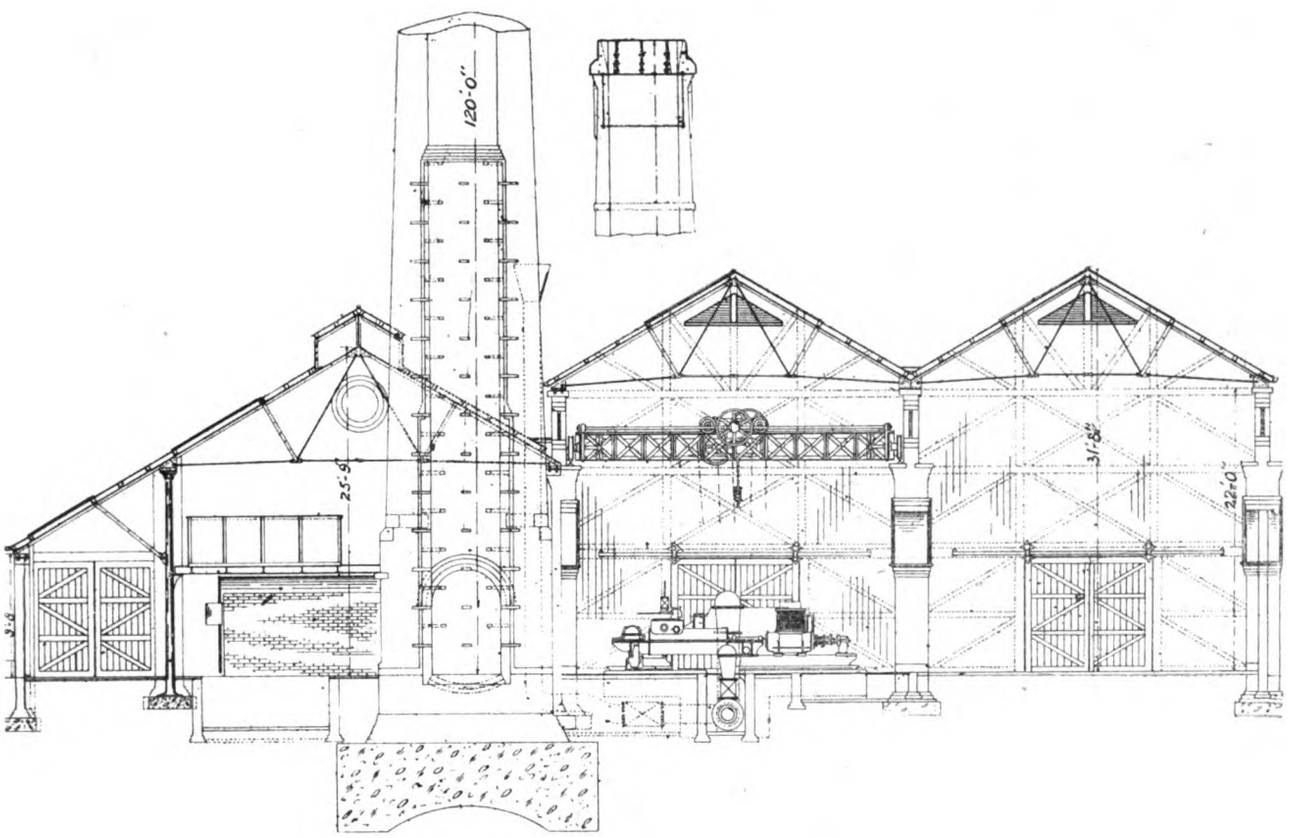

FIG. 3.—Section through A B, Electricity Works, West Bromwich.

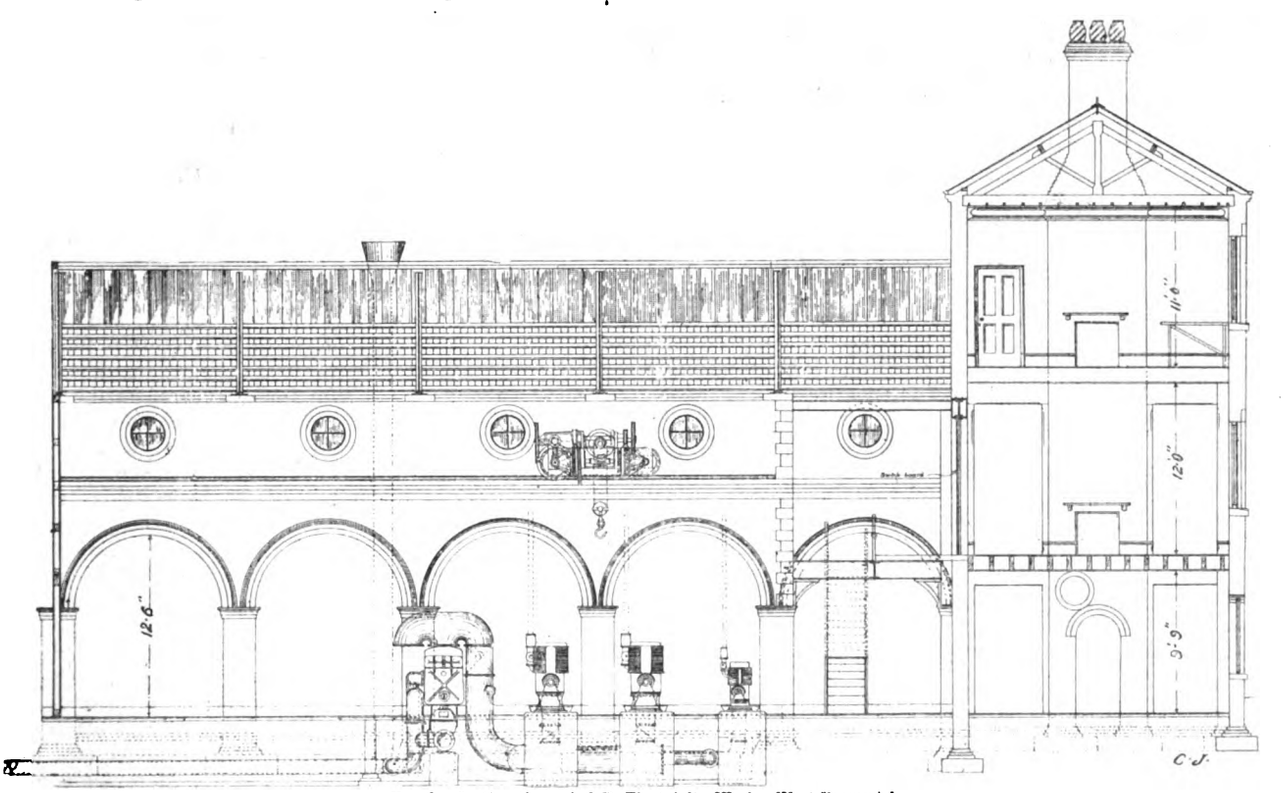

FIG. 4.—Section through C D, Electricity Works, West Bromwich.

ventilated with electric fans. The battery switchboard is fixed in the wall between the engine-room and accumulator-room. The testing-room is on the first floor, immediately above the accumulator-room, and is 48ft. 6in. by 18ft. wide, and communicates with the engine-room directly by the district. The cost of the buildings, with chimney and fittings complete, was £5,800, the contractor being Mr. J. Mallin, of West Bromwich.

The present installation of plant in these buildings consists of two dry-back marine boilers, with mechanical

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stokers, superheaters, etc., two steam turbine-driven dynamos, each of 100 kw. capacity, and balancing steam dynamo of 50 kw. capacity; there is also an independent condensing plant capable of dealing with 10,000lb. of steam per hour. This is of sufficient capacity for double the present installation of plant. As regards storage capacity, there is a secondary battery of 236 cells in the basement and the usual switchboards and connections. The feeding and distributing and pilot cables are laid in earthenware troughs under the footpaths, filled in with an acid and water-resisting and insulation compound, the troughs being covered with hard-burnt bricks. Each cable is laid in a separate and distinct trough, and there is a distance between adjacent cables of 6in. The cables are laid in the footpaths on both sides of the main road from Carter's Green to Beeches-road, and also along several streets near the town hall, the total lengths of cables being—feeding cables, 6 miles; distributing cables, 4¼ miles; pilot cables, 2¾ miles. The work of laying the cables was carried out by the author and consulting engineer by direct labour. The cost of the installation was £30,000. The charge for electricity for lighting purposes was originally fixed at 6d. per Board of Trade unit for the first hour and 2d. for each hour afterwards; but, owing to pressure being brought by the Council upon the committee, the charges were

The Corporation obtained powers in their General Bill of 1900 to supply fittings, etc., the clause being as follows: "Power to Supply Electric Fittings.—The Corporation may provide, sell, let for hire, and fix, set up, alter, repair, and remove, within the borough, but shall not manufacture, lamps, meters, electric lines, fittings, apparatus, and things for lighting and motive power, and for all other purposes for which electric energy can or may be used or otherwise necessary or proper for the supply, distribution, consumption, or use of electric energy, and may provide all materials and do all works necessary or proper in that behalf, and may require and take such remuneration in money or rents and charges for and make such terms and conditions with respect to the sale, letting, fixing, setting up, altering, repairing, or removing of such lamps, meters, electric lines, fittings, apparatus, and things as aforesaid, and for securing their safety and return to the Corporation as the Corporation may think fit, or as may be agreed upon between them and the person to or for whom the same are sold, supplied, let, fixed, set up, altered, repaired, or removed." For this purpose a loan has been sanctioned for the sum of £10,000, and in consequence many persons have adopted the light who would under ordinary circumstances doubtless not have done so, or who would have found great difficulty

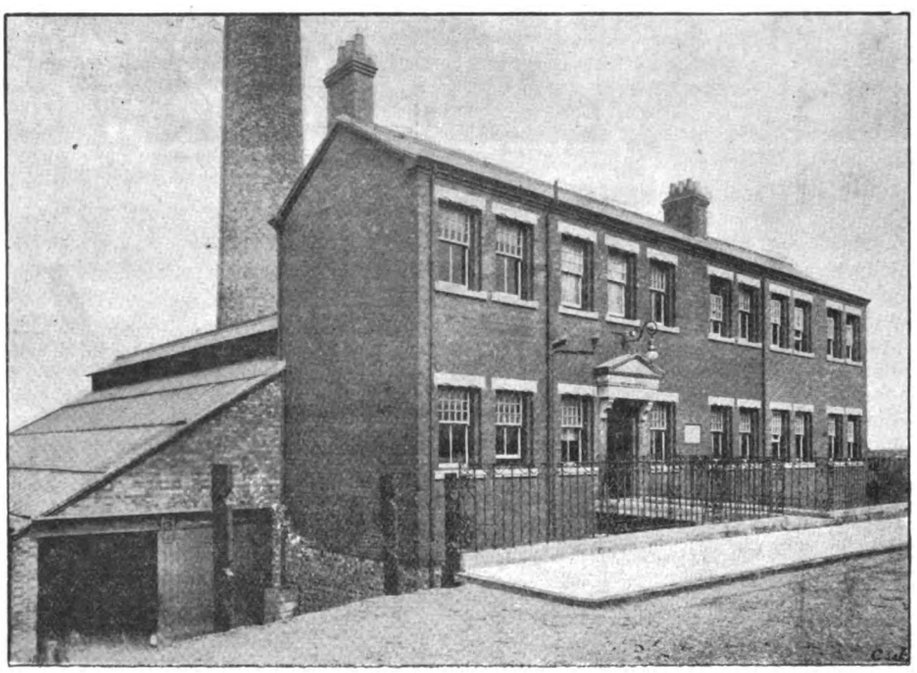

FIG. 5.—Electricity Works, West Bromwich.

reduced to 4½d. per unit until an equivalent of 91 hours' use of the maximum demand has been reached in each quarter, and thereafter, during the same term, at the rate of 1½d. per unit. The charge for electricity for motive purposes is 1d. per unit. The standard pressure at which electricity is supplied and charged for is 230 volts for lighting and 460 volts for power purposes. Owing to the low charges, the undertaking cannot be made to pay for the first few years, but the committee are assured by the borough electrical engineer that when the tramways are in working order the station will be better able to pay its way.

The Corporation in their General Bill of 1900 obtained power to suspend the repayment of money borrowed for the purpose of the electric lighting undertaking for a period of two years from the completion of the works, or for a period of two years from the borrowing thereof, whichever shall be the earlier. This is of considerable assistance to such an undertaking. The number of lamps connected from May 24, 1901, when the works were ready for supply of current, to Sept. 1, 1902, was equivalent to 7,196 8-c.p. lamps, and when the new art schools, hospital, and other orders are completed will be very few short of 10,000—a very successful state of affairs, considering the undertaking has only been established 16 months.

in providing the necessary funds. The arrangements in force for this purpose are as follows: Any person desirous of having the electric light installed on his premises on the "hire-purchase system" has to sign an undertaking agreeing to pay annual sum for 10 years, until the said annual payments together shall amount to a sum equal to the cost of installation, when the payments cease and the installations become the property of the consumer. After making the necessary application, an estimate is given of the cost, and the work is carried out by the department when the actual cost of the installation is ascertained. If the account is paid within 28 days, a special discount is allowed; if paid during the first year 10 per cent., during the second year 7½ per cent., during the third year 5 per cent., and during the fourth year 2½ per cent., but after the fourth year the whole amount is charged. The cost of installation does not include lamps; these are supplied and charged on the first account for supply of electricity. The Corporation, however, maintain the fittings, etc., until the end of 10 years, or when paid off. Motors are hired on fixed charges and maintained by the Corporation.

In order to show the advantage taken of this system, the author is able to give the following table, which shows the equivalent number of lamps and relative percentage of system as compared with the ordinary method up to Aug. 30, 1902:

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	Equivalent to 8-c.p. lamps.	Per cent.
Lighting consumers on Corporation "hire-purchase system"	3,944	54·81
Power consumers hiring Corporation motors	1,143	15·88
	5,807	70·69
Consumers wiring own premises	2,109	29·31
Total	7,196	100·00

In connection with the supply of energy for the trams, a small extension has been made to the electric lighting station by the author for the accommodation of extra cells and the erection of a tramway switchboard. Two additional boilers are being erected by Messrs. Babcock and Wilcox, also two additional steam turbine-driven dynamos by Messrs. Parsons and Co., each machine being capable of developing from 200 kw. to 250 kw. with condenser. There is also to be provided a Highfield reversible booster and a negative booster; these works are being carried out under the supervision of the borough electrical engineer, Mr. J. H. Wray, the estimated cost being £10,000, a loan having been sanctioned for this amount for a period of 25 years.

(To be continued.)

THE NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY'S NEW STATION.

The Newcastle and District Electric Lighting Company has under its provisional order the sole right to supply the western half of the city of Newcastle-on-Tyne. It will be remembered that it was in the station of this company that steam-turbines were first tried for a large system of distributing electrical energy for lighting purposes. The company has done good work, and, as a natural consequence, its first station has become too small for the output demanded. About two years ago some extensions were made with steam-turbines driving continuous-current machines, and these completely filled up the old works. The partial change over from alternating to continuous current was made to meet the demand for power. This demand is largely on the increase, and in consequence, the new station is being equipped on the continuous-current system for supplying a three-wire network at 480 volts. The new works are situated on the banks of the Tyne, adjoining the Close, and hence are more conveniently situated for condensing water than the old station. The plant now fixed and being connected up for early service consists of five large Stirling boilers, designed for a working pressure of 250lb. per square inch. These boilers supply steam to two Parsons turbo-generators, each of 1,000 kw. output. The condensing plant, of which an independent set is provided for each of the turbines, is placed in the large pit running the full length of the engine-room. The circulating pumps for drawing water from the Tyne are placed at mid-tide level, so that there will be no trouble in consequence of the small extra lift required at low water. The coal stores run the full length of the boiler-room, and are at a considerable height, so that automatic trimming of the coal from the bunkers into the hoppers of the chain grate stokers will be easily effected by gravity. In the old station the whole of the coal was brought in by carts, but with the new works it is expected that the river will be the more convenient means of transport. The contract for the coal-handling plant is not yet let, but it is to be capable of handling an enormous quantity in a short time. The switchboard in the new works is of the Ferranti type, and is now practically completed. As soon, therefore, as the pipework is completed, Mr. W. D. Hunter, the engineer of the company, will be able to take part of his load from the new station. At the time he kindly showed us round this station this week, the boilers were under slow fires drying off the brickwork. The design of these works is excellent throughout, and should allow of extreme economy in the production of energy. With this plant the company will be able to supply at low rates electrical energy to the large users of power in the numerous important works within their district.

THE ELECTRICAL CONDUCTIVITY OF CERTAIN ALUMINIUM ALLOYS AS AFFECTED BY EXPOSURE TO LONDON ATMOSPHERE.*

BY ERNEST WILSON.

The physical properties of certain light aluminium alloys have formed the subject of a communication to the *Journal* of the Institute of Electrical Engineers, 1902, Part 154, vol. xxxi., and, as stated therein, a specimen of each alloy was placed on the roof of King's College, London, in order to investigate the effect of exposure to London atmosphere The specimens are in the form of wire, 0·126in. (3·2mm.) diameter, supported on a wooden frame, and were placed on the roof on June 11, 1901. They have been tested after about 13 months' exposure, and have revealed some interesting facts. In order that the chemical analysis may be inspected it is again given in the followlng table, which gives the results of the tests. It is assumed that the observed effects are principally due to pitting at the surface, but exposure might also affect the structure of these alloys:

Number of specimen.	Analysis. Si.	Fe.	Cu.	Ni.	Mn.	Zn.	Specific resistance in 10^{-6} ohms before exposure on June 11, 1901.	Percentage variation in resistance as found on July 23, 1902.
16	0·31	0·37	0·11	—	—	—	2·92	1·81
4	0·38	0·25	0·16	—	—	—	2·88	1·83
13	0·38	0·25	1·58	—	—	—	3·34	4·50
14	0·40	0·31	1·86	—	—	—	3·25	6·18
15	0·40	0·40	2·61	—	—	—	3·34	8·07
1	0·38	0 22	0·17	—	—	0·62	2·86	1·98
2	0·43	0·28	0·30	—	—	1·20	2·94	1·30
5	0·43	0·39	0·09	—	—	2·04	3·07	2·30
7	0·37	0·25	0·05	0·75	—	—	3·05	1·21
8	0·35	0·29	0·09	1·19	—	—	3·24	2·07
20	0·37	1·10	0·06	2·25	—	—	3·18	1·64
24	0·35	1·16	0·09	—	—	—	2·97	0 60
3	0·37	0·28	0·59	—	—	0·59	3·06	2 49
6	0·39	0·31	0·63	—	—	1·20	3·12	2·00
17	0·35	0·53	0·10	0·83	—	0·90	3·03	0·99
12	0·31	0·59	0·19	1·09	—	0·73	3·33	1·21
18	0·43	0·40	0·21	1·13	—	1·94	3·24	2·59
19	0·35	0·29	0·11	2·01	—	1·77	3·26	3·21
11	0·39	0·56	0·24	2·31	—	0·38	3·48	1·93
22	0·37	0·43	1·08	1·29	—	—	3·41	-1·41
21	0·39	2·57	0·10	1·39	—	—	3·24	-0·80
10	0·32	0·54	0·02	—	0·05	—	3·09	0·62
9	0·31	0·35	0·03	—	0·35	—	3·30	1·92
23	0·44	0·56	0·09	—	1·78	—	3·49	2·20

The position of aluminium in the electro-chemical series with respect to the other substances in the analysis is as follows: Al, Mn, Zn, Fe, Ni, Cu, Si. We should expect to find that copper, widely separated as it is, would be effective in the production of corrosion. This is found to be the case (specimens 16, 4, 13, 14, 15), the effect increasing with the percentage of copper. Nickel is well separated from aluminium in the series, and alone (specimen 20) has considerable effect, but if alloyed with copper (specimen 22) conductivity has slightly increased during exposure. This specimen is specially promising, as it has a breaking load of 45,900lb. and limit of elasticity 36,600lb. per square inch. It has, comparatively, a low percentage extension (0·146 with 16,250lb. per square inch), a high coefficient of expansion (0·0000252), and a low temperature coefficient for electrical resistance (0·00178 per 1deg. C. between 0deg. C. and 100deg. C.). Again, iron in the presence of nickel (specimen 21) has slightly increased conductivity. This specimen has a comparatively high breaking load of 42,200lb. per square inch, and its conductivity is slightly larger than in specimen 22. Silicon is the most widely separated of all the substances in the above series, and it should be remembered that all commercial aluminium contains traces of silicon and iron. Since these alloys were supplied the purity of commercial aluminium has been greatly improved, so that further research may yield results from which more definite deduc-

* Paper read before the Belfast meeting of the British Association.

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tions may be made. For exposed light aluminium alloys it appears that copper alone should not be used in the alloy; the presence of equal amounts (about 1 per cent.) of nickel and copper certainly reduces conductivity to a small extent, but the gain in mechanical and corrosive properties is great.

A FUNDAMENTAL PRINCIPLE.

BY J. F. MOORE.

In all undertakings competition usually exists, and the electrical industry is no exception to this rule. Our principal rivals, if the term may be used, are usually the gasmaking profession.

It is often the routine of the borough electrical engineer to answer, sometimes two or three times daily, the question "How does electric light compare with gas?" this question being sometimes answered without a true grasp of its meaning.

It will be patent to all that throughout the generation of gas and electricity one fundamental principle exists common to both—viz., what is the candle-power available from every ton of coal, and the revenue derived thereby from the consumer?

The following tables will explain themselves:

GAS DEPARTMENT.

Basis: That 5 cubic feet of gas give 12½ candle-power hours, or 1 cubic foot of gas gives 2½ candle-power hours

One Ton of Coal.

↓

10,000 cubic feet of gas.

↓

25,000 candle-power hours.

↓

Revenue at the Following Prices:

Price per 1,000 cubic feet ...	2s. ...	2s. 6d.	3s
Gas revenue per ton	£1. ...	£1. 5s. ...	£1. 10s.
Revenue from consumer per candle-power hour	·0096 ...	·012 ...	·0144

ELECTRIC SUPPLY DEPARTMENT.

Basis: That one B.T.U. is used by a 16-c.p. lamp burning for 16 hours.

One Ton of Coal.

	↓	↓	
At	5lb.	10lb.	Per B.T.U.
	↓	↓	
Number of units	448	224	Per ton of coal.
	↓	↓	
Candle-power hours...	114,668	57,344	Per ton of coal.
Revenue at 4d. per B.T.U.....	£7. 9s. 4d.	£3. 14s. 8d.	
Revenue from consumer per candle-power hour	·0156	·0078	

Consequently one can see from the above, considering lighting alone, the revenue derived from a ton of coal is considerably more in the case of electricity than gas, although the revenue per candle-power hour is in certain cases (when the price of gas = the price of electricity) the same.

The following table will approximately show at what prices gas = electricity with different efficiency lamps:

Price per B.T.U.	Three watts.	Four watts.	Per candle-power.
1 penny ...	1s. 0d. ...	1s. 2d. ...	Per 1,000 cubic feet.
2 „ ...	1s. 9d. ...	2s. 0d. ...	„
3 „ ...	2s. 5d. ...	2s. 9d. ...	„
4 „ ...	3s. 2d. ...	3s. 7d ...	„
5 „ ...	3s. 7d. ...	4s. 5d. ...	„
6 „ ...	4s. 8d. ...	5s. 3d. ...	„

The gas company's revenue per ton, however, is increased by their residual products, and is roughly indicated below:

One ton of coal will produce

10,000 cubic feet of 15-c.p. gas at 2s 6d.	£1	5	0
12cwt. of coke at 6d	0	6	0
18 gallons of ammoniacal solution.....	0	1	6
10 gallons of tar	0	1	3
	£1	13	9

SOME EXPERIMENTS ON RADIATION AND ABSORPTION—A PRELIMINARY STUDY FOR A STANDARD OF LIGHT.*

BY J. E. PETAVEL.

The first part of the paper refers to some determinations of the intrinsic brilliancy of iridium and platinum-iridium at their temperature of fusion. It has been previously shown (see *Phil. Trans.*, vol. 191, p. 501) that if t be the temperature Centigrade and b the intrinsic brilliancy in candle-power per square centimetre,

$$t = 889{\cdot}6\ \sqrt[6{\cdot}9]{b} + 400 \quad . \quad . \quad . \quad . \quad (1)$$

The photometric observations and calculated temperatures of fusion are given in the following table:

	Intrinsic brilliancy in candle-power per square centimetre.		Melting point in degrees C. from Formula I.
Platinum.....	19	.....	1,763
Platinum-iridium (25 per cent. Ir.)	34	.....	1,883
Iridium	290	.....	2,423

The temperature of a radiating body may also be estimated by a second method.

The percentage of the total radiation passing through 2cm. of water has been measured at various temperatures. It is shown that for platinum above 1,000deg. C. this quality is approximately a linear function of the temperature, the relation being

$$t = 872 + 81{\cdot}63\ h.$$

where t is the temperature Centigrade, h the percentage of total radiation passing through a 2cm. water-trough having quartz sides 2mm. thick.

	Percentage of total radiation transmitted through 2cm. of water.		Melting point in degrees C. from Formula II.
Palladium	8·84	...	1,593
Platinum	11·0	...	1,770
Platinum-iridium (25 per cent. Ir.)	12·2	...	1,868

The first formula only applies strictly to a platinum radiator; the second is at the best a rough approximation. They may, however, be of some practical use in many cases where very accurate results are not necessary, or where the temperatures are too high to be directly measured. In the second part of the paper the absorption curves of a number of substances, including glass, quartz, fluorspar, water, benzol, bisulphide of carbon, etc., are given. The curves refer to the radiation emitted by incandescent platinum, the temperature range being from 1,000deg. to 1,700deg C. For all these bodies the percentage of heat transmitted increases with the temperature. One exception to the rule is noted—namely, black fluorspar. In experimental work it is frequently desirable to maintain the temperature of a radiating body constant; the anomalous absorption of black fluorspar provides a ready means by which this may be done.

If two thermopiles, one measuring the radiation through, say, glass, the other through black fluorspar, are connected in opposition, there will be a critical temperature at which the resulting galvanometer deflection will be zero. The actual temperature at which this will occur will depend on the relative thickness of the plates and on the relative distance of the thermopiles, but for a given disposition of the apparatus it will always be the same. Some experiments are now being made with a standard of light based in principle on the above results.

* Abstract of paper read before the Belfast meeting of the British Association.

TRADE NOTICES AND NOVELTIES.

The Crompton Potentiometer.

We have received from Messrs. Crompton and Co., Limited, Arc Works, Chelmsford, a copy of an admirable little pamphlet, wherein is fully described and illustrated the construction of the Crompton potentiometer, in its latest improved form. The employment of the potentiometer as a normal instrument for electrical measurements connected with direct-current supply was originally suggested by Prof. J. A. Fleming, F.R.S., and its introduction into engineering practice is due to Lieut.-

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Colonel R. E. B. Crompton, R.E., C.B., the founder of the present firm of manufacturers. Fundamentally the instrument consists of a long wire carrying a current of electricity from a constant battery. If the wire is of uniform size and quality throughout, the potential difference between any two points is proportional to the length of wire intercepted between them. The construction of the potentiometer itself is shown diagrammatically in Fig. 1. The calibrated wire is

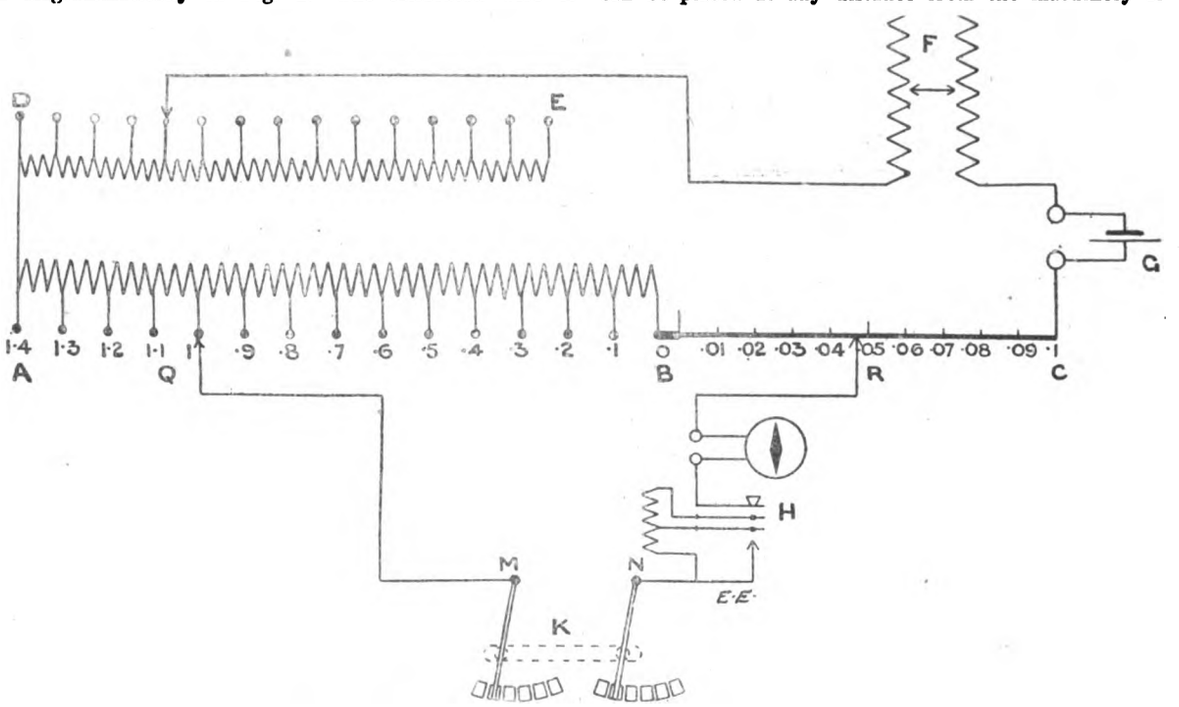


FIG. 1.—Construction of the Crompton Potentiometer shown Diagrammatically.

arranged in 14 coils, called potentiometer coils, lettered A B, and a straight section B C, called the scale wire, the resistances of the several coils and of the straight section being equal. One sliding contact, Q, moves over the terminals of the 14 coils, and another, R, along the straight wire. The reading of the instrument in the position shown is 1·046. The pairs of points whose potential differences are to be compared are connected to the blocks of the double-pole switch, K, whose levers, M N, connect them, one pair at a time, to the sliding contacts, Q R, through the galvanometer. The galvanometer key, H, is arranged to complete the circuit through two resistances, which are short-circuited in succession as the key is depressed. The current required is derived from a small secondary battery, G. An adjustable resistance, consisting of a set of coils, D E, and a continuous rheostat, F, is placed in the circuit. By adjusting these the resistance of the circuit and the current passing through it from the storage cell, and consequently the fall of potential along the scale wire, can be continuously altered, and the operator is able to obtain a galvanometer balance against a standard cell when the reading of the sliders is that of the known E.M.F. of the cell at its actual temperature. If, for example, the temperature of the cell be 15deg., so that its E.M.F. is 1·434 volts, the sliders may be set to that reading, and the galvanometer brought to zero by adjusting the resistance, D E, and the rheostat, F. When this has been done, the scale readings at all points are direct readings in volts. A view of the potentiometer is given in Fig. 2 herewith. Two scales are engraved for slide wire readings. One is a series of even divisions from 0 to 105, the resistance of the scale wire between 0 and 100 being the same as that of each potentiometer coil. It has been found convenient to be able to take readings a little beyond the 100 mark without having to move the potentiometer coil switch, and the scale is extended to 105 to admit of this. The other scale gives the values of the Clark cell at different temperatures. In its latest form the instrument is fitted with a switch, which allows each of the potentiometer coils to be separately compared with the scale wire, so that their equality to it and to one another can always be verified. From the principle of its construction, the results obtained with the potentiometer are singularly free from instrumental errors; the range of measurement of currents and E.M.F.'s is practically unlimited; and the measuring appliances can be placed at any distance from the machinery or other apparatus under test. Volt boxes and galvanometers, etc., for use with the potentiometer are also fully described and illustrated in the pamphlet under notice.

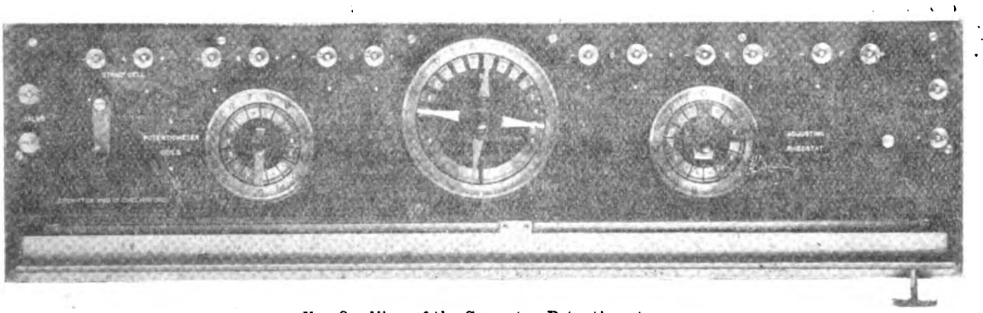
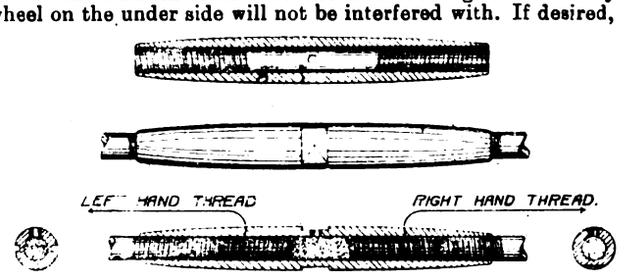


FIG. 2.—View of the Crompton Potentiometer.

Sleeve for Repairing Broken Trolley Wires.

We illustrate herewith a sleeve or muff for repairing broken trolley wires, which has been patented by Mr. H. N. Thomas, A.M.I.E.E., engineer to the Huddersfield Corporation Tramways Department. In using this sleeve, all that is required is that a left and right hand screw plate be carried on the tower wagon and a few sleeves. On arrival at the scene of the break a thread can be screwed on the broken trolley wire ends—right and left respectively—and the sleeve then screwed home by means of the squares provided and a spanner, the squares being left on the sides in order that the free running of the trolley wheel on the under side will not be interfered with. If desired,



Sleeve or Muff for Repairing Broken Trolley Wires.

solder may be run into the interior of the sleeve, through the small hole shown in this illustration. These sleeves can be cheaply made and sold by the dozen. Their use, it is claimed, ensures great economy, as they obviate the necessity of cutting off the wire at each side of the break and scrapping these odd lengths.

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CONTENTS.

Notes	469	Reviews	487
The Tyneside Tramways and Tramroads	474	The Use of Electricity in Iron and Steel Works	487
Electric Lighting and Tramways at West Bromwich	479	St. Helens Accounts	490
The Newcastle and District Electric Lighting Company's New Station	483	Companies' Meetings and Reports	491
The Electrical Conductivity of Certain Aluminium Alloys as Affected by Exposure to London Atmosphere	483	New Companies Registered	491
A Fundamental Principle	484	Appointments Vacant	491
Some Experiments on Radiation and Absorption—A Preliminary Study for a Standard of Light	484	Forthcoming Events	491
Trade Notices and Novelties	484	Questions and Answers	491
Depreciation on Tramways	486	Bolton	493
		Contracts for Electrical Supplies	494
		Traction Notes	496
		Lighting Notes	498
		Provisional Patents, 1902	502
		Specifications Accepted	503
		Companies' Stock and Share List	503
		Traffic Returns	504

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DEPRECIATION ON TRAMWAYS.

In his annual report to the Bolton Council the borough engineer, Mr. E. Ll. Morgan, gives two special reports as submitted to the Tramways Committee, one on the "relaying, etc., of track," the other on "depreciation of track." The latter is given complete in another part of this issue, and presents some very interesting reading. Whatever may be the merits or demerits of municipal socialism, there is one feature of municipal work that stands out in complete and satisfactory contrast as against similar work done by companies. It is that all information relating to it is forthcoming, and generally the responsible officials are more anxious than otherwise to have the results of their labours made public and criticised by experts. Exceptions to this state of things only prove the rule. It is the great publicity given to municipal work that really keeps professional men acquainted with the most recent developments in that class of work. Broadly speaking, tramways are constructed, maintained, and worked under one or other of three systems. In the first, the municipality does everything; in the second, private enterprise does everything; and in the third, the municipality construct and maintain, but leases to a company for the working. In any discussion on depreciation it is only necessary to consider and compare the first and second of these methods. A municipality raises its capital upon the security of the rates at an interest of, say, 3 or 4 per cent., under the proviso that the whole capital is paid off within a certain number of years—this number varying according to the class of work to be done. The underlying idea in this case is that the work, of whatever class it may be, deteriorates from the moment of its being finished, and dies a natural death at the end of the period for which the loan was contracted, having a capital value at any moment during that period equal to the amount of loan outstanding at that moment. It is, however, a well-known fact that what we may term the loan period is generally assessed at too low a figure; hence that the undertaking is generally at any particular time of somewhat greater value than the capital value at which it stands in the accounts. For the purposes of argument, it may be assumed that, calculating interest upon the loan at the rate of 6 per cent., the amount so reckoned will suffice to pay both interest and annual repayment of loan obtained. Thus we may look upon this part of the question as meaning that a municipality has no power to obtain money at a lesser rate than 6 per cent. It is a fact that interest and repayment are both compulsory, and that the annual burden upon the loan during the time it exists is as above stated. Theoretically, the undertaking and the capital cease to exist at the same time, leaving things as they were in the beginning; practically, it is quite different. In tramway work the undertaking has to be kept efficient, and the maintenance is paid for either out of revenue or by additions to capital. So far as things have gone at present, the maintenance is out of revenue. Now turn to the company. It raises its capital on the credit of its promoters and the hope the investing public have of a fair return, or the hope that a speculating public has of getting out at a good profit before evil days come. Anyhow, assume the capital is raised. The amount is constant, and not a diminishing one. The interest paid may be anything or nothing, depending upon the success of the undertaking. There is and can be no compulsory minimum of interest, because there is nothing to fall back upon in the case of non-success Unless, therefore, the undertaking prove a success in the case of a company, the capital may prove a total or a partial loss. The maintenance charges may

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be dealt with in a similar way in both cases—that is, out of revenue or by addition to capital. Further, in the case of a company, depreciation depends largely upon success. There is and can be no similar compulsory depreciation, as with a municipality, for in the latter case repayment of capital is compulsory depreciation. The question as to the exact amount of depreciation for electrical tramway rails can only as yet be answered by an estimate, as insufficient time has passed to enable any trustworthy facts as to life to be ascertained. Mr. Morgan estimates an average life of twelve years, and calculates on a depreciation of track of 8 per cent. The interest must be added to this when the total annual payment is to be ascertained, which would under these conditions be far more than generally paid, and it is extremely doubtful if this rate of depreciation would be acceptable to any private company. It will be seen that the depreciation suggested by Mr. Morgan is well on the safe side in that the initial cost per mile is £6,050, while after relaying the cost would stand about £5,700, less the value of the old material. In the last paragraph in the report it is estimated that the original capital would be reduced from £6,050 per mile to £3,500 per mile of track. If, after relaying, the track is as good as originally, why the necessity for so large an expenditure? From a business point of view, if you have a tramway equally good at the end of twelve years as at the beginning, should not the capital amount stand at the same figure? This, of course, assumes that tramways are more or less a permanent necessity. If, however, they are looked upon as temporary in character, the large rate of depreciation is warranted in order that the municipality may have no heavy capital charges to meet when tramways are superseded. After the relaying the total liability per mile would be only a thousand pounds, assuming the credit side to stand as before. If the interest upon the amount obtained through this heavy depreciation is taken into account, it will be seen that practically a tramway equal to new would be obtained with no capital charge at the end of this period of twelve years; hence we imagine that to ask an undertaking to incur so heavy a depreciation, though sound finance, means increased charges to the user during the earlier years of the undertaking, and provision for posterity which will not be duly appreciated.

REVIEWS.

Encyclopædia Britannica, Vol. XXIX. Published by Adam and Charles Black, Edinburgh and London, and the *Times*, Printing House-square, London, E.C.

The conception of the value of these additional volumes of the "Encyclopædia Britannica" increases with the publication of each successive volume. Far and away beyond compare as to utility are the various articles dealing with geography, trade, and politics. The mass of statistical information that is crammed into the short space devoted to such towns as Glasgow, to countries as India, Hungary (if we may term this a country), or Japan, or islands as Java, brings forcibly before the careful reader the exact position in the world of economics, trade, and politics that such places hold. Take India as an example of the comprehensively condensed treatment. There is hardly a question an educated man would want to know but is easily answered by a reference to the few pages devoted to it; be it population, occupation, or what not, we find at once in the tabular statements an answer. So it is as regards crops and acreage devoted to particular crops, to railways, to industrial occupations, to imports, exports, revenue, expenditure, and even the tonnage and flag of the vessels clearing for foreign countries One or two of the more technical articles are weak, the weakest being, perhaps, that on "Hygiene." The author of this had a great opportunity, but, we think, has missed it. He ought to know that ozonation of water for purification purposes was long ago shown in operation in this country. What we looked for was not a list of names and experiments, but a discussion of principles. The article on "Iron and Steel" is far better; indeed, it is the most complete and succinct on the progress of the past 20 years that we have read; and we may here take the opportunity of saying that, although outstripped in the production of pig iron by the States and Germany, the progress into the constitution of iron and steel is largely due to the labours of British ironmasters and men of science. Bell, Roberts-Austen, Stead, Hadfield, and half a score of other names are those of pioneers, and not of followers, and it is to the labours of such men in the micrographic examination of iron and steel and alloys that the world's knowledge of the subject has progressed so rapidly. As a source of reference these volumes are unsurpassed.

Merck's Index. By E. MERCK. Ed. Roether, Darmstadt. Second edition, October, 1902.

To all familiar with this useful catalogue—almost a pharmacopœia in itself—the event of this second edition, which contains the latest information up to the end of July, 1902, will be most welcome, as the first edition has long been out of print. Started in the first instance to give the public (more especially doctors, chemists, and dealers in medical preparations) an idea of many thousand preparations and appliances manufactured by E. Merck, it has developed into the most complete and concise book of reference on aniline and tar preparations and on reagents, etc, for analyses and microscopic experiments. Each preparation is described, and dose and method of application is given. The list contains also such accessories as filter papers, coloured fluid for microscopic use, etc., and collections of minerals and precious stones for technical schools.

THE USE OF ELECTRICITY IN IRON AND STEEL WORKS.*

BY F. KYLBERG, BENRATH, NEAR DUSSELDORF.

(Continued from page 443.)

Patent Electrically-Driven Pig-Iron Casting Machine (Fig. 5). The pig-iron casting machine represented in the illustration is of an entirely novel type of construction. The chief advantage consists in cooling the moulds by causing them to pass through two water channels. By means of this arrangement the machine is considerably shortened and occupies much less space as compared with other similar machines, a point of great importance for ironworks which have only a limited space at their disposal. A further advantage is that on account of the short travelling band less power is required for driving the machine. The capacity of the machine is very great, amounting to about 60 tons per hour. At each end of the chains conveying the moulds is arranged an electric motor of 25 h.p. for driving.

An Electrically-Driven Tilting Arrangement for Mixers, Open-Hearth Furnaces, and Converters (Fig. 6).—For this purpose also electric power can be suitably applied. The large heavy pig-iron mixers were hitherto operated by means of one or two hydraulic cylinders, an arrangement that can now be replaced by a combination of levers which receive their motion direct from a motor and crank. The motor is placed as far as possible from the mixer, so that in pouring in the molten metal the risk of injury by the splashing of the metal is avoided, and it is not too much exposed to the excessive heat. The tilting of an open-hearth furnace could be effected in the same manner as that shown in Fig. 6. As regards the arrangement of motors for tilting the converter, this is in accordance with the details previously given in the case of the mixer, and the power is transmitted by means of spur wheel and worm gearing. The power necessary for tipping the mixer or for tilting the open-hearth furnace amounts to about

* Paper read before the Iron and Steel Institute at Düsseldorf.

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7 h.p, and the time required for the performance of the operation is not more than half a minute. For the converter, on the other hand, since the contents of this must also be lifted, the requisite power is about 60 h.p., and the time in this case is about one minute.

Standard Screw Casting Crane (Fig. 7).—In the crane shown in Fig. 7, the customary chains or wire ropes for hoisting the casting ladle are replaced by screwed spindles. Notwithstanding the fact that this arrangement was at first looked upon with disfavour, it has been found that these electrically-driven spindles have proved most successful. The advantage as compared with rope or chain gearing is exhibited in the increased precision in handling the crane, and in the comparatively small amount of wear and tear, in spite of the rough-and ready work to which it is exposed in the converter shed. It is only after a long period of time that the phosphor-bronze nuts require to be changed and be replaced by new ones. The screwed spindles are protected against dust by means of telescoping sheet-iron cases. The author has seen various cranes of this type at work in German iron-works, and all doubts which he formerly entertained with regard to screw cranes were removed on observing the smoothness and precision with which they worked.

Electric Adjuster for Ingot Cars.—In most of the American open-hearth steelworks, the method has now for several years been followed of pouring the metal direct into the ingot moulds when standing on small cars. By this plan the whole of the time and labour in the casting pit is saved. At the Differdingen works also this system was introduced some years ago, and is working with signal success.

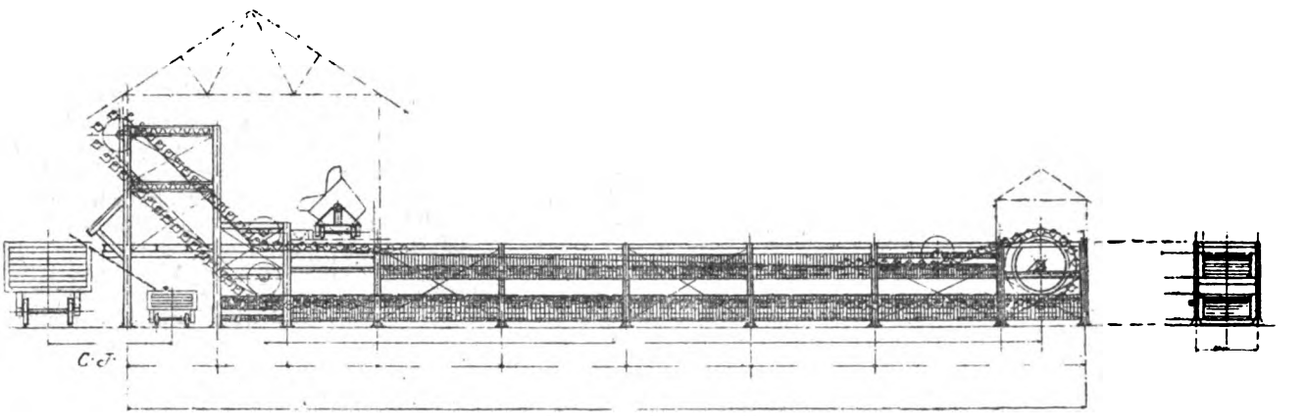

FIG. 5.—Pig Iron Casting Machine.

The charge from the open-hearth steel furnace is tapped direct into a casting ladle, and is conveyed to a platform at one end of the casting shed. Here the steel is poured into the ingot moulds mounted on the cars, which latter are drawn forward one by one upon a track alongside of the casting platform. In order to adjust the ingot cars without moving the crane, an electric adjusting gear for pulling forward the cars is provided, and an arrangement of this description was constructed for the Differdingen works by the Benrath Engineering Company.

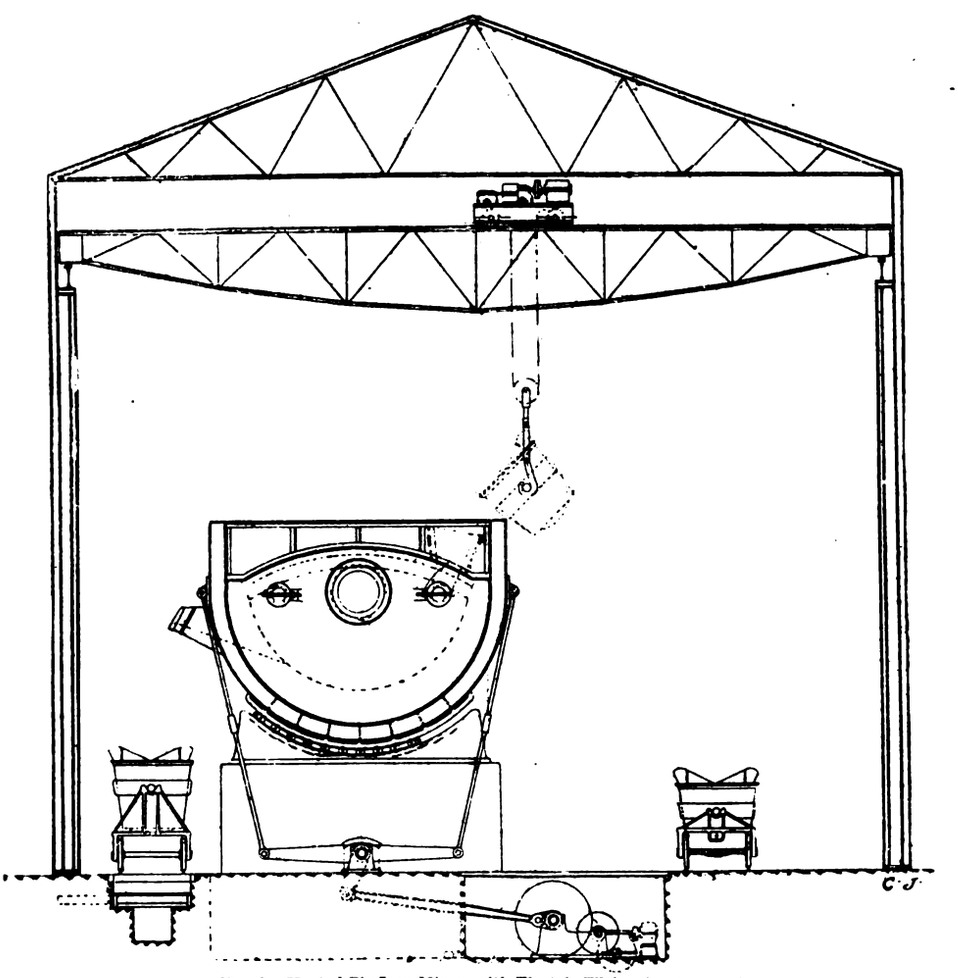

FIG. 6.—Heated Pig Iron Mixer, with Electric Tilting Arrangement.

The Further Process of Handling Ingots in Steelworks by Means of (1) *Electrically-Driven Stripping Cranes;* (2) *Com-*

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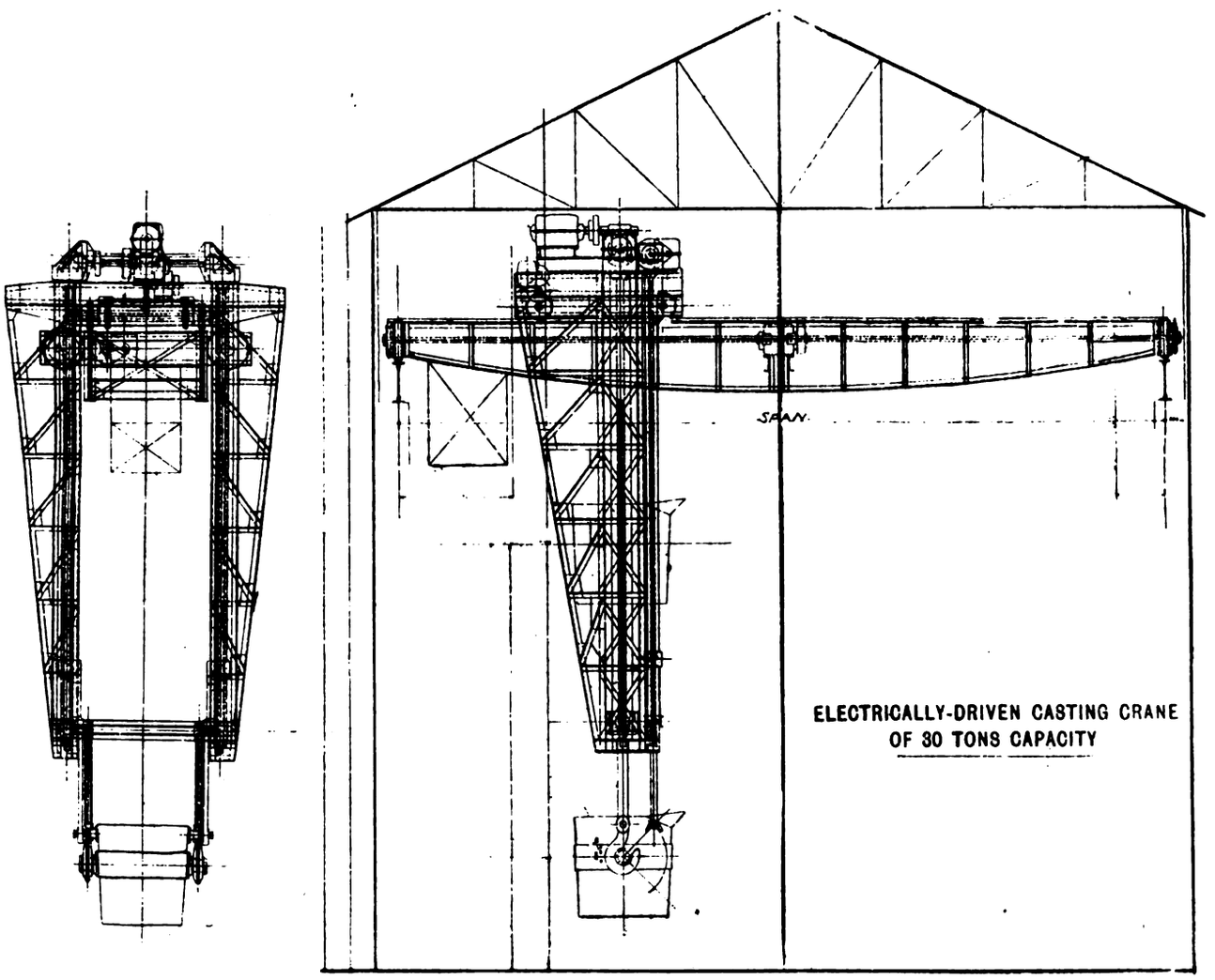

FIG. 7.—Electrically-Driven Casting Crane of 30 tons capacity.

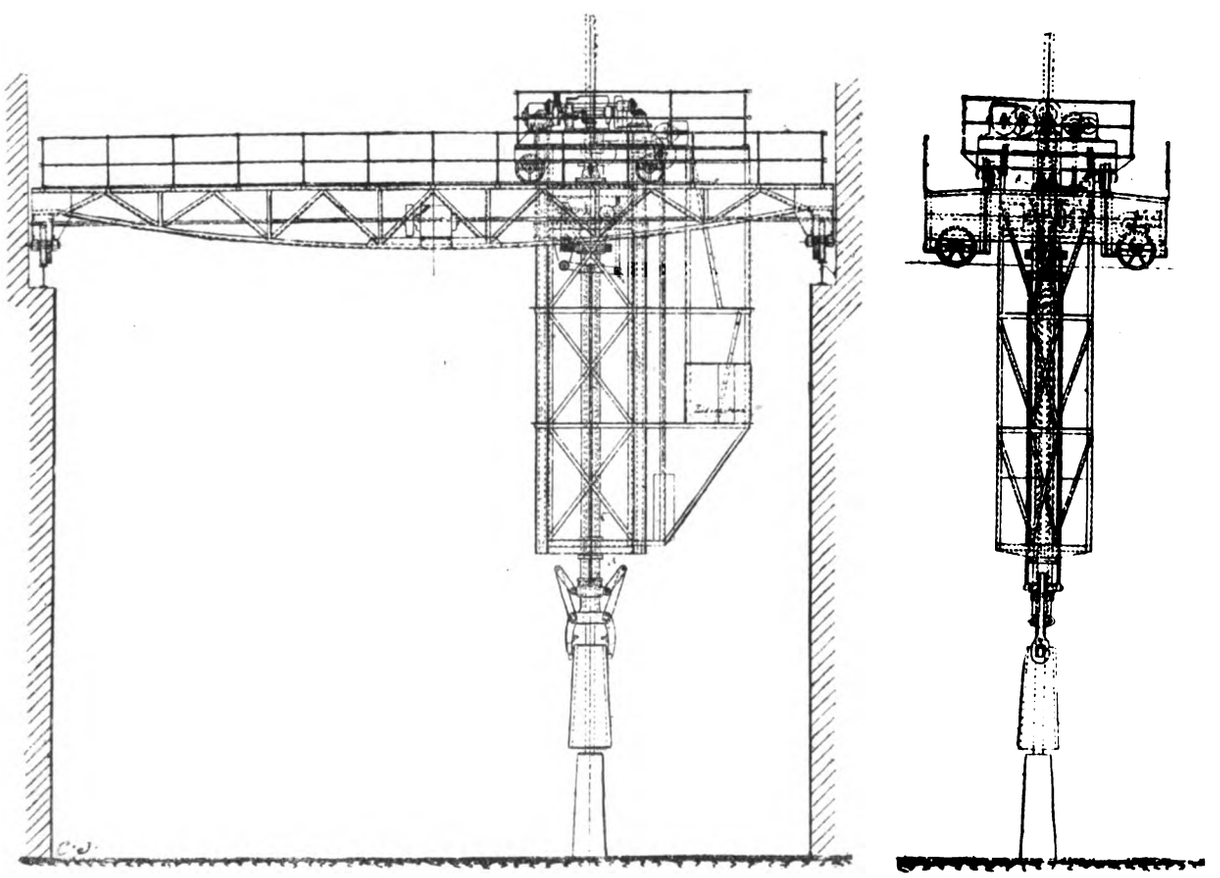

FIG. 8.—Combined Pit and Stripping Crane.

bined Soaking Pit and Stripping Cranes: (3) *Soaking Pit Cranes* (Fig. 8). As a necessary adjunct to the above-mentioned method of the direct casting of ingots upon cars, the ingot stripper plays an important part. Such machines, of

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TABLE A.—STANDARD MINE LOCOMOTIVES.

Minimum gauge for this type.	Number of motors—i.e., axles.	Power of the engine				Dimensions				Weight including electric equipment.
		Horse-power.	Tractive force on the hook.	Speed when fully loaded.	Gross weight which can be hauled on the level.	Minimum wheel base.	Maximum length over the buffers.	Maximum width over footboards.	Clear height, excluding trolley arm.	
Mm.			Kg.	Km. per hour.	Tons.	Mm.	Mm.	Mm.	Mm.	Kg.
425	1	10	250	8	20-25	700	2,500	1,000	1,250	2,500
425	1	15	250	12	20-25	700	2,500	1,000	1,250	3,000
600	2	25	600	9	50 60	1,000	4,000	1,250	1,500	6,000
600	2	25	1,200	4-5	100-120	1,000	4,000	1,250	1,500	9,000
700	2	30	1,200	6	100-120	1,0 0	4,000	1,250	1,500	12,000
700	2	45	1,500	7	120-150	1,200	4,000	1,250	1,500	14,000
700	2	60	2,000	7	150-200	1,200	4,500	1,500	1,500	16,000
700	2	75	2,000	9	150-200	1,200	4,500	1,300	1,500	18,000
700	2	90	2,500	9	200-250	1,500	5,000	1,800	1,600	20,000
1,000	2	110	2,500	11	200-250	1,500	5,000	2,000	1,600	22,000
1,000	2	150	3,000	12	250-300	1,850	5,300	2,000	1,800	25,000
				STANDARD SHUNTING LOCOMOTIVES.						
1,000	2	30	600	10-12	60-70	1,800	4,500	2,000	2,750	7,000
1,000	2	45	1,000	10-12	100-120	1,800	4,500	2,000	2,750	9,000
1,435	2	60	1,200	12-13	120-150	2,000	4,700	2,300	3,000	12,000
1,435	2	75	1,200	15-16	120-150	2 000	4,700	2,300	3.000	12,500
1,435	2	90	1,500	15-16	150-180	2,000	4,700	2,300	3,000	13,500
1,435	2	110	1,750	15-16	175-210	2,000	4,700	2,500	3,200	15,000
1,435	2	150	2,000	16-18	200-240	2,200	4,900	2,500	3,200	17,000
1,435	2	200	2,000	20 24	200-240	2 200	4 900	2,500	3,300	19,000
1,435	2	400	3,000	30	300-350	2,500	5 000	2,750	3,400	25,000

various design, were first constructed by the practical Americans. In the later types, electricity as the driving medium has replaced hydraulic power. The difficulties which had to be overcome in order to adapt electricity to this purpose lay in the fact that the pressure to be exerted is very considerable in order to force out the hot ingot from the ingot mould. By the employment of screwed spindles the problem was at length solved, and there are now several such ingot strippers with screwed spindles in active operation. Fig. 8 represents an ingot stripper as constructed by the Benrath Engineering Company. The ordinary electrically-driven ingot stripper only draws the mould from off the ingot, and afterwards places the empty mould upon another car provided for the purpose in the neighbourhood. Fig. 8, on the other hand, represents an entirely new kind of construction, which is better adapted for production on a small scale. This is a combination of a stripper and soaking-pit crane, by means of which it is possible first to strip off the mould and afterwards to pick up the ingots with the same tongs and convey them to the soaking pits. After reheating they are extracted and carried by the same crane to the live rollers. An electrically-driven soaking-pit crane with automatic gripping tongs, with the raising and lowering of the ingots effected by means of a screwed spindle, and one operator only necessary for the service of the crane and manipulation of the tongs, has been in operation for several years at the Differdingen works, and from the time that it was first put into operation has worked admirably, dealing with the entire production of ingots made at these works. In this connection might be mentioned the well-known charging machine for open-hearth and horizontal reheating furnaces, by means of which considerable economy in power is secured, as well as in increased efficiency of the steelworks. These machines also bear further testimony to the advantage of applying electricity as a source of power in the steel-making industry.

Electrical Appliance for Lifting the Soaking-Pit Covers.—Among the more recent electrical appliances for iron and steel works may be mentioned the lever combination for raising the lids of soaking pits. By the adoption of this arrangement hydraulic cylinders, which are ordinarily used to pick up and carry away the covers of these pits, can be dispensed with. The apparatus is constructed to span one to three rows of soaking pits, and is able to serve a very large number of these.

Live Roller-Driving Gear.—In the general construction of electric driving gear for live rollers, as usually carried out, two motors are used for the heavier roller trains for ingots or for long transporting trains of rollers. In other cases a simple driving gear with one motor is employed for standard roller trains of lighter construction. These trains of rollers are so well known that to describe them in detail here would be superfluous. It is only necessary to remark that this method of driving them is greatly superior to the ordinary methods of steam driving. It has unfortunately been impossible to give diagrams and other data in connection with these electric roller-driving gears on account of the shortness of time available, but the author hopes on a future occasion to be able to give fuller details.

(To be continued.)

ST. HELENS ELECTRICITY ACCOUNTS.

We give herewith abstracts of the revenue account of the above Corporation electricity works for the year ended March 31, 1902, together with statement of electricity generated, sold, etc.:

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	3,058	14	5
Distribution of electricity	1,247	11	0
Rents, rates, and taxes	413	12	9
Management expenses	1,521	13	0
Insurances	44	8	3
Interest on loans and dividends	3,290	14	0
Bad debts and superannuation fund	8	16	3
Repayments of loans and stock	3,316	0	7
Balance—profit	260	11	1
	£13,162	1	4

Cr.	£	s.	d.
Sale of current per meter	4,550	0	10
Working charge for tramway current	3,070	3	1
Standing charge for tramway current	2,820	0	0
Public lighting	229	6	1
Rent—St. Helens Tramway Company's overhead equipment	2,165	7	3
Fittings account	28	3	5
Motors	16	6	3
Public lamps—repairs, etc	40	16	0
Interest—purchase of plant	120	12	0
Meter rents	121	6	5
	£13,162	1	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Units generated			1,480,786
Units sold	Tramway	827,837	1,237,965
	Private lighting	211,784	
	Motors	143,311	
	Public lighting	55,033	
Used on works			38,320
Total accounted for			1,378,768

Efficiency, 93 per cent.

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COMPANIES' MEETINGS AND REPORTS.

BRITISH COLUMBIA ELECTRIC RAILWAY.

An extraordinary general meeting of the shareholders in this Company was held on Wednesday at the Cannon-street Hotel, E.C., for the purpose of confirming the resolutions passed on the 9th ult., making certain alterations in the articles of association, and submitting a resolution authorising the Board "to create and issue, subject and in addition to the issue of £250,000 4½ per cent. first mortgage debentures of the Company, further debentures for securing the payment of the principal sum of £220,000, and to apply the same, or any part thereof, to purchasing shares in the capital of the Vancouver Power Company, Limited, or in any manner the directors may consider conducive to the prosperity of the Company."

Mr. R. M. Horne-Payne presided, and in regard to the special resolution explained that it was practically the same as that passed on April 24 last, the only difference being that that authorised the Board to lend the money to the Vancouver Company, while the present resolution was for authority to purchase the shares of the company. The Board had decided that the latter was the more convenient method of financing the water-power scheme.

Mr. G. P. Norton seconded the resolutions, which were agreed to.

DICK, KERR.

The ordinary meeting of the shareholders in this Company was held in London on Monday, when the report of the directors, given in our last issue, was submitted for approval. The Press was not admitted.

NEW COMPANIES REGISTERED.

Woodhouse and Mitchell, Limited.—Capital, £30,000. Objects: to take over and carry on the business of Woodhouse and Mitchell, and to carry on the business of mechanical, electrical, and general engineers, etc.

Atmospheric Electrical Purification Company, Limited.—Capital, £16,000. Objects: to acquire a license to manufacture, sell, and use, exclusively in Lancashire, all apparatus necessary to carry into effect patent No. 17,805, of 1901, for improvements in the purification of air; to adopt an agreement with Colonel J. Harris and S. E. Ede; and to carry on the business of an electric company, etc.

Alpha Motorcar and Cycle Works (1902), Limited.—Capital, £50,000. Objects: to acquire and amalgamate the businesses of the A. B. Cycle Company, Limited, of 59-60, Chancery-lane, W.C., and the Alpha Company, Limited, Birmingham, and to carry on the business of builders of and dealers in cycles, automobiles, autocars, carriages, and vehicles, whether propelled by electricity or other modes, etc.

APPOINTMENTS VACANT.

Shift Engineer, Canterbury, 30s. per week, Oct. 6.

Junior Assistant Engineer, Hanley Town Council, £100 per annum, Oct. 10.

Shift Engineer, Southport Corporation electricity works, 45s per week, Oct. 7. See advertisement.

Gentleman, to act as depôt manager in the electrical trade, must be thoroughly conversant with the trade generally See advertisement.

Chief Assistant Engineer, West Bromwich Corporation Electric Light and Power Department. £2. 5s. per week, Oct. 13. See advertisement.

Improver, Walsall Corporation Electricity Department, 12s. per week. Particulars from Mr. A. Wyllie, borough electrical engineer, Wolverhampton-street, Walsall.

Demonstrator and Assistant Lecturer in the electrical engineering department of the Heriot-Watt College, Edinburgh, £100 per annum, Oct. 4. See advertisement.

Switchboard Attendants, Eccles Corporation Electricity Works, £62 per annum, Sept. 31. Particulars may be obtained from the Town Clerk, Town Hall, Eccles. Kendal, Oct. 4.

FORTHCOMING EVENTS.

The following fixtures for meetings have been made:

Municipal and County Engineers.—District meetings. Home: Oct. 11, Aldershot. Eastern: Oct. 18, King's Lynn.

Municipal Officers' Association.—District meetings at Birmingham, Liverpool, and Newcastle are being arranged.

Sanitary Inspectors' Association.—Oct. 4, 6 p.m., Holborn Restaurant, annual meeting.

Society of Engineers.—Oct. 8, "The Hennebique System of Concrete Construction," by Mr. A. R. Galbraith.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

521. Is there any economical way of disposing short lengths of carbons for arc lamps from a large system of public arc lamps?—CUBE.

522. An engineering works building a large extension some distance from existing steam generating plant is installing a 100-kw. steam dynamo for driving motors in new shops and lighting both new and old shops. Supply company is to be used as a stand-by for Sunday and holiday work. Continuous current on three-wire system at 205 and 410 volts is the system used. Describe how this may best be accomplished, giving diagram of connections.—R. A. M.

ANSWERS.

Question No. 514.—Some sawmills (river power) are having their electric light installation extended. At present one dynamo (compound), driven from the main shafting, is used. As the speed varies about 10 per cent. indifferent results have been obtained. Could a constant voltage be obtained by using a battery of accumulators in conjunction with the same or larger shunt-wound dynamo?—L. D.

Answer to No. 514 (*awarded 7s. 6d.*).—The question is rather indefinite, and it is not clear whether the dynamo is to be used only to charge the battery or if it is desired to supply the lights from the dynamo and battery at the same time. This latter scheme would not be completely satisfactory. Suppose that the E.M.F. of the circuit is 100 volts, then to charge cells to give this tension on discharge a charging current of 135 volts would be required. If, in accordance with this scheme, a battery were installed, what would occur in practice is this: In the first place the battery would not have to be protected by means of any automatic device, so that there would always be a closed circuit between the dynamo and battery. Now assume that the normal machine of the dynamo is 1,000 revolutions per minute, then the speed actually may be anything between 900 and 1,100 revolutions per minute. At the lower speeds the battery will assist to drive the dynamo as a motor, and so help to increase its speed; at the higher speeds the battery will be charged, and as the voltage will be in many cases much higher than that required for charging purposes there will be a large rush of current into the cells, and the dynamo will be overloaded, and so will tend to slow down. In this way the battery will tend to give a more constant voltage, but the E.M.F. will be far from steady, and the wear and tear of the battery will be so great that no firm of manufacturers would undertake its maintenance on these conditions, as in practice it will be found that at one time it will be charged with too high a current, while at others it will be completely discharged. The result will be that buckling will arise, and the paste drop out, so that we may state that this method will not give satisfactory results, and will be expensive to maintain.

A second method of using accumulators is perfectly feasible, and will give good results. The lighting will only be required during the dark hours If, then, a battery be installed, protected by some suitable automatic cut-out and cut-in switch, such as the Neville, the battery could be charged in the daytime and discharged at night. This means that the whole of the lighting would be off the battery, but as the cells would not be subjected to the rough treatment described above they would last, and give a fair return for the capital spent on them. The fluctuations in the speed would not affect the battery, especially if it be

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convenient to alter the shunt resistance when the speed attains its highest limits, as any back rush of the current on the dynamo would be prevented by the automatic switch. In both the above cases the dynamo should be altered to have a shunt winding in place of the present compound winding.

There is yet a third method which will give admirable results. This is to control the E.M.F. by means of a suitable governor. Many years ago Messrs. W. T. Goolden and Co. put a voltage regulator on the market. This is rarely, if ever, seen nowadays, but yet the writer has obtained very good results with it. The regulator consists of an external shunt resistance electrically controlled. The lever of the step-switch is actuated by means of a solenoid energised by a current supplied from the dynamo. If, then, the E.M.F. rises owing to an increase in the speed, the solenoid immediately and automatically increases the amount of the shunt resistance, and so reduces the excitation. If the E.M.F. drops the opposite results are effected.

In place of adopting means to secure a constant voltage, would it not be advisable to put down a turbine governor so as to maintain constant turning of the shaft?—M.

Answer to No. 514 (*awarded* 7*s.* 6*d.*).—The use of a battery in parallel with a shunt-wound dynamo would certainly give greatly improved voltage regulation, and is probably the best way out of the difficulty. The battery for this purpose need only have a charge and discharge current capacity equal to about one quarter of the maximum lighting current. The ampere hour capacity can also be quite small, as the battery will be alternately charged and discharged for short intervals of time only. A charge and discharge switch will have to be provided, so that the number of cells in use can be altered by hand according to the state of charge they are in. It will also be necessary to provide some means of raising the dynamo voltage by some 25 or 30 per cent. in order to fully charge the cells. This can be either be done by raising the speed of the main dynamo for a certain number of hours during the daytime, or else by providing a small belt-driven or motor-driven booster to be used in series with the main generator.

There is another method of ensuring a fairly steady supply voltage in spite of large variations in the main

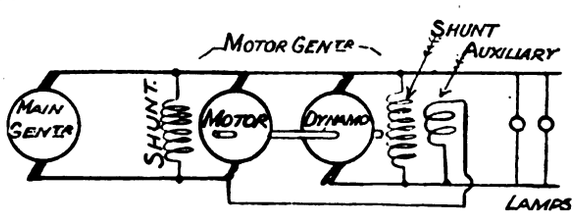
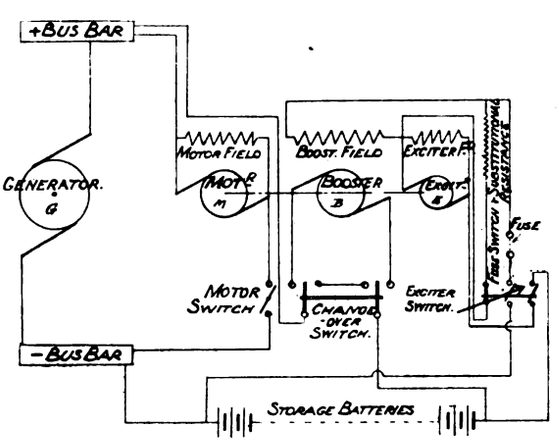


FIG. 1.

generator voltage. It is sometimes employed in connection with traction mains from which lighting is to be carried out simultaneously. It consists in passing all the lighting current through a motor generator, and it is probably cheaper than the battery method, considering the expenses for maintenance and repair, in spite of the size of the motor generator. The motor should be shunt wound, and directly coupled to a compound-wound generator. The field magnets of the motor should be working in a quite unsaturated state, whilst those of the dynamo should be fairly saturated. Both armatures may be wound alike, and the dynamo should give the correct lighting volts when runing at the normal speed. Should the main generator volts rise above the normal, the motor speed will hardly increase at all, for the tendency to speed up, due to the higher volts on the armature, will be almost entirely counteracted by the strengthened field due to the increased volts across the shunt. Should the main generator volts fall the reversed action takes place, and the speed of the motor still remains practically unchanged. In this way the lighting voltage obtained from the dynamo side of the motor-generator remains practically constant.

Sometimes the steadying effect of the motor-generator is heightened by connecting terminals of like sign on motor and dynamo together through an auxiliary exciting winding on the dynamo field (Fig. 1). In this case, the dynamo part of the motor-generator would be wound to give the correct lighting voltage as a plain compound dynamo when running at the normal speed, the motor and dynamo voltages being then alike, and no current passing through the auxiliary winding. Should the volts on the motor rise a current will pass through the auxiliary winding in such a direction as to slightly weaken the dynamo field and so compensate for any slight increase in motor speed. The effect of the auxiliary winding is reversed when the main generator volts fall—a current then passing back through the auxiliary winding from the dynamo side to the motor side. The amount of the current passing through the auxiliary winding for a given rise or fall in main generator voltage depends entirely on the resistance of the winding, and can be readily controlled by means of a small regulating resistance.—Q.

Answer to No. 514 (*awarded* 5*s.*).—The problem put forward by this question is rather complicated, and one is chary of touching it. The root of the evil is without doubt the unsteady governing of the turbine. Governors of such apparatus are reputedly rather slow, but under normal conditions some are to be obtained which will act within narrower limits than those stated. As it is, a scheme must be evolved which will serve as a spring buffer or dashpot for the governor, and which will confine the voltage variations within the desired limits. But even here choice is limited to those methods of regulation whose operation is dependent on the variations of voltage, as distinguished from current variations. Probably the "Highfield" method of reversible boosters lends itself best to the solution of the problem. The accompanying diagram shows the general arrangement of the connections. All measuring and recording instruments have been omitted, but these can be easily inserted according to requirements.



The following is an explanation of the diagram: G is the main generator, preferably shunt wound, connected to the positive and negative 'bus bars through the usual switches and instruments. M, B, E are respectively a motor, booster, and exciter, mounted on one baseplate and coupled together on one shaft. The motor is shunt wound, and driven from the 'bus bars. The booster is of special design, and separately excited from the exciter. Its field magnets are laminated, and wound with a fine coil so proportioned in its convolutions and resistance that the armature will give, when run at constant speed, an E.M.F. corresponding to that across the ends of the exciting coil. The armature is connected, through a change-over switch, at one end to the positive 'bus bar and at the other to the positive of the battery. The other terminals of the switch are connected together, so that when the switch is thrown over the battery feeds direct on to the 'bus bars. The exciter is an ordinary small generator, designed to give the same normal voltage as the main generator and the necessary exciting current. Its armature is connected direct on the one side and through the booster field coil on the other to the battery. A double-pole switch and a field breaking switch are shown on the diagram.

The operation of the combination depends practically upon the differences in voltage at the battery and exciter terminals. If these be equal then no current passes between them, hence the booster field is not excited and

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the booster is inoperative. This is the normal condition. Should the battery voltage be higher than that of the exciter, then a current will pass through the booster field coil proportional to the difference of the pressures, and the booster will give a pressure at its armature terminals corresponding thereto. Similarly, if the exciter pressure be higher a current passes, and the booster gives a corresponding pressure but in the reverse direction. Thus, whilst the main generator runs at normal voltage the battery pressure at the 'bus bars will be kept practically constant quite automatically. If the generator pressure rises abnormally, charging of the battery will begin and the booster will then run as a motor, whilst the exciter will act as a generator and give current to the battery, whereby the load on the generator will increase and its voltage will fall again. If the battery pressure be abnormally high, it will begin discharging through the booster, which will be motored, and the motor will now act as a generator and return energy to the 'bus bars, thus relieving the generator, whose voltage will rise again until balance is attained.

If in the case in question it is proposed to extend the electric lighting beyond the capacity of the existing generator, it would be economical to put in instead a battery of the required size working on this method. Satisfaction is almost sure to be secured with moderate care and attention, and many unlooked-for advantages would probably be discovered.—ALPHA.

Answer to No. 514 (*awarded* 5*s.*).—Although, as suggested in the question, a battery of accumulators would greatly mend matters, many engineers, particularly those who have had experience in this direction, would be very chary in recommending such a combination. The expense would be considerable, and unless the plant had very careful supervision the result would be anything but satisfactory. Perhaps the best and cheapest method would be for "L. D. W." to use a shunt-wound dynamo and a series of liquid resistances. These should be sufficiently large to carry the full current, and consist of plain lead plates in a solution of dilute sulphuric acid. Each of these would give a back E.M.F. of two volts. If the normal voltage is 110, and speed varies 10 per cent., six of these couples would be required. The regulating switch if connected across the brushes would then cut the couples out and in as the speed of dynamo, and consequently its E.M.F., varied. Although this arrangement gives a difference of two volts per step in practice it works very well. The dynamo must be driven so that at its lowest speed, with all couples cut out, the E.M.F. is at the normal figure. Then as the volts increase couples will come into action and keep an approximately equal potential at lamps.—M. M.

Answer to No. 514 (*awarded* 5*s.*).—There is no satisfactory rough-and-ready way of obtaining a constant E.M.F. under the conditions named in this question, as it may be assumed that the E.M.F. of the dynamo would vary with its speed while this was anything near the normal rate. By far the best thing to do would be to put in a separate engine to drive the dynamo only, and then first-class results might easily be obtained. Probably the installation consists of arc and incandescent lamps, and if so, a considerable current would be wanted, and the cost of an accumulator would be great when the necessary fittings and the annual charge for maintenance have to be faced; and, further, it must be remembered that a shunt-wound dynamo is all but absolutely necessary for charging accumulators, especially when the speed cannot be maintained constant. If the present dynamo is large enough for the new work in contemplation, it might be retained with all its special advantages belonging to its compound winding, and an accumulator would not be necessary; therefore, the cost of the new engine would be about set off by the saving of the cost of the accumulator. But if, on the other hand, a new dynamo must be had, and it would be desirable to drive it from the main shafting with its variation of 10 per cent. in speed, then I should certainly advise a shunt-wound dynamo with an adjustable resistance and switch inserted in its field coils circuit. This would enable the engine driver to maintain a fairly constant E.M.F., but hardly good enough for office lighting. Personal attention to this adjustment would be necessary, as no satisfactory automatic device has yet been put on the market for maintaining constant E.M.F. on a shunt-wound dynamo with varying speed. The office lamps might be fed from an accumulator, but we must bear in mind that arc lamps and shunt-wound dynamos do not make the best combination—not so good as a compound-wound machine. If water power is available and no steam is used, then a turbine would not cost much, and being used only for the dynamo, it would give most satisfactory results; and as in the case of the independent steam-engine recommended above, no accumulator would be wanted. This would be ideal for cheapness and efficiency.—F. G. A.

Question No. 515.—Two two-phase similar machines in parallel are supplying 50 amperes each phase external load, and they share the load equally on one phase, but one machine takes 28 amperes and the other 22 amperes on the second phase. Why is this?

Best Answer to No. 515 (*awarded* 10*s.*).—It will most likely be found that the windings on these two-phase machines are not quite symmetrical, or else perhaps that the magnetic circuits are not symmetrical, so that the voltage given on the one-phase is not equal to that on the other. "R L." could try if this is the cause by ascertaining the voltage on each winding of each machine on different loads. Another means of ascertaining if this is the reason for the want of balance, would be to alter the excitation of one machine when it is running in parallel with the other, and see if this transfers the out-of-balance current from one phase to the other. It must be remembered that a two-phase alternator is not unlike two single-phase machines coupled on the same shaft, and it does not follow that each of the circuits is symmetrical because they have apparently the same dimensions. If desired, a compensating transformer with only a few turns could be used to prevent the out-of-balance effect complained of.—P. T.

Answer to No. 515 (*awarded* 5*s.*).—This unequal loading points to a slight difference in voltage—probably not more than 1 per cent. of the terminal voltage—existing between these particular phases. Such a difference might be set up in several ways. It may be inherent in the machine due to a turn or two, too few having been put on one of the armature coils by mistake; or it may be due to the short-circuiting or partial short-circuiting of some of the turns. Such defects can be readily discovered by measuring the volts across each coil of the faulty phases when the machines are running on open circuit. Should all these coil voltages be found to be practically alike, it is likely that the fault lies in the connections to the switchboard. If one of the leads from one phase passes through even quite a short length of iron piping on its way to the switchboard, whilst the other lead and both leads of the corresponding phase on the second machine do not pass through any such piping, the magnetic field set up in the piece of pipe might easily give rise to a sufficient inductive drop in voltage to account for the difference in current noticed. The use of iron-armoured cable in one phase and not in the other would also have much the same effect.—Q.

Answer to No. 515 (*awarded* 5*s.*).—A two-phase generator may be regarded as two separate single-phase machines, in which there is a difference of phase between the currents and the voltages of the respective machines, and it does not at all follow that because one phase is synchronised that the other is ready for parallel connection. In the case in point, one phase appears to be in absolute synchronism, but the other is only approximately so. If before the machines are coupled in parallel careful tests are made, it will probably be found that the machines can be arranged so that the load is shared equally between them on each phase.—M.

BOLTON.

The report on depreciation of tramway track given below is taken from the annual report of Mr. E. Ll. Morgan, A.M.I.C.E., the borough engineer of Bolton.

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To the Chairman and Members of the Tramways Committee.

Gentlemen,—As requested by you I have gone into the question of depreciation of tramways. You are doubtless aware that owing to the limited experience of the life of the permanent way under electric traction, it is impossible to gauge with any degree of accuracy what would be the life of the rail as worked in Bolton. A paper was recently published by an engineer of experience in tramways, the following of which is an extract bearing upon the subject of the life of rails under certain conditions: "From the limited experience in this country of the effects of wear, etc., from electric traction it is difficult to determine with any degree of definiteness what may be generally calculated upon as a fair average period for rails to last before requiring renewal. The author has for some years given attention to this matter, and, in his opinion, the rails laid on tramways under electric traction in this country will probably be found to have an average life as under:

Where frequency of car service is five minutes or less and vehicular traffic heavy.	Eight to twelve years on straight lines, with gradients flatter than 1 in 40.
Ditto, ditto.	Six to ten years on straight lines, but gradients steeper than 1 in 40.
Ditto, ditto.	Two to six years on curves less than 22 yards radius.
Where car service is less frequent than five minutes, vehicular traffic light.	Ten to fifteen years on straight lines with gradients flatter than 1 in 40.
Ditto, ditto.	Seven to twelve years on straight lines with gradients steeper than 1 in 40.
Ditto, ditto.	Four to eight years on curves less than 22 yards radius.

"The use of a thoroughly efficient joint will probably add at least 50 per cent., and such additional life may be gained by careful attention to engineering details."

The author of the article before mentioned may be correct in his statements, but I suggest that he, like others, has not the experience to decide authoritatively upon the point, but I am of the opinion that with the present service on the Bolton Corporation tramways it would be fair and reasonable to assume that on the average the life of the track would be 12 years, of course, it being understood that during this period it would be necessary to expend a considerable sum in repairs and maintenance, particularly on the curves and on the town portion of the tramways, as owing to the constant traffic on this portion the life would be materially less in comparison to the outside routes. One fact, however, must not be overlooked—viz., the doubling of the lines—as I am of opinion that in doing this your committee have exercised sound judgment, as it is but fair to assume that generally the life of a double line will be double that of a single line. The average cost of tramways in this country is £6,046. 16s. per mile, made up as follows:

	£	s.	d.
157 tons rails, 94lb. to 98lb. per yard, at £6. 15s. per ton, rails 60ft. long	£1,059	15	0
Fishplates and fishbolts with six holes, 12s. 3d. per pair	107	16	0
Soleplates and bolts, 6s. 6d. per joint	57	4	0
4½ tons of tiebars, at £10 per ton	45	0	0
Bonding per mile	97	0	0
7,040 lineal yards cement parging to rails at 3d.	88	0	0
1,760 lineal yards laying permanent way at 2s. 6d.	220	0	0
1,800 cubic yards excavating at 3s. 6d.	315	0	0
1,000 cubic yards Portland cement concrete 6 to 1 at 20s.	1,000	0	0
1,044 tons granite setts at 32s 6d., 4in. cubes	1,696	10	0
68 tons pitch at 38s.	129	4	0
11 tons creosote oil at 82s.	45	2	0
4,700 super yards cement and sand bed for paving at 9d.	176	5	0
4,700 super yards paving, ramming, etc., at 1s.	235	0	0
4,700 super yards racking and grouting, labour only, at 6d.	117	10	0
1,760 super yards making good outside edge, at 1s.	88	0	0
1,760 yards watching and lighting	132	0	0
1,500 tons carting material to site, at 2s. 6d. per ton	187	10	0
1,000 cubic yards removing surplus soil and materials, at 2s. per cubic yard	100	0	0
Allowance for interference to manholes, service pipes, drains, gas and water mains, per mile	150	0	0
Say £6,050. Total	£6,046	16	0

In the foregoing no allowance is made for contractors' profit, it being assumed that the work is being done by direct labour. Taking the basis of depreciation of track at 8 per cent., you will in the course of 12 years, which is the period decided upon by your committee, have wiped off 63·23 per cent. of your capital expenditure of £6,050, taking the foregoing estimate as your basis, and would reduce the capital amount from £6,050 to £2,224. 7s. 8d. per mile of single track, or a sum equal to 36·77 per cent. of the original cost. Against this you would have the following items on the credit side—viz.:

	£	s.	d.
Old rails, say 130 tons at £2. 5s.	£292	5	0
Old fishplates, etc., eight tons at £2. 5s.	18	0	0
Old copper	30	0	0
Concrete foundations, say	1,000	0	0
Say 700 tons of granite setts at 20s.	700	0	0
Excavating, say	250	0	0
Sand for bedding	150	0	0
Removing surplus soil	100	0	0
Total	£2,540	5	0

A total of £2,540. 5s., or equal to 41·9 per cent. of the original cost of single line of track. Taking the depreciation of track on a variable basis, in accordance with the estimated life of each particular portion as follows:

	£	s.	d.
Rails, fishplates, fishbolts, sole-plates, tiebars, bonding cement, parging, laying permanent way, pitch, creosote oil, paving, ramming, racking, grouting, making good margins, watching and lighting, carting materials, removing surplus soil, allowance for interference, etc. (12 years)	£2,859	1	0
Granite setts, cement and sand bed, etc. (20 years)	1,872	15	0
Concrete foundations (30 years)	1,315	0	0
Total	£6,046	16	0

The depreciation in 12 years would amount to £4,399. 17s., and would leave a balance of £1,646. 19s. due on the original capital; against this would be the credits. Taking the estimated cost of tramways at £6,050 per mile, and depreciating at the rate of 8 per cent. on the gross cost, the unpaid capital at the end of the 12 years would amount to £242; against this the credit would amount to £2,540, and the cost of renewing the track would amount to £3,462. 17s., which, added to the balance of £242, would reduce the capital cost per mile at the relaying to £3,704. 17s., or 61·23 per cent. of the original cost of £6,050. From experience it may be found that under the conditions upon which the Bolton tramways are worked the life of rails may extend beyond 12 years, and may possibly reach 15 years, particularly on the straight tracks, where the gradients are not exceptional; this, of course, would be an advantage to the undertaking. Assuming, however, that at the end of 12 years it would become necessary to relay the whole of the lines, my estimate of the cost of doing this would be £3,500 per mile, made up as follows:

	£	s.	d.
1,760 yards taking up old rails, paving, preparing foundations, etc., at 2s. 6d.	£220	0	0
157 tons new rails at £6. 15s. per ton	1,059	15	0
Fishplates and bolts	107	16	0
Soleplates and bolts	57	0	0
Tiebars	45	0	0
Bonding	97	0	0
7,040 lineal yards cement parging at 3d.	88	0	0
1,760 lineal yards laying permanent way at 2s. 6d.	220	0	0
125 cubic yards cement concrete at 20s.	125	0	0
344 tons new granite setts at 32s. 6d.	509	0	0
Pitch and oil	174	6	0
700 tons cleaning setts at 2s. 6d.	87	10	0
4,700 yards paving, ramming, racking, grouting etc, at 1s. 6d.	352	10	0
1,760 yards making good to outside margins, at 1s.	88	0	0
1,760 yards watching and lighting	132	0	0
1,000 tons carting material to site, at 2s.	100	0	0
Say, £3,500. Total	£3,462	17	0

These figures, however, would only apply to girder rails, as I am of opinion that when it becomes necessary to remove the Demerbe rail the cost of taking up, etc., would be considerably more than given in the foregoing estimate. You will note that I have allowed for one quarter the quantity of setts being renewed when the track is relaid. This item may, however, be considerably reduced, as I am of opinion that the life of the setts is at least 20 years. The allowance has, however, been made so as to admit of breakages, and the extra wear along the rails consequent upon the vehicular traffic. On comparing the cost of the renewed line of tramways with the original cost, it will be found that the amount of original capital would be reduced from £6,050 to £3,500 per mile of track, or 42·14 per cent.—I am, gentlemen, your obedient servant,

E. Ll. Morgan, borough engineer and surveyor.

Town Hall, Bolton, April 25, 1902.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Swindon.—The Corporation require tenders for wiring of consumers' premises by Oct. 7.

Wigan.—The Corporation invite tenders for 18 bogie cars, double-deck, four-motor equipment. Tenders by Oct. 20. See advertisement

Manchester.—The Tramways Committee invite tenders for the supply of steel tramway poles. Tenders by Oct. 4. See advertisement.

Bury.—The Tramways Committee of the Corporation invite tenders for rails bonds and compressors. Tenders by Oct. 14. See advertisement.

Belfast.—The Gas and Electric Committee invite tenders for the supply of electric motors for a period of 12 months. Tenders by Oct. 10. See advertisement.

Great Western Railway.—The Directors invite tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1903. Tenders by Oct. 20. See advertisement.

Paris.—The Post and Telegraph Department, Rue Grenelle 103, require tenders for 800,000 kilos copper wire and 100,000 copper joints in 17 lots. Tenders by Oct. 9 at 11 a.m.

Tientsin (China).—Mr. A. W. Harvey Pellingham, secretary of the British Colony at Tientsin, China, invite tenders for installation and working of electricity works. Tenders by Nov. 30.

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Wigan.—The Corporation invite tenders for the electrical equipment of a short length of new tramway and of a portion of their existing tramways. Tenders by Oct. 20. See advertisement.

Huescar (Spain).—The Municipality invite tenders for the installation and working for 20 years of the electric lighting of the town. Tenders to the Municipality, Province of Granada, by Oct. 6.

Cambridge.—The Saxon Portland Cement Company, Limited, require tenders for the supply of calcium carbide in weekly quantities of 8cwt. for a period of six months commencing Oct. 31, 1902.

Ipswich.—The Corporation invite tenders for main switchboard, motor boosters, connections in generating station, and overhead construction for tramways. Tenders by Oct. 22. See advertisement.

Batley.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Batley, Yorks, of 240 accumulator cells and accessories. Tenders by Oct. 10. See advertisement.

Wigan.—The Corporation invite tenders for the construction of a short length of new tramway and for the reconstruction of a portion of their existing tramways. Tenders by Oct. 20. See advertisement.

Paris.—The Municipal Wood Paving Factory at Javel requires five electric motors of 7 h.p. to 30 h.p. Particulars may be obtained at that factory. Tenders will be opened at the Town Hall, Paris, at 2.30 p.m., on Oct. 22.

Rotherham.—The Corporation invite tenders for steam pipes and valves, feed pipes and valves, feed pump and economiser, exhaust, water, and drain pipes and valves, and extension switchboard. Tenders by Oct. 16. See advertisement.

Bootle.—The Corporation invite tenders for the wiring of the refuse destructor in Pine-grove for the purposes of electric lighting. Specification, etc., may be obtained at the Borough Electricity Works, Pine-grove. Tenders by 10 a.m. on 14th inst.

Brussels.—The Belgian Government Railways will let by tender the installation of electric lighting at the stations Brussels East and Marchienne au Pont in nine lots. Specification No. 866 may be obtained from the above. Tenders by Oct. 8 at 1 p.m.

Brussels.—The Government Telegraph Department require 109,000 kilos galvanised iron telegraph wire, 300,800 metres telegraph cable, further copper wire insulators, etc., in 18 lots. Specification No. 153 may be obtained from the above. Tenders by Oct. 8 at 11 a.m.

Maidenhead.—The Corporation invite tenders for a complete installation for electric light at the Guildhall. Specifications, etc., may be obtained on application to Mr. C. O. Milton, resident electrical engineer, Guildhall, Maidenhead. Tenders by 4 p.m. on Oct. 6.

Tunbridge Wells.—The Town Council invite tenders for the construction of main flues at their central electric light station, Tunbridge Wells. Specification, etc., can be obtained on application to the Borough Surveyor, Town Hall, Tunbridge Wells. Tenders by Oct. 18.

Barrow-in-Furness.—The Corporation invite tenders for two batteries of accumulators and two automatic reversible boosters, switchboards, etc. Specifications, etc., can be obtained from Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness. Tenders by Oct. 15.

Paris.—The French Government have decided to invite tenders for the supplying and laying of the following cables: (1) from Brest to Dakar; (2) from Tamatave to Reunion and from Réunion to Mauritius; (3) from Saigon to Pontianak, at Borneo. Tenders must be sent in by Oct. 21 next.

West Ham.—The Corporation invite tenders for the supply of 46 combined arc lighting and traction poles with side brackets. Specification and further particulars may be obtained from the borough electrical engineer, Mr. James K. Bock, Abbey Mills, West Ham. Tenders by 4 p.m. on Oct. 4.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of two electric car traversers at certain of the Council's depôts in the south of London. Specification, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 21.

Wakefield.—The Guardians invite tenders for the electric lighting of old workhouse buildings, including supply and erection of steam dynamo, pipe work, switchboards, and wiring. Specifications and particulars may be obtained from Mr. H. Beaumont, clerk, Union Offices, Tetley House, Wakefield. Tenders by 18th inst.

Gefle (Sweden).—The City Architect requires tenders for supply and erection of electrical machinery, accumulators, etc. Drawings, specifications, etc., may be obtained from the Gefle stads byggnadskonter against payment of 25 kroner, which will be refunded. Tenders by Oct. 15, addressed Anbud a elektriskt maskineri, Drätselkammare Stads, Gefle, Sweden.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for Lancashire boilers, economisers, surface condenser, and pumps, etc., steam, feed, blow-off, and drain pipes, etc., and travelling crane. Specifications, etc., can be obtained from Mr. F. Schofield, clerk to the Board, Town Hall, Stalybridge. Tenders by Oct. 13.

Shanghai.—Messrs. Preece and Cardew are authorised to receive tenders for the supply and delivery c.i.f. of two 500-kw. steam alternators (the engines to be enclosed double-acting type and alternators to have stationary armatures, pressure 2,100 volts, periodicity 100), switchboards, and two condensers and circulating water pumps. Tenders by Oct. 30. See advertisement.

Ilford.—The Urban District Council invite tenders for the supply and erection of dry-back, semi-marine type boiler (15,000lb evaporation per hour), superheater and accessories, and motor feed pump; steam, feed, and blow-off pipes, and feed filter; surface condenser, cooling tower, motor pumps, hot-well, grease extractor, exhaust, steam, and water pipes. Tenders by Oct. 6. See advertisement

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Swindon, Wilts, of all the materials, fittings, and accessories for a complete installation of the electric light and wiring to the motors on the works, and also for the supply and delivery at the electricity works of testing instruments and engine-room accessories. Tenders by Oct. 4. See advertisement.

Newcastle-on-Tyne.—The Directors of the North-Eastern Railway Company invite tenders for the complete electrification of about 37 miles of standard-gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment. Tenders by Oct. 7. See advertisement.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

London, N.—The Light Railways Committee of the Middlesex County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction bridge work, etc.), of the following light railways—viz.: (Contract No. 1) railway No. 1—a line of double track (with cross-overs, contingent works, etc.) to be laid along Lordship-lane and Bruce-grove, in the districts of Wood Green and Tottenham, in the county of Middlesex, having a length of 1 mile 7 furlongs 6·8 chains or thereabouts; (No. 3) railway No 3—a line of double track (with cross-overs, contingent works, etc.) to be laid along the Archway and Great North roads, from Highgate Archway to Whetstone, in the districts of Hornsey and Finchley, in the county of Middlesex, having a length of 4 miles 6 furlongs 1·5 chains or thereabouts; (No. 5) railway No. 5—a line of double track (with cross-overs, contingent works, etc.) to be laid along the Edgware-road, from Cricklewood to Edgware, Hendon, Kingsbury, and Hendon Rural, in the county of Middlesex, having a length of 4 miles 6 furlongs 8 chains or thereabouts. Specification, etc., for each contract may be seen and schedule of quantities obtained on application at the office of Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster, S.W Tenders by Oct. 7.

RESULTS OF TENDERS.

Worksop.—The Urban District Council have accepted the tender of Glover and Co., in connection with the electric cables, at £1,189.

Colchester.—The Town Council have accepted the tender o Williams and Co. for tools, and of Davey, Paxman, and Co. for steam-pipes.

Nottingham.—The School Board have accepted the tender of Mr. F. Skerrit, at £103, for the electric lighting of St. Ann's Well-road School.

Andover.—The Board of Guardians have accepted the tender of Mr. Spry for replacing the electric bell wires between the infirmaries at £2. 13s. 6d.

Devon.—The County Council have accepted the tender of the Northern Electric Company, Grimsby, at £1,066, for improving the electric light installation at the County Lunatic Asylum.

Hampstead.—The Borough Council have accepted the tender of Rowland Carr and Co., of 6 and 8, Lime-street-square, London, E.C., for the supply and delivery of 28 arc lamp columns and brackets.

Colchester.—The Churchwardens of St. Botolph's Church have accepted the tender of J. A. Kunce, 10, Williams-walk, Colchester, at £139. 10s., for a complete installation of electric light at the church.

Barking Town.—The Council have accepted the following tender for construction of tramways in their district: W. Griffiths and Co., Hamilton House, London, E.C. (Section 1), £1,221. 6s.; (2), £6,100. 7s. 9d.—total, £7,321. 13s. 9d.

Newcastle.—The City Council have accepted the tender of the Lorain Steel Company for crossovers and junctions in connection with the extension at Walker, at £3,631. The tender was more favourable than any of the English tenders, and was the lowest.

Southampton.—The Corporation have received the following tenders for the construction of tramways in Onslow-road, Bevoir-valley, and Portswood-road, having a total length of about 2,053 yards of single track:

M. A. Shepstone and Co., London	£3,317 11 11
P. Smith, London	3,040 14 0
W. L. Meredith and Co., Gloucester	2,821 12 9
F. Grace, Southampton	2,571 0 0
Douglas and Richards, Southampton	2,360 0 0
F. Osman, Southampton	2,298 0 0
Coston and Co., Limited, Southampton (accepted)	2,283 0 0

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Stockton.—The Town Council have accepted the tender of the Triumph Stoker Company, London, for five mechanical stokers, at £620, and the tender of Mr. A. J. Cooke, for the foundations of the two engines, etc., at £669. 10s., in connection with the extensions of the electric light works plant.

Harrogate.—The Corporation have received the following tenders for the supply and delivery of material necessary for the laying of about 6,000 yards of light railway (single line), for steam or electric traction, 24in. gauge, including rails, patent rail supports, chairs or sleepers, also keys or other fasteners, together with the necessary points and crossings for sidings, etc., also turntables, for the Masham water scheme :

Askham Bros. and Wilson, Limited, Sheffield	£1,536	18	6
Orestein and Koppel, London	1,284	11	8
A. Penney and Co., London	1,397	13	4
Dick, Kerr, and Co., Limited, London	1,394	10	0
R. Hudson, Leeds	1,802	5	0
A. Koppel, London (accepted)	1,227	18	4
W. G. Bagnall, Limited, Stafford	1,357	16	8
T. Summerson and Sons, Limited, Darlington	1,271	12	6
J. Fowler and Co., Limited, Leeds	1,590	10	0
Heenan and Froude, Birmingham	1,481	0	0
R. White and Sons, Widnes, Lancs.	1,302	14	2
E. Le Bas and Co., London	1,287	13	1
W. Bain and Co., London	1,223	10	0
Kerr, Stuart, and Co., Limited, London	1,490	16	4
A. von Glehn and Co., London	1,606	2	6
C. F. E. Swindon and Co., London	1,086	16	1
W. H. White and Co. (Decker and Co.), London	1,070	0	0

BUSINESS NOTES.

TRACTION.

Liverpool.—On Wednesday the Town Council instructed the Tramways Committee to apply for a provisional order authorising the construction of a tramway between Lodge-lane and Aigburth-road.

Accrington.—Regarding the proposed joint purchase of the tramways by the Accrington, Haslingden, and Rawtenstall Corporations, it is understood that a further stage has been reached in the negotiations.

Steyning West.—On Wednesday the Rural District Council approved the agreement with the tramway company with reference to the electric tramway so far as it concerns Kingston-by-Sea and Lancing.

London County Council Tramways.—The London County Council on Wednesday officially took over another portion of the tramway system in South London—namely, the Wandsworth-Battersea roads.

Halifax.—On Wednesday the Town Council decided to authorise the Tramway and Electricity Committee to lay a line of tramway from Stump Cross to Hipperholme, at an estimated cost of £6,498, and another line to West Vale.

Twickenham.—A memorial has been received by the District Council from frontagers in Heath-road, protesting against the laying of a double line of rails in the vicinity of the bridge. The matter has been referred to committee.

Wigan.—The Tramways Committee have decided that a double line of tramway be laid along Standishgate from Crompton-street to the Old Market-place, and that the proposed tramway along Mesnes-street and New Market-street be abandoned.

Harrogate.—The feeling against the introduction of tramways in Harrogate is growing—that is, so far as the town itself is concerned. On the other hand, it is stated that the new portion of the borough—Starbeck—is strongly in favour of the innovation.

New York.—A syndicate has been formed in New York, with a capital of £1,000,000, for the purpose of constructing an electric railway in Cuba, which will run from Havana across the island. It is expected that the line will be in operation within 16 months.

Llanelly.—The British Insulated Wire Company have now definitely made arrangements with another firm to take over the work of introducing electric traction into the town. It is promised that the scheme will be completed before the National Eisteddfod of 1903 at Llanelly.

District Railway.—The directors of the District Railway announce a further substantial reduction in fares between the City and those districts in the West-end which suffer most from the severe competition of the London United Tramways combined with that of the Central London Railway.

Birkenhead.—A statement presented to the Town Council on Wednesday showed that on seven months' working of the tramway system the sum of £3,514 had been transferred to renewals account for depreciation, as being the net surplus after paying interest and sinking fund charges.

Exeter.—The City Council are proposing to lay about eight miles of single-track tramways, and a special meeting was held last week to consider a report of the Electric Traction Committee on the routes to be followed. These were approved. The cost of construction is estimated at £6,500 a mile.

Geneva.—The strike of tramway employés at this place continues. The directors have asked the workmen to return to their posts, but without eliciting any favourable response. Twenty-five tramcars were sent out from the depôt on Monday, leaving 55 idle. Each car continues to be protected by gendarmes.

Liverpool Overhead Railway.—An accelerated service of trains was inaugurated on the Overhead Railway on Wednesday. Henceforward the journey from Dingle to Seaforth will be accomplished in 20 minutes, as compared with the old time of 32 minutes. The speed now attained averages 19 miles an hour, including stops.

Rotherham.—At this week's meeting of the Town Council it was moved: "That bending, tensile, and chemical tests be made from time to time by the Sheffield Testing Works or Messrs. David Kirkcaldy and Son, London, on behalf of this Corporation, of the tramrails and fishplates now being delivered." The proposition was carried.

Sheffield.—The tramway receipts for the week ended Sept. 28 amounted to £4,233. 2s. 8½d., bringing the income for the quarter to £55,900. 12s. 10½d. This total shows a great increase on previous quarters, being £3,000 more than the previous quarter of this year, and nearly £6,700 more than the corresponding quarter of last year.

Swansea.—The Sub-Tramways Committee at their last meeting were engaged in considering several surface-contact systems of electric traction for the new extension lines. An illustrative model installation of the Dolter system was laid in the Council-chamber, and representatives of other systems, including the Kingsland, were also present.

Bradford.—The conductors and drivers of the tramways in the employ of the Corporation are being asked by ballot whether or not they are satisfied with the concessions made by the Tramways Committee in connection with the grievances to which attention has been called. To prevent accidents the tramways are to be worked on the block system during the winter fogs.

Stourbridge.—Owing to the restrictions the Council have imposed on the traffic through High-street, the tramways company have refused to run through cars between Stourbridge and Kingswinford. An application of the company to lay a double line of rails in the centre of the road in Lower High-street, Stourbridge, in place of the single line has been granted.

Antwerp.—A Brussels dispatch states that an important English syndicate has applied for a concession for the construction of an electric railway from Brussels to Antwerp in competition with a Belgian syndicate. It is understood that the conditions offered by the English syndicate are more favourable, and that they are likely to be accepted by the Belgian Government.

Airdrie.—Engineers are now engaged on behalf of the British Electric Traction Company taking accurate measurements of the streets in Coatbridge and Airdrie with a view to starting operations in connection with the laying of tramways in these burghs It is intended to commence work at about Christmas in both towns, and the tramways will be open for traffic in about four months thereafter.

Leigh.—Yesterday week the Board of Trade inspectors inspected over 16 miles of new track, constructed by the South Lancashire Electric Tramways Company, in the Leigh and Tyldesley district. Twenty miles in all are completed, and when the present plans are carried out the company will own 105 miles of tramways connecting many of the principle centres of population in South Lancashire.

Torquay.—The routes of the proposed electric tramways have now been decided upon, and it is proposed that when the expenditure on the first section constructed shall amount to £50,000 for tracks and equipment, but not including power station, no further outlay shall be made in respect of the other sections scheduled in the Bill until the outlay on the £50,000 shall have been ascertained to be remunerative.

Nottingham.—Major Pringle on Friday made an official inspection of the latest addition to the electric tramway system—the route running from the Walter Fountain along Lenton-boulevard to the Ilkeston-road. The inspection of the works, which have been in progress for many months, is reported to have been entirely satisfactory, and it is anticipated traffic on the new section will be opened in a few days.

St. Helens.—An application has been made on behalf of the St. Helens Tramways Company for the sanction of the Corporation to the principle of through passenger traffic between the St. Helens system and that of the South Lancashire Tramways Company. This would involve the granting of running powers to the South Lancashire Company over the lines of the St. Helens Corporation. The matter is being considered by a sub-committee.

Newcastle.—The members of the Tramways Committee on Friday made a survey of the new tramlines which are being laid from Raby-street to the extent of the borough boundary. The line, which is about to be finished, and expected to be opened next month, is upwards of a mile in length, and double track. In the course of next week a commencement will be made with the tramline proposed to be laid from the borough boundary, extending past the car-sheds, into Walker.

Sheffield.—Arrangements have been completed between the Tramways Committee and the Post Office authorities, by which additional postal facilities will be afforded by means of tramcars running at stated times in the evening from various termini to the centre of the city. Red metal boxes for the receipt of letters are now at the tramway office in Mulberry-street. These are to be attached to certain cars each night, and the experiment will be watched with a good deal of interest.

Keighley.—The question of the proposed electric tramway from Shipley to Keighley was again discussed at the last Town Council meeting. The Council resolved that if Mr. Quin, the engineer and part promoter of the scheme, would undertake to construct the tramway from Shipley to the Stockbridge boundary, they would apply for Parliamentary powers to continue the tramway to the top of Cavendish-street, and so connect with the existing tramways in the town.

Belfast.—The suggestion has been made that, in view of the fact that the negotiations for the purchase by the Corporation of the tramway company's undertaking have fallen through, the company's lease should be extended, and a special meeting of the Trades Council

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was held on Saturday to consider the question. A resolution was passed pledging the Trades Council to do their utmost to prevent any renewal or extension of the lease being entered into by the Corporation.

Leeds.—A proposal was brought forward at the meeting of the Town Council on Wednesday to include in their next application for powers to lay tramways, an extension of the present line at Kirkstall Abbey to the city boundary, thus giving an almost direct communication with Horsforth. The extension was agreed to. Last week the receipts on the city tramways amounted to £5,267. 15s. 4d., compared with £4,535. 11s. 4d. in the corresponding week of last year, an increase of £732. 3s.

Hamilton.—A public meeting has been held to consider the obstruction to the thoroughfare by the erection of poles in the centre of the streets in connection with the electric tramways now in course of construction. The requisitionists expressed a belief that the poles would be the cause of serious accidents, and would make the driving of vehicles dangerous. A resolution was passed protesting against centre poles being erected, and calling upon the Town Council to do their utmost to have them withdrawn.

Manchester.—The Tramways Committee have decided to ask the Parliamentary Sub-Committee, amongst other matters, to include in the General Powers Bill of next session a proposal to amend the Manchester Corporation Tramways Acts, so as to provide that the powers of Section 22 as to laying down double or interlacing lines in place of single lines and *vice versa*, and as to altering the positions of tramways and other matters, shall extend to tramways outside the city which are or shall be leased to the Corporation.

Aberdeen.—The Tramways Committee are seeking an interview with the Harbour Board before recommending the council with regard to the proposed Torry tramway extension. The Committee have presented a report to the Town Council on the new cars built by the British Electric Car Company for the Aberdeen system, in which they express dissatisfaction at the construction of the new vehicles. The departures from the specification, however, are not such as in their opinion would warrant the rejection of the cars.

Huddersfield.—The Linthwaite Ratepayers' Association at their last meeting discussed the tram fares question. The following resolution was unanimously adopted: "That this association regrets the action taken by the Huddersfield Corporation in threatening to raise the fares to certain stages on the Linthwaite section, and respectfully suggests that the Tramways Committee reconsider the unanimous resolution of the Linthwaite Council requesting the Corporation to allow the fares and stages to remain as at present"

Dundee.—The drawings from the Corporation tramways for the week ended the 24th ult. amounted to £803. 1s. 1d., being an increase of £109. 2s. 6d. compared with the same period of last year. As regards passengers. the number carried last week was 207,174, or 28,637 more than in the same period of 1901. The new tramway along Constitution-road was tested on Monday. The route is over a very steep gradient, but the test was very successful, and it is believed that the route will be open for traffic in a few weeks.

Leighton Buzzard.—An enquiry was held last week by the Light Railway Commissioners into the proposed construction of a light railway of 19 miles to connect the London and North-Western Railway line at Leighton Buzzard with the Midland at Harlington and the Great Northern at Hitchin. The project is being successfully promoted, and a realisation of the scheme is fully anticipated, there being no opposition on the part of local authorities, landowners, or general public. The Commissioners were the Earl of Jersey and Colonel Boughey.

Gloucester.—At the last Town Council meeting the agreement between the City of Gloucester Tramways Company and the Council, providing for the sale of the Company's undertaking to the Corporation for £26,000 was confirmed. Application will now be made to the Board of Trade for their approval, and for a loan to cover the cost of the purchase. A memorial from 13 parishes, situated on the other side of Westgate Bridge, opposing a light railway from Priory-road to Westgate Bridge, was received and handed over to the Tramways Committee for consideration.

Leicester.—Now that powers have been conferred on the Corporation to carry out an electric tramway scheme the Tramways Committee are anxious that the work shall be commenced without delay, in order that the town may be provided at the earliest possible time with the much-needed improved tramway service. They accordingly recommend that all works of main and pipe laying which will be required to be done on the tramway routes shall be commenced immediately in order that any such works may not be the means of delaying the tramway works.

Additional Traffic Returns.—Anglo-Argentine, £94 decrease; Barcelona Ensanche y Gracia, £86 increase; Barcelona, £1,202 increase; Brisbane, £850 increase (month of August, £11,442, increase £2,942); Buenos Ayres and Belgrano Electric, £20 increase; Calcutta, £498 increase; Cape Town (month of August), receipts £15,450, expenditure £7,801; Isle of Thanet Electric, £123 increase: Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £188 increase; Port Elizabeth (month of August), receipts £4,014, expenditure £1,979.

Lancaster.—The Lancaster and District Tramways Company have reopened the negotiations with the Corporation with regard to the purchase of their undertaking, the Corporation having informed the company that they are willing to consider any further offer from them for the sale of their property. It was stated at the last meeting of the Town Council that the track of the municipal system was practically ready, but that there was no power to drive the cars, the generating station not yet being ready for work. It was hoped, however, that the running of the cars would not be delayed much longer.

Appointments.—Mr. John Kerrigan, who has been manager of the tramways at Dewsbury, Batley, and Birstal since the British Electric Traction Company took over the undertaking, has been appointed manager of the tramway system at Peterborough, and his successor in the Dewsbury district is Mr. Lionel Johnston, who has been in the service of the British Traction Company at Gateshead and Middleton, in Lancashire. Mr. Johnston will have control of the new lines which have been laid between Dewsbury and the Spen Valley, as well as the Bradford-road system. The new electric tramway is expected to be opened in a few weeks' time.

Cardiff.—At a meeting of the Tramways Committee on Friday complaints were made with reference to the noise caused by the running of the electric cars. Mr. Ellis, the electrical engineer, explained that the noise was due to the gear being a bit soft, but that would soon wear off. Everything possible was being done to remove the cause of the complaint. He added that there was something wrong with the gear of the last few cars delivered. The *London Gazette* of Friday contained a notification of an application by the Corporation to the Board of Trade for confirmation of the by-laws as to tramways made by the Council on Sept. 9.

Warrington.—Arrangements, it is stated, have been entered into by the Corporation of Warrington and the South Lancashire Tramways Company whereby their respective lines will be joined together on the boundaries of Warrington and Winwick. The Corporation are just completing their portion of the work, and on the tramways company completing theirs it will be possible for the general public to travel along the roads from Warrington to Bedford Leigh, St Helens, Prescot, Liverpool, and *vice versa*. Eventually it is intended that there shall be a continuous tramway route between Liverpool, St. Helens, Wigan, Warrington, Bolton, and Manchester.

South Shields.—Mr. J. H. Cawthra, borough electrical engineer, has submitted a report to his committee on the various systems of electric traction for tramways under construction or in operation in this country at the present time The South Shields Corporation have not yet decided which system they will adopt. The Parliamentary Committee recommend that the town clerk be instructed to include in the draft Bill, to be presented in the next session, a clause similar to the one inserted in the Bill of last year enabling the Corporation to work and take tolls and charges in respect of the tramways, and also a clause debiting the tramways undertaking with a sum of £20,000, being one-third of the estimated cost of the widening of Fowler-street.

Brighton.—Two electric cars came into collision on Monday, owing, it is said, to the failure of the brakes on one of them. The impact was so severe that the front of one car was greatly damaged, and it had to be shunted on to the Union-road line and subsequently removed to the depôt for repairs, but although there were passengers in both cars no personal injuries were sustained. This is the first accident of the kind that has occurred on the Brighton system, the brake equipment of which is considered as perfect as it is possible to make it. A model installation of the Dolter contact surface system will be shown to the Tramways Committee of Brighton and Hove to-morrow. The following week it will be exhibited at the electrical exhibition at Brighton.

Guiseley.—An alternative scheme to that noted last week is proposed by Messrs. Dick, Kerr, and Co. for the construction of a tramway to run through the centre of Horsforth. Instead of passing along the main road from the Leeds boundary at Kirkstall, it is proposed to take the line along Hawksworth Wood-road, through Woodside, up Broadgate-lane, across Town-street, Horsforth, up Lee-lane, and along a private road into Brownberries-lane, thence forward through Rawdon to the bottom of Over-lane, there joining the main highway again, and running along it right to Guiseley. Messrs. Le Maitre and Parker's scheme, it will be remembered, was confined exclusively to the main road, with branch lines at Horsforth and Yeadon, where the demand made it necessary for such to be constructed.

Halifax.—A reply has been formulated to a memorial from the tramway employés, presented through the Trades and Labour Council, asking for the redress of certain alleged grievances. Regarding the question of wages and hours the committee state that a few months ago a new scale of pay was adopted, which places the men on a much better footing than obtained in most of the neighbouring towns using electric tramcars. Whenever it is possible the manager arranges for the men to be employed for nine hours per day, but it is not always possible. The suggestion which has been made by the men that they should be paid time and a quarter for each hour above the nine hours is not one that the committee can agree to. The committee conclude by expressing the unanimous opinion that the men have no real cause of complaint.

Kendal.—A joint committee of the Town Council has had before it an offer from the Electric Haulage Company, who are prepared to supply on approval one of their latest electric omnibuses for two dozen passengers, and to fit up at their own expense a mile or two of overhead line, to be connected with the Corporation electric feeders. They agree to run the 'bus for a period—say, six months—on the understanding that the Corporation will take over the car and line, if satisfied with the working results, at a charge of £1,800 per mile and £600 per car delivered, or, failing a satisfactory issue, they will remove both at their own cost. The joint committee considered that the information to hand was not sufficient upon which to definitely advise the Council, and they appointed a sub-committee to enquire further into the question.

Salford.—To-day a new section of the electric tramways will be opened for traffic—*i.e.*, that running from Frederick-street to Patricroft Bridge. An electric car accident occurred on the Corporation tramway system yesterday week. A car was proceeding along Bolton-road in the direction of Irlams-o'-th'-Height, when it collided with a lurry laden with cloth, which was travelling in the direction of Man-

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chester. The front of the car was smashed, whilst a portion of the rail along the staircase was carried away. The Town Council on Wednesday empowered the Tramways Committee to carry into effect the provisions of Part 6 of the Salford Corporation Act, 1902, which provides for an interchange of through traffic with Manchester so far as is reasonable upon such terms as should be agreed upon, or, failing agreement, as should be settled by the Board of Trade.

Shipley.—The dispute between the Bradford Corporation and the Shipley District Council as to the conditions on which the Corporation should take over the running of the tramways in the area of the District Council was submitted to arbitration on Monday before Mr. A. B. Baker, manager of the West Ham tramways, the arbitrator appointed by the Board of Trade. The District Council claim a return of 6½ per cent. on £27,614, the cost of the tramway. The Corporation, on the other hand, claim for a 30 years' lease of the line; for the payment of a more reasonable interest on capital expenditure; that they should not be required to pay instalments on sinking fund; and that the charge for electricity be fixed at the net cost price at which it could be produced. An allowance of £100 per mile per annum to the Shipley Council for maintenance of the line has been agreed to.

London to Brighton Railway Schemes.—At present there are three electric railway schemes from London to Brighton contemplated. One is being promoted by the syndicate which was at the back of the electric railway undertaking of which a good deal was heard a year ago. From this syndicate Mr. F. H. Cheesewright, the engineer-in-chief, has separated. Mr. Cheesewright has now a new scheme, the important distinction with regard to which is that the terminus, instead of being in Lupus-street, will be at Waterloo. By this arrangement a saving of nearly a million sterling is expected to be effected and the total length of the line reduced to 46½ miles. It is contemplated to run the journey in 40 minutes. The third scheme is being promoted by Mr. Behr, who intends, it is believed, to apply to Parliament for powers to construct a line on the system associated with his name, and it is understood that the Brighton Railway Company will give him their moral support.

St. Marylebone.—The Parliamentary Committee recommended the Borough Council at yesterday's meeting to inform the London County Council that they are strongly of opinion that surface tramways should not be constructed from Marble Arch to Cricklewood, for the following reasons: (*a*) that powers have already been obtained for the construction of more than one tube railway to meet the needs of the locality referred to; (*b*) that the frequent congestion of the traffic in Edgware-road and Tottenham Court-road would prevent the successful introduction of surface tramways in them; (*c*) that the suggested financial arrangements by which it is proposed that only one-third of the cost of the necessary widenings should be charged to the trams account is unsound from a business and economical point of view; and that having regard to these objections the Borough Council will resist the proposal in the interests of the ratepayers, and will appeal to the adjoining borough councils to co-operate with them in such resistance.

Eccles.—The Parliamentary Special Committee of the Corporation have recommended the Finance Committee to pay the Salford Corporation £20,000 on account of the expenses already incurred in the reconstruction of the tramways in Eccles for electrical traction. The tramways from Eccles Cross to Peel Green are to be opened for traffic to-day. The borough surveyor has submitted plans received from the Salford tramways manager showing his proposals with regard to the construction of tramways in Wellington-road, Eccles, and Monton-road, on the circular route, by way of Parrin-lane, Worsley-road, Winton, to Patricroft and Eccles. The Parliamentary Committee cannot see their way to accept the alterations, and the Salford tramways manager has been informed that the Salford Corporation must accept all responsibility for alterations during the progress of the work when such alterations involve a departure from the terms of the agreement between the two Corporations, unless they are first sanctioned in writing by the Eccles Committee.

Ayr.—The Corporation electric tramways have just completed a year's running. A specially satisfactory feature has been the entire immunity from serious accident, while it may also be said that the financial result has been much more favourable than was anticipated by even the most sanguine of the promoters. During the year the cars have run 289,099½ miles, carried 2,979,317 passengers, and earned £12,273. 14s. 9d., being an average of £236 per week, or at the rate of 10½d. per car mile. The highest sum drawn in one week was £874, being the sum earned during the Glasgow Fair week, when the rate per car mile reached the high figure of 2s. 3d. The power for the tramways is supplied by the electricity department of the Corporation at the price of 1½d. per unit up to 200,000 units and 1d. per unit thereafter. The amount of current used was 270,874 units, and the cost was £1,545. 6s. 2d. The accounts for the year have not yet been made up, but it is roughly estimated that after meeting all charges, including depreciation and sinking fund, there will be a profit of about £2,000.

Hammersmith.—The Borough Council have decided to consent to the construction of the proposed tramways by the London County Council from the Hammersmith Town Hall to Harlesden, and to contribute one-third of the cost, estimated at £26,500, of the street widenings in connection therewith; and that in the event of the tramway being constructed from Shepherd's Bush-road to Marble Arch the Council will be prepared to contribute one-third of the cost, estimated at £2,500, of widening the north-east corner of Richmond-road, which will be of advantage to the general traffic. The Council have received an intimation from the London United Tramways Company that they intend to revive their application to Parliament in the next session for power to construct the following lines: (1) the Hammersmith Bridge, and the Bridge-road, Hammersmith; (2) from Hammersmith-broadway, Brook Green-road, Shepherd's Bush-road, The Lawn, Wood-lane, and Scrubbs-lane to Harrow-road; (3) Netherwood-road, Richmond-road, Uxbridge-road, Norland-road, Latimer-road, to Bramley-road.

Oldham.—At Wednesday's meeting of the Town Council, the chairman of the Tramways Committee sought to allay fears which, he said, were entertained in the town that the tramway undertaking promised to be a financial failure. He never had the slightest doubt that the electric trams would eventually be a financial advantage to the borough exchequer, besides being a very great convenience to the ratepayers, and that the Council took the right step in promoting the undertaking in order to keep monopolies out of the borough. He had examined the returns for last week—that being a normal week—and had found that the number of passengers carried was 196,754. They were running more cars, carrying more passengers, and, with the developments at the electricity station, they were practically reducing the amount they were paying per car for energy. Whereas the energy formerly cost £7 per week per car, it was now under £6. He hoped that at the end of the financial year he would be able to say they had wiped off their debit balances and had prospects of making a good profit.

Stretford.—We understand that there is considerable difficulty in the way of the tramway conversion at Stretford. Although in the adjacent area of Moss Side and in the city district of Hulme the lines are already laid and the overhead equipment partially erected, there is yet no sign of activity across the boundary of Stretford. From Lucy-street corner to the Old Cock Hotel, in the village of Stretford, the lines have to be converted for electrical traction by the Urban District Council. Two years ago the lease of the Manchester Carriage Company with the Council expired, and since that time, owing to the newly-made lease not being taken up by the City Council, the carriage company allege a loss of interest. This is argued to be 5 per cent., and the Manchester Carriage Company lay a claim to the sum of 5 per cent. per annum on the amount of the arbitration settlement, whether that be on the higher or lower scale. Stretford is opposed to the payment of this percentage, and so the difficulty increases. The result of the trouble is the delay in the beginning of the work. Stretford ratepayers in Old Trafford and the village anxiously await the coming of the electric trams.

Devonport.—An accident on the electric tramways on Saturday was responsible for the death of one person and injury to eight others. About nine o'clock in the morning a car containing eight passengers got beyond the control of the driver on the incline leading to the South-Western Railway Station. The brakes were promptly applied, but failed to check the progress of the car. At the foot of the slope, where the line takes a sharp curve into one of the main roads to Devonport, the vehicle jumped the rails, crossed the road, and dashed into a wall enclosing the carriage entrance to the station. The force of the impact broke the wall, and caused the car itself partly to topple over. Some of the passengers on top jumped into the roadway, and others were thrown off. The position of the car enabled it to be seen that the brakes were gripping the wheels tightly, while the rail brakes appeared to be down to the utmost extent. The driver remained on the platform until the car was about to collide with the wall, and then sprang to the ground, escaping injury. The conductor also jumped without being hurt. The inquest on the body of the man who was killed in the accident was opened on Monday and adjourned for a week. The Board of Trade have appointed Major J. W. Pringle R E., to hold a local enquiry into the circumstances attending the accident.

Woodbridge.—On Thursday last week the Earl of Jersey and Colonel Boughey, Light Railway Commissioners, held an enquiry at Woodbridge into the application to construct a light railway from Woodbridge to Bawdsey. It was explained for the promoters that the light railway was proposed to serve the district between Woodbridge and Bawdsey, commencing at Woodbridge Station, along a tramway as far as Melton. It then turned towards the east, and crossed the Deben nine yards east of Wilford Bridge, went over Bromeswell and Sutton, crossing the main road between Sutton and Melton, and then passed Shottisham, Hollesley, Alderton, and Bawdsey. Arrangements had been made with the Great Eastern Railway Company to acquire what land was necessary for running to Melton. It was proposed to run a single line at the normal gauge, and the scheme presented no engineering difficulty. The ruling gradient was 1 in 70, and the sharpest curve three furlongs. The number of acres of land to be taken in was 107. The railway crossed a certain number of public roads, which were proposed to be crossed on the level, with the exception of at Bromeswell and Sutton, which would be crossed by means of a bridge. The Chairman said the Commissioners would recommend that an order be granted for carrying out the proposed line, subject to the consideration of the plans with regard to the bridge at the Cherry Tree crossing.

LIGHTING AND GENERAL.

Exeter.—The new road which is being made in Newtown is to be lit with electricity instead of gas.

Camborne.—The Urban Electric Supply Company are considering the question of lighting King's-road.

Leicester.—The Leicester Corporation have during the past half-year made a net surplus of £4,563 out of electric lighting.

Wood Green.—The Urban District Council have asked Mr. Hawtayne to prepare plans for electric lighting in the compulsory area.

Hythe and Sandgate.—It is expected that at both these places the electric light will before long be seen in the streets and buildings.

Burnley.—The Town Council intend to apply for sanction to a loan of £3,500 for the provision of additional plant required at the electricity works.

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Wigan.—The Corporation are raising £5,000, being the balance of the sum of £85,000 contracted to be borrowed in connection with the electrical undertaking.

Erdington.—It is expected that probably 12 months hence electricity will be the illuminant power in Erdington, Aston being prepared to supply current.

London Bridge.—We learn that there will be an improved electric lighting installation provided upon the opening of the widened bridge for vehicular and pedestrian traffic.

Weardale.—An electric light company are enquiring as to the probable requirements of Walsingham in the event of the company constructing a power station there.

London Gazette.—The partnership existing between W. A. Stevens and R. A. Barker (trading as Stevens and Barker), Maidstone, Kent, has been dissolved by mutual consent.

Dorking.—We understand that Messrs. Edmundsons are about to complete arrangements for the site of the proposed electric lighting station, and plans will be ready in a short time.

Dewsbury.—The Mayor has received from Lord Savile a donation of £20 towards defraying the cost of installing the electric light in the infirmary and providing a Röntgen rays apparatus.

Northamptonshire Telephones.—The establishment of municipal telephone services is being considered by a joint committee of Northampton, Kettering, Wellingborough, and Rushden.

Brierfield.—The electric lamps which are being fixed to the poles on the main road from Nelson to the end of Brierfield boundary were turned on for the first time last week as an experiment.

Cannock.—We understand that the Urban District Council have deferred the question of erecting 15 additional street lamps until receipt of the report of the Electric Lighting Committee.

Crewe.—The Town Council have resolved to take up loans amounting in the aggregate to £32,402 for electric lighting purposes, water supply, street improvements, technical instruction, works, etc.

Sunderland.—The Electricity and Lighting and the Tramways Committees are conferring about the question of the price charged to the Tramways Committee for current. We learn that they will not fight.

Elland.—The work of providing an electric light installation is proceeding rapidly. A number of men are engaged in erecting buildings at Low Field, and cables are being laid along the principal streets.

Newark.—The negotiations between the Corporation and the Notts and Derby Electric Power Company are still going on, and Oct. 31 has been given to the company as the limit in which to come to a decision.

Tipton.—The directors of the Mond Gas Company have decided to proceed with the erection of their central generating station at Dudley Port. Plans have been adopted, and contracts will be let shortly. The works will cost £250,000.

Theft of Wire.—It is reported that the Manchester and suburban districts telephone service has greatly suffered during the past month through thefts of wire. Altogether 18 miles of wires are said to have been removed from various districts.

Doncaster.—Mr. Norman E. G. Little, late of the Bolton Corporation electrical works, has been appointed chief assistant engineer at the Doncaster Corporation electrical works, in place of Mr. Jones, who is leaving to take up the position of chief engineer at Batley.

Swansea Telephones.—The Telephones Committee are going ahead, and a clerk of the works for the new municipal exchange has been appointed. The building has already been commenced, and is erected to the ground level. It will be completed in about four months' time.

Falmouth.—The Mayor said at the last Council meeting he did not think the town would get electric lighting for at least two years. A draft agreement between the Council and Messrs. Crompton and Co. with reference to the electric lighting of the town has been forwarded to that company.

Anglo-American Telegraph Co.—The directors, after placing £6,000 to the credit of the renewal fund, have declared an interim dividend for the quarter ending Sept. 30 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, less tax, payable on Nov. 1.

Fulham.—The Borough Council on Wednesday appointed Mr. F. P. Fletcher, Canterbury, as shift engineer at the Council's electric lighting station in the place of Mr. E. Perry, who has recently resigned. Mr Fletcher was one of the selected candidates when the last similar appointment was made.

Berwick.—The Harbour Commissioners have leased a portion of the old shipbuilding yard on Berwick Quay to the Urban Electric Supply Company for the purpose of erecting installation works. The company have for some time been in negotiation with Berwick Sanitary Authority for the electric lighting of the town.

St. Helens.—The St. Helens Electric Supply Committee have instructed the town clerk to apply for sanction to the borrowing of the sums of £5,600 for extensions of mains, overhead work, etc., and £2,000 for the erection of a retaining wall, and the alteration of railway sidings at the power station, Cropper's-hill.

Scunthorpe.—The Urban District Council have resolved that a Bill be promoted in Parliament for the amendment of the Scunthorpe Urban District Gas and Water Act, 1899, by repeal, alteration, or amendment of certain sections *i.a.* authorising the Council to manufacture and supply electricity for all public and private purposes in their districts.

Mansfield.—At a recent special meeting of the Town Council it was reported that the contractors were getting on very rapidly with the electricity works. The refuse destructor and the boiler-house were roofed, and it was hoped that the engine-house would be done shortly. They had decided to spend £15 on an iron cap for the Custodis chimney.

Halifax.—The Corporation Tramways and Electricity Committee recommend that application be made for sanction to the borrowing of £28,000 for the extension of the electricity undertaking. It is stated that the present plant is fully loaded, and that should a breakdown occur on any of the present generating units there would be no spare plant to take its place.

Partnership.—We are informed that Mr. Philip Dawson, A.M.I.C.E., M I.Mech.E., M.I.E.E., has become a partner in the firm of Messrs. Kincaid, Waller, and Manville, and the business of consulting engineers carried on by them at 29, Great George-street, Westminster, will now be under the name of Kincaid, Waller, Manville, and Dawson.

Salford.—At the last meeting of the General Purposes Committee of the Corporation it was decided to give the thanks of the borough to his Honour Judge Parry for his services in presiding over the electricity enquiry, and to ask him to accept an honorarium of 100 guineas. It was also decided to recommend the Council to pay only the costs incurred by the Corporation.

Lead Trust.—A Reuter's telegram announces that plans were practically concluded on Sept. 29 for the formation of a mammoth combination, including all the important lead-manufacturing concerns in the country, with a capital of at least 60 million dollars. The *New York Herald* says that the plans for financing the new combination have been satisfactorily arranged.

Redditch.—The electric lighting scheme seems to make good progress, for at a recent special meeting it was stated that most of the £2,000 raised by loan for the purchase of the new generating plant had been required for extensions, and that £2,000 to the credit of capital account for another loan would soon be wanted in connection with the electric lighting scheme.

Irvine.—At a special meeting of the Town Council last week the report and plans of a proposed scheme of electric lighting was submitted. The compulsory area will comprise streets and houses in the centre of the town, and plant sufficient to supply an equivalent of 3,000 8-c.p. lamps for lighting the streets in the compulsory area will be provided. The initial cost is estimated at £10,000.

Battersea.—The following additional estimates have been adopted: £70 for purchase of bitumen; £110, purchase of 200 yards of ·06 cable; £345, extension of electric light and arc light leads from Nightingale-lane to "Penilow," Bolingbroke-grove. The conference *re* telephones has been adjourned until Oct. 7, owing to the fact that the majority of the borough councils are still in vacation.

Lancaster.—A sub-committee (consisting of the Refuse Destructor Sub-Committee and members of the Electricity Committee) which recently considered the question as to dealing with the supply of steam from the refuse destructor at the electricity works, have reported that the recent working of the destructor is satisfactory, and that there is no need for further action in the matter at the present time.

Earsdon.—In view of the prospective lighting of the locality by the Northern Counties Supply Company, the Council at a previous meeting having decided to allow the matter to lie in abeyance for the present, it is stated that the Co-operative Society will abandon their scheme as soon as any lighting authority produced a cheaper light. The question will come again before the Council at their next meeting.

Wimbledon.—Mr. F. Barnes Spencer, M.I.E.E., the able chief electrical engineer to the Council, has resigned his post. Mr. Spencer has made the undertaking show a reasonable profit at a very early stage in its existence, and his departure will be a distinct loss to the town. The Council have been sensible in promoting Mr. H. T. Lee, A.M.I.E.E., who has been Mr. Spencer's right-hand man, to the vacant office.

Manchester.—A proposal that the Council should allow the committee to fix arc lamps in Portland-street, Oxford-street, and Cheetham Hill-road, with a view to making certain experiments as to the best form of electric street-lighting was defeated at the last Council meeting. A resolution was unanimously passed asking his Honour Judge Parry to accept an honorarium of 100 guineas for his services in conducting the recent enquiry.

Barnstaple.—The Town Council have decided to ask the Postmaster-General to arrange for the keeping open of the Barnstaple office for telegraphic purposes at night and throughout Sundays. Barnstaple has within the last few months been put into direct telegraphic communication with Bristol—which means a welcome acceleration of the service to Bristol and the north—and it has assumed the dignity of a transmitting station for North Devon.

General Post Office.—Mr. E. May, controller at the Central Telegraph Office, St. Martin's-le-Grand, retired from the service on Tuesday on a pension. Mr. May has been connected with the Telegraph Office for over 50 years. When the Government took over the telegraphs in 1870 he was assistant-controller, and when the position of deputy-controller was created he was appointed to it. A few years ago he succeeded Sir Henry Fischer as controller.

Stock Exchange.—The Stock Exchange Committee has appointed Oct. 8 special settling day for the Colombo Electric Tramways and Lighting Company's £120,000 5 per cent. first mortgage debenture stock. Application has also been made to the committee to allow the Blackheath and Greenwich District Electric Light Company's £100,000 4½ per cent. first debenture stock, in lieu of the provisional certificates now quoted, to be quoted in the official list.

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British Westinghouse Co.—Mr. Morton Beales, formerly of Messrs. Ferranti Limited, and latterly commercial engineer to Messrs. J. G. White and Co., 22A, College-hill, Cannon-street, E.C., has resigned his position with that firm in order to accept a post on the staff of the British Westinghouse Electric and Manufacturing Company, Limited, Norfolk-street, Strand.

Bath.—At the last meeting of the Surveying Committee the Chairman stated that he saw the Mayor in relation to the recent failure of the electric light, and pointed out that the streets could not be left in darkness for two or three hours, and suggested that incandescent lamps could be attached to the arc standards for temporary use during breakdowns. The Mayor agreed with the suggestion, and the matter was under the consideration of the committee.

Gloucester.—The last report of Mr. Hammond states that the whole of the building work in connection with the refuse destructor is practically completed, and that the connecting pipes have now been delivered. Mr. Bache states that the cells had been slowly and carefully dried, and that the new boiler had been heated, though the steam could not be used until the connecting pipes had been fixed. An application for a supply of electricity to Ryecroft district is under consideration.

Winchester.—A new ceiling has been put into the guildhall, which is picked out in panels of moulded timber frames, and at each intersection of which an electric lamp has been placed. A handsome new panelled front is to be fitted to the stage, which will have permanent electric head and foot lights, the illumination of the remaining part of the building being by electricity, and an electric fan has been placed in the roof. Messrs. Coston and Co. are carrying out the work under the direction of the city surveyor, Mr. W. V. Anderson.

Ferranti, Limited.—We have to congratulate Messrs. Ferranti upon having secured the services of Mr. Michael B. Field, at present electrical engineer to the Glasgow tramways, for the position of contract engineer to their business. Mr. F. Barnes Spencer, at present engineer to the Wimbledon Urban District Council, has been appointed to the position of sales manager by the same company. We learn that these gentlemen will jointly represent Messrs. Ferranti, Limited, and their headquarters will be in London, where an office is shortly to be opened.

Perth.—The Caledonian Railway Company are about to fit up the electric light at Perth North. Judging from experience at Perth South, this will prove a great boon to those employed in the yards. The introduction of the electric light has been so successful that the Town Council were in a position on Thursday week to reduce the price from 7d. and 3d. per unit to 4½d. per unit. The works started with only nine private consumers. Since the opening of the electric station the number has increased to 185, with a connection equivalent to 19,000 lamps.

Croydon.—The 600-kw. engine and generator erected by the Electrical Construction Company, Limited, is to be taken over subject to the company's entering into a guarantee for a period of three years from the date of taking over. The Council are getting a very satisfactory output at present from the machine, which is running the whole of the tramcars. The recent change from alternating to the direct current for private lighting has given very great satisfaction. Mr. H. C. Barkham, of Bedford, has been appointed mains superintendent.

Leigh.—Mr. John Foster has resigned his position as gas, water, and electrical engineer to the Council consequent upon his having obtained the appointment of chief assistant gas engineer to the Birmingham Corporation. It was decided on Tuesday to separate the management of the electricity department from that of the gas and water departments, and to appoint Mr. D. M. Kinghorn electrical engineer at a salary of £156 per annum. An amendment to advertise for an electrical engineer at a commencing salary of £200 per annum was defeated by 15 votes to 6.

Poole.—The Town Council have referred to a committee a letter received from the Bournemouth Corporation asking whether they would co-operate with Bournemouth in the event of its being deemed financially practicable and otherwise advantageous to establish a municipal exchange on the lines of such co-operation to be hereafter discussed and settled. The Poole Chamber of Commerce have passed a resolution recommending the Town Council to join with Bournemouth and Christchurch in finding out whether it was desirable to establish such telephone within their area.

Edinburgh.—The Town Council propose to put the Electricity Committee's surplus, amounting to over £10,000, to the reserve fund, which will then amount to about £27,000. No change is to be made in the price for electric energy for the current year, the charge remaining at £13 per lamp per annum, 3½d. per unit for private lighting, and 1½d. for motor power. The Heriot-Watt College extensions just opened have been amply provided with electric light, as much of the work will be done at night. Each student will have, in the antique and life classrooms, an electric lamp at his or her bench.

Stoke-on-Trent.—At the last meeting of the Town Council, the Electricity and Destructor Committee reported that the surveyor had prepared a plan for a scheme providing for a refuse destructor, electric light station, fire station, mortuary, disinfecting sanitary depôt, town yard, and recreation ground, and recommended that the surveyor and electrical engineer be instructed to prepare plans, etc., for the proposed destructor and electricity generating station, and submit the same to the committee and Council. This was agreed to. Electric baths for treatment of lead poisoning in the potteries are now in use in the town.

Beverley.—The Council at their last meeting resolved to confer with Edmundsons, Limited, as to that company establishing and working plant on a certain buying-out scheme. The company, it will be remembered, offered to erect and work a plant providing they could use the money which the Corporation have received sanction to borrow. If these terms were agreed to, the Corporation could buy out the company after a number of years at a certain percentage, which would decrease as the number of years lengthened, until no percentage at all would be required. It appears, however, that the sum required exceeds the Council's powers by £5,000.

Birmingham Small Arms Co.—In the annual report for the year ended July 31 it is mentioned that to secure greater economy in working electrical power is being substituted for steam in the gun department, and already a set of engines and dynamos is erected, to be followed by two more sets. The old engines, of about 600 h.p., which have been running for over 30 years, and are fully depreciated in the books, will be removed, and it is hoped that in a few months all the gun machinery will be driven by electricity. Other improvements effected at the works include the erection of an electric power house, and the partial reconstruction of the smithy and the barrel-making shop.

Spain.—From statistics of the year ended Dec. 31, 1901, it appears that there were in Spain 859 electricity stations at work, out of which number 648 were supplying current for public and 211 for private lighting. The largest number in one province is 59 in Gerona—namely, 24 public and 35 private lighting undertakings. The total public lighting of the towns amounts to 87,112 incandescent lamps, aggregating 1,012,945 c.p., and 1,470 arc lamps, representing 1,136,590 c.p. The private lighting amounts to 1,237,836 incandescent lamps, representing 38,640,641 c.p., and 2,819 arc lamps, aggregating 1,292,425 c.p., giving a grand total of 1,329,237 lamps and 43,082,601 c.p.

Warning.—A correspondent of a Zürich paper who, it is said, is thoroughly familiar with Roumanian affairs, writes from there to warn electrical firms against having anything to do with orders from Roumania, unless payment is absolutely assured. In particular is he against anyone's attempting to erect works in that country, where only a few and insignificant industrial undertakings are as yet to be found, so that there can be little sale of current for power, and the chances for electric lighting are bad in a country where petroleum costs about 1½d. per litre. The same may be said of motor cars and vehicles, for cab fares are only 3d. to 4d. In addition it will be necessary to import almost every workman and certainly every skilled worker, and above all, nothing can be done without a concession is first obtained, which means a considerable expenditure of time and "palm oil."

Accidents.—A slight failure (the first since the opening of the works 18 months ago) of the electric light occurred at Rotherham last week, owing to the fusing of a cable connection. On Saturday night the electric current failed at Winchester (also for the first time). The supply was resumed in half an hour. Whilst the harvest thanksgiving service was being conducted at St. John the Baptist's Church, Newport, on Sunday night there was a local failure of the electric light installation, and the church had to be lit up for the remainder of the service with candles. On the 29th ult. at Drury Lane during the firing of an iron mortar, which is ignited by means of an electric current, a serious accident occurred, owing to the bursting of the mortar, not connected with electricity, but we regret to say that Mr. George Clifton, who is employed in the electric light department of the theatre, is reported amongst the injured. During the course of the construction of Signor Marconi's towers at Poldhu, Mullion, a carpenter fell from a height of 215ft., without, it is said, breaking a bone. A slight leakage through the pavement at a street corner at Sheffield seems to have afforded some amusement a few days ago to those who passed over it while it was yet damp.

Hull Telephones.—At a meeting of the Hull Telephones Committee on Friday, the National Telephone Company's action as to the Corporation's notice to the company to take up their underground wires at the completion of the term of their present licenses was again mentioned. The Town Clerk also stated that the company had asked for a further interview, and had served a writ upon the Corporation for the purpose of testing the question of the validity of the Corporation's notice to remove their wires at the time stated. It was ultimately agreed that whilst the Corporation at present saw no reason to alter the terms of their resolution, they were prepared to have a further meeting with the company. The claim of the National Telephone Company is for: (1) a declaration that the powers which the plaintiffs acquired by agreement with the defendants for placing and maintaining underground pipes, wires, and other telephonic appliances and apparatus connected therewith within the city of Kingston-upon-Hull, and in pursuance of which the plaintiffs have incurred material expenditure, are powers which, in pursuance of Section 3 (Sub-Section 1) of the Telegraph Act, 1899, are continued and are in operation until Dec. 31, 1911, the period of duration of a license to provide public telephonic communication, which has been granted to the defendants by his Majesty's Postmaster-General; (2) a declaration that three notices, dated respectively Aug. 4, 1899, and served by the defendants on the plaintiffs, are and each of them are invalid and inoperative so far as the same relate to any of the plaintiffs' aforesaid powers for placing and maintaining underground pipes, wires, or other telephonic appliances connected therewith; (3) an injunction to restrain the defendants, their servants, or agents from removing or otherwise interfering with any of the plaintiff's underground pipes, wires, or other telephonic appliances and apparatus connected therewith so long as the plaintiffs' powers to maintain the same shall continue; (4) costs.

Admiralty.—Mr. A. E. Richards, constructor of the Admiralty, recently employed upon overseering duties, has been appointed to succeed Mr. H. Cock as chief constructor of Pembroke Dockyard forthwith. Mr. Richards is an expert on electrical work. Mr. Jas. Yates, chief constructor at Portsmouth Dockyard since 1895, has been promoted civil assistant to the Admiral Superintendent at Chatham Yard, and will be succeeded by Mr. W. Gard, chief constructor at

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Malta. Mr. John Apsley, constructor at Chatham, has been appointed to Portsmouth, and Mr. G. Young, assistant constructor, has been promoted acting instructor at Portsmouth, *vice* Mr. W. Hockaday, who has been appointed chief constructor at Bermuda, from Dec. 1.

Aston.—Aston is about to celebrate its incorporation by the installation of an extensive electrical scheme for lighting and tramways. For a couple of months the builders have been at work on the power station, which is to be erected in Chester-street, and the foundation-stone has just been laid by Councillor J. J. Gittings, the chairman of the Electricity Committee. The station will be used for generating power both for lighting and traction, and the cost of erection is estimated at £12,000. The scheme in its entirety will cost upwards of £52,000. In addition, £24,500 will be expended on the electrical equipment of the tramways, which are already in the Council's hands, and a further amount of £11,500 will, it is estimated, be required for providing overhead wires.

South Shields.—The Health Committee, the Electrical Committee, and the Municipal Buildings Committee have laid before the Parliamentary Committee of the Corporation, who are preparing the Parliamentary Bill proposed to be promoted in next session of Parliament, the following resolution: "That the Council be recommended to insert in the proposed Bill the clauses embodied in the last Bill with regard to the following matters be also inserted: (1) With regard to the use of land for a generating station; (2) power to supply electric fittings; (3) power to make by-laws with respect to electric fittings; (4) power to supply electric energy in bulk; (5) supply of electricity for traction purposes; (6) power to purchase compulsorily certain lands surrounding the electricity works."

South Staffordshire Mines Drainage Commission.—We gather from the annual reports which will be submitted at the next meeting of the Commissioners that the cost of the water raised during the past year has been a farthing per ton of water raised. An amended drainage engineering scheme, prepared by the engineer, showing especially where gas-engines and electricity are applicable in addition to the use of modern-type steam pumping engines, will be submitted at a special meeting to be held at the close of the annual meeting. Mr. E. B. Marten, in his report on surface works, states that the cost of surface pumping has been a little less than last year. The new works were required more especially for the sites of electric pumps. An experimental electric pump was about to be put at Ocker Hill, near the Midland Electric Corporation works.

Alloa.—The electric light installation at the town hall has now been successfully completed. The stage is lighted by means of 51 concealed top and side lights and by 30 footlights, while six electroliers of very handsome design containing 20 lights each effectively light the hall, and three smaller electroliers of four lights each supply the lighting under the back gallery. Mr. Thomson Paton has defrayed the cost of these improvements, as well as the renovation of the premises The contractors for the electric lighting were Messrs. Anderson and Munro, Edinburgh, and for the painting and decorating Mr. John Robertson, Alloa. The consulting engineers for the electric lighting were Messrs. Buchan and Hogarth, Edinburgh, and we understand that Messrs. John Melvin and Son, architects, Alloa, carried out the whole scheme of decoration with the approval of Mr. Waterhouse, the architect of the hall.

Dundee.—The electric engineer in his last report states that he had had an enquiry from the North British Railway Company as to the rate at which the Corporation would supply the Tay Bridge passenger and goods stations, offices, and yards with electrical energy. The Electric Lighting Committee offered to supply the first 20,000 units per annum at 4d. per unit, less the usual discount, and all over and above 20,000 units at 2d. per unit, provided that the company took a minimum supply of 20,000 units per annum. The question of providing increased boiler power at the station was discussed at a meeting of the committee on Tuesday. A proposal was made to instal two tubular boilers, the relative merits of which contrasted with those of the Lancashire type at present chiefly in use were discussed. It was remitted to the engineer to formulate a report on offers which had been made for supplying the new plant.

Obituary.—We learn with regret of the death of Mr. Fred. Bathurst, which occurred on Saturday last, owing to heart failure having supervened on an attack of asthma. Mr. Bathurst was a pupil of the City Guilds at Finsbury under Prof. Ayrton, after which he joined the staff of Messrs. Woodhouse and Rawson, with whom he held an appointment for several years. He then went over to the United States and obtained a good position at the Edison Works, his department being more particularly connected with Mr Edison himself and his laboratory experiments. On his return from the States some years ago, he brought back with him the agency for the interior conduit system of wiring, which he has since exploited in a manner which is probably well known to our readers. A few years ago he was awarded a gold medal and £25 premium by the Society of Arts, for his paper on prevention of fire risks.

Barrow.—An enquiry has been held into an application of the Corporation for sanction to borrow £20,000 for the purpose of extending the electric lighting system. The Town Clerk explained that the application was being made in consequence of an increased demand for supply of electricity, and also in respect of an agreement entered into with the British Electric Traction Company for a supply of current for the proposed reconstructed tramway system. It was 3½ years since the current was first supplied by the Corporation, and the demand was now so great that the capacity of the works was practically exhausted The total amount already borrowed was £58,575. It was proposed to ask for repayment over a period of 30 years, and that the commencement of the repayment be deferred for three years. The Inspector said he was afraid this would not be allowed, as the Local Government Board had decided they had no power to grant it.

Brighton.—The work of putting in the foundations of the Corporation's electricity works at Southwick is now very rapidly drawing to a close. There can be no doubt, says the *Sussex Daily News*, as to the complete success of the scheme, which is a triumph of engineering skill. Where all was mud and water one can now walk on either of the great walls or from pier to pier on solid ground. The remaining work causes far more trouble, owing to the enormous amount of water to be dealt with, than was met with in some sections, on account of the berth, over 200ft. long, which it has been found necessary to cut for the steamers that are to come alongside to supply the finished works with coal. This indispensable item has, unfortunately, proved for the present a source of greater difficulty than was anticipated, for in making the foundations for the office walls, which abut on the canal towing-path, the workmen have to contend against a large volume of water ever pressing to enter into the space devoted to the formation of the foundations.

Temple Telephones.—It is understood that the authorities of the Middle Temple have now given their consent to the Post Office telephone service being introduced into their Inn, and that accordingly the laying of the wires will shortly be commenced from the entrance to the Temple at the Thames Embankment. With regard to the Inner Temple, communications have been going on between the Post Office and the Benchers, the latter proposing that overhead wires should be used. To this proposal the Postmaster-General pointed out several objections, and also called attention to the fact that in no part of the Temple would it be necessary to lay a pipe of more than 3in. in diameter, and that pipes of this or smaller size could be laid at a very short distance below the surface. The Postmaster-General states that if the Benchers decide against the introduction of the underground system he will be reluctantly obliged to abandon the idea of introducing the Post Office telephone service into the Inner Temple. The Benchers will reserve their decision until after the Long Vacation.

Luton.—The Town Council on Tuesday decided to increase the salary to the electrical engineer, Mr. Crooke, by £50 per annum, and to apply for a new loan of £5,000 in order to carry out certain extensions. Mr. A. T. Snell, in his last report, states that he has completed the whole of the work he has been commissioned to do in reference to the installation of electric light at Luton. The Electrical Engineer reported that since July 18 8,888 units had been generated, 167 8-c.p. lamps and one 3-h.p. motor connected, making a total of 67 consumers with 5,051 lamps and seven motors of 25 h.p.; 770 lamps and one 8-h.p. motor were also ready for connection. It was resolved to order two Aron meters at £5. 5s. each, one pump for oil separator at about £4, and 25 pairs house fuses at 10s. 6d. per pair. An extension of cables in Guildford-street, Mill-street, and New Bedford-road is to be carried out at £70, and in Stuart-street at £55. The engineer is to report as to the laying of mains and the supply of light and power to two large firms who have applied. An application for an extension to High Town has also been received.

Dublin.—The Lighting Committee are considering the lighting of Pembroke-row, Haddon-row, Clontarf, Pleasant-street, the Dockyard Company's premises, etc. The length of mains laid in the streets up to the present month is 180,000 yards. Last Thursday the Dublin section of the Institute of Electrical Engineers (on the invitation of Councillor Irwin, J.P., chairman of the lighting Committee) visited the Pigeon House station. The roofing of the works has commenced, and the erection of the plant will be begun in about two weeks. Some of the boilers are already on the ground. The main building occupies almost the entire eastern side of the new harbour, and the ground covered measures 182ft. long by 140ft. deep, the height from ground level to the engine-house ridge being 60ft. The walls are extremely substantial, and stand on massive concrete foundations, in many places 10ft. wide. The chimney shaft rises 186ft. from the ground level, while its foundation work starts at nearly 30ft. below the ground level. The shaft is 20ft. square where it appears over ground, while the base of the foundation is 38ft square.

Wallasey.—At the last meeting of the District Council, the Gas and Electricity Committee made a recommendation that the Council apply to the Local Government Board for sanction to borrow £52,350 for electricity extensions. The matter was referred back in order that it might be discussed by the members of the Tramways, Gas, and Electricity Committees. A meeting of this joint committee has now been held, and a statement of the engineer, showing the probable requirements of the electricity works in the matter of capital expenditure for the next seven years, having been considered, it was decided to recommend the borrowing of the sum named at the Council meeting last night. In view of a report of the electrical engineer, the Gas and Electricity Committee recommend that the charge for electric energy to the Tramways Committee be 1⅝d. per unit instead of 2½d., and that in regard to the charges for energy to consumers in the district there be a reduction in the energy required to be consumed before becoming entitled to the lower scale of ½ unit per lamp—that is, 2 units instead of 2½, as at present - and a reduction also of 1d. in the lower scale—viz., from 4d. to 3d. per unit, the initial price of 6d. remaining.

Presentation.—The officials and staff of the Harrogate Corporation electricity department last week presented to Mr. Geo. Wilkinson, M.I.E.E., M.I.M.E., borough electrical engineer, a handsome clock, suitably inscribed, on the occasion of his marriage. Mr. Neil McLean, chief assistant engineer, in making the presentation, said that "it was mainly due to Mr. Wilkinson's management and goodwill to his employés that the undertaking had grown to the extent which it had done; and he had no doubt that in the future, if the same mutual good feelings existed between Mr. Wilkinson and his staff, the place would grow with the same rapidity as it had done hitherto, and he thought that the present record of 1½ lamps per head of population was one which could not be beaten." The following appeared in the

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local Press: "On Thursday afternoon at St. Mark's Church, Harrogate, the wedding took place of Mr. Geo. Wilkinson, electrical engineer to the Harrogate Corporation, and second son of Councillor Wilkinson, of Harrogate, to Miss Annie Ellis, only daughter of Mr. T. W. Ellis, of Otley-road. The Rev. James Wilkinson, M.A., vicar of Brenzett, Kent, elder brother of the bridegroom, was the officiating clergyman. The honeymoon will be spent in the South of England."

Islington.—At the meeting of the Council to-day it will be recommended that mains be laid as follows: Cloudesley-place at a cost of £450, Wharfedale-road at £63, Junction-road at £227, Archway-road at £54, Seven Sisters-road at £82, Canonbury-road at £110, and Highbury-grove at £198. The Finance Committee will submit the following report: "We have had under consideration various applications by consumers and others for a reduction of the rates of charge for motive power. It is pointed out that while the rate of 2d. per unit for daylight supply is a favourable one as far as it goes, the effect of the 7d. and 4d. sliding scale after dusk is to make motive power expensive during the winter season. We understand that motive power is generally taken over a larger number of hours per day than is the case with lighting, and that it is unusual for motive power to add to the peak of the lighting load so as to render necessary an increase in the capital expenditure required to meet the maximum demand on the station. For these reasons we are of opinion that the use of motive power should be encouraged, but since motors have a well defined period of use, we consider that any change of rate should embody a reversion to a flat rate or uniform scale of charge. We, therefore, recommend that the supply of electricity for power purposes only be charged for at the following rates: from 12.30 a.m. to sunset 2d per unit, from sunset to 12.30 a.m. 5d. per unit."

St. Marylebone.—At last night's meeting the Lighting Committee reported that, after consultation with counsel and the Council's consulting electrical engineer, objections had been made to the works proposed in notices received from the Metropolitan Electric Supply Company, Limited—viz.: (1) to lay a cast-iron conduit for extra high-tension mains across Edgware-road at Blomfield-road, and along Edgware-road, Richmond-street, Carlisle-street, Church-street, Exeter-street, Devonshire-street, Lisson-grove, Marylebone-road, Wyndham-street, Wyndham-place, Montagu-place, Dorset-street, Manchester-street, and South-street, to their Manchester-square station; (2) to lay a 5in. cast-iron pipe from Rathbone-place station to Marylebone-passage sub-station; that the company had appealed to the Board of Trade, under the provisions of their West London Lighting Order of 1889, against the objections, and that the Board held an enquiry on Sept. 4 with respect to the proposed works. A communication was read from the Board of Trade, forwarding copies of the orders which the Board have issued to the company under the powers conferred upon them by the Metropolitan Electric Supply Company (West London) Lighting Order, 1889, allowing the appeal in each case, and approving of the proposed works, subject to the conduit for extra high-pressure mains proposed to be laid along Edgware-road and certain streets of the borough to the company's generating station in South-street, being laid from Dorset-street, along Baker-street to George-street, and along George-street to Manchester-street, instead of continuing along Dorset-street, east of Baker-street, and along Manchester-street.

Cheshire Power Scheme.—In the next session of Parliament a syndicate will apply for parliamentary powers to erect electric generating stations and power throughout the county of Cheshire, and northern part of the county of Stafford. It is called the Cheshire and North Staffordshire Electric and Power Gas Syndicate, and will go to work with the large capital of £1,500,000. The chief object of the company is to supply electricity and produce gas for power purposes, but it is not intended to encroach upon the power of the local authorities to deal with the local distribution of the electric energy within their respective areas. Should powers be obtained, the area to be embraced will extend over 1,770 square miles. In this area there are four county boroughs, 12 boroughs, 44 urban districts, and 28 rural districts, and a population of about 1½ millions. The company propose to supply electricity in bulk, conveying it ready made to the authorities and others requiring it at cheaper rates than they can produce it themselves. For this purpose three power stations are to be erected, one being in Sutton just outside Macclesfield, another is to be situated near Stone in Staffordshire, and the other near Frodsham. The station near Macclesfield will be able to supply the whole of this district, including Alderley and Wilmslow should it be necessary. It is contended by the promoters of this scheme that there are no local authorities in the proposed area to supply, with the exception of Birkenhead and Stockport, large enough to manufacture electrical energy on a sufficiently large scale to place the undertaking on a sound financial basis. The maximum charge is to be 2d. per unit. In Alderley powers for electric supply have already been obtained and transferred to private companies. The Wilmslow Urban District Council have an order, and have just decided to establish generating works. The solicitors to the syndicate are Messrs. Rowcliffe and Co., of Manchester and London, and Mr. R. Fleming, 37, Cross-street, Manchester, is the secretary.

Leeds.—The members of the City Council on Tuesday inspected the new buildings and plant at the Corporation electric lighting station, Whitehall-road. The site of the new works comprises an area of 290ft. by 181ft., and the buildings consist of an engine-house, switchroom, cable cellar, boiler-house, stores, and workshops. The engine-house is completed. It is 220ft. long, 65ft. in width, 33ft. high from floor line to crane rail, and 44ft. from floor line to the underside of the roof binders. The plant consists of one McLaren and one Belliss engine, both coupled to alternators made by the Electric Construction Company. The engines are capable of 2,400 h.p., and the capacity of the dynamos is 1,500 kw. each. There is a 30-ton overhead travelling crane equipped with a two-phase motor. The cable cellar under the switchboard is so arranged that the cables leaving the board are carried down direct on to shelves into the cable subway which runs as far as Queen-street, a distance of 350 yards. By this means it is possible to get at any cable that may need repair. The boiler-house will be able to hold 24 watertube boilers. The undertaking has grown in nine years from a small private venture with a capital of £42,154, and a plant with a capacity of generating 250 kw., until it is now one of the most important of the municipal undertakings, the capital expenditure upon which has been considerably over a quarter of a million sterling, while the generating capacity of the plant has grown to 8,740 kw. At the commencement 4,000 35-watt lamps were supplied; to-day the demand is equal to about 200,000 lamps. Nine years ago 130,068 units were sold in the course of 12 months; last year the sale totalled to 3,055,165 units, and the demand is still increasing. The price per unit has fallen from 8d. to 4d. for lighting, and from 5d. to 1½d. for motive power, meter rents having been abolished entirely. The Lord Mayor (Alderman Butler) said that there was one thing which struck him with great pleasure, and that was that one of the new engines had been supplied by a Leeds firm. Of all the lighting stations in the country, that in Leeds consumed the least coal in proportion to the energy produced. It was only ·27 per unit, which was lower than every other lighting station. Working expenses cost Leeds only ·62 per unit, and the total cost, including everything except capital charges, was only 1·04, which, with the exception of Liverpool, where about 20 million units were sold annually, was the lowest in the kingdom.

Colne.—The opening ceremony of the Corporation's electricity works at Phillips-lane took place last Thursday, when the Mayor (Alderman W. H. Varley) called upon the chairman of the Electricity Committee (Councillor H. Hewitt) to start the engine. There was a large attendance, including Messrs. J. Foster (Leigh borough electrical engineer), A. Fraser (borough electrical engineer of Nelson), J. Birkett (borough electrical engineer of Burnley), J. Giles (borough electrical engineer of Blackburn), and J. H. Smyth (borough electrical engineer of Keighley), who were subsequently entertained by Councillor Hewitt at a banquet at the Crown Hotel. With the exception of the installation of the plant for supplying traction power to the new Colne and Trawden Light Railway, the new works are practically completed. The total outlay up to the present time is about £24,000, and about £3,000 more will be required in connection with the plant for the electric railway. Borrowing powers up to £39,000 have been obtained. The Corporation are under contract to supply the Colne and Trawden Light Railway with current, which will mean a minimum income of about £1,500 a year for current, and as soon as this is reached another generating set, similar to the one now erected, will have to be provided. The professional supervision of the scheme has been entirely in the hands of Mr. Alfred George Cooper, A.M.I.E.E., the borough electrical engineer, for whose description of the works we are indebted to the *Colne Chronicle*. The generating plant at present installed consists of a 160-kw. generator of Messrs. Greenwood and Batley's make, coupled to a Belliss cross-compound engine of 240 b.h.p. when working condensing with 165lb. pressure on the boiler. The plant is capable of lighting 5,200 8-c.p. lamps. It is fitted with a Korting ejector condenser supplied with water from the river by means of Greenwood and Batley's electrically-driven centrifugal pumps. The steam is supplied by a 30ft. by 8ft. Lancashire boiler, made by Yates and Thom, fitted with a Proctor sprinkler stoker, the steam on its way to the engine being passed through a Hick-Hargreaves superheater. The water is passed through a Green's economiser by means of a Hall's compound direct-acting pump from the hot-well. An exhaust steam injector is fitted for feeding the boiler when the engine is running non-condensing; this injector can also be used as a live steam injector when the engine is standing. The switchboard was made by Cowan's Limited to Mr Cooper's design, and consists at present of two generators, balancer booster, recording meter, battery, plugboard, and three feeder panels. The battery consists of 270 cells of British Power Traction and Lighting Company's make, and is capable of maintaining 950 lights for nine hours. The Parsons turbo-generator fitted at the destructor is capable of maintaining 3,200 8-c.p. lamps. This dynamo, like the other, generates at 480 volts for lighting and 500 to 550 volts for traction. The three-wire system is balanced by means of a Siemens balancer capable of dealing with an out-of-balance amount of 100 amperes. The boosters attached are for charging the batteries, and will give 80 amperes each at 10 to 80 volts. They can also be used for boosting any of the feeders if required by means of plugboard. The feeders are triple concentric, and lead to underground distributing chambers, where each distributor is suitably fused to cut it off should any accident occur. Each distributor consists of a three-core cable, also paper insulated, and made by the British Insulated Wire Company. The feeders and distributors are all on the draw-in system.

PROVISIONAL PATENTS, 1902.

SEPT. 22.

20616. Improvements in dynamo-electric machines. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 24, 1901, being date of application in United States.) (Complete specification.)

20624. Improvements in alternating-current generators. Edwin Gaskell and Archibald John Hedgcock, 78, Fleet-street, London.

20645. Improved means for regulating the consumption of current by electromotors. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany.)

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20647. Improved construction of electrical transformers, choking coils, and the like. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany.)

20648. Improvements in telephonic installations having several branch stations communicating by a common line wire with a central exchange. Arnold Goldwurm and Arthur Horowitz, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20651. Improvements in and connected with the purifying or other treatment of water and other liquids or fluids by electrolysis. Walter Badenoch Hardy, 323, High Holborn, London. (Charles F. Warner, United States.)

20656, Improvements in or relating to switches and connections for testing electric current circuits. George Leonard Addenbrooke and Lionel Robinson and Co., 37, Essex-street, Strand, London.

20663. Improvements in emergency stoppers or brakes for use on electric cars and like vehicles. Ambrose Mitchel Martin and John Joseph Kay, 6, Lord-street, Liverpool.

20680. Apparatus for automatically detecting and showing the existence of foul gas in mines and like places, and electrically indicating and recording the presence of such gas to those in charge of the mine or the like works. John Hylard, Palace-chambers, Westminster, London.

20682. Improvements in and connected with apparatus for printing telegraphs. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Charles Luman Buckingham, United States.) (Complete specification.)

20683. Improvements in page-printing telegraphs. William Lloyd Wise, 46. Lincoln's-inn-fields, London. (Charles Luman Bukingham, United States.) (Complete specification.)

20684. Improvements in perforating machines for preparing telegraphic messages for automatic transmission. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Charles Luman Buckingham, United States.) (Complete specification.)

SEPT. 23.

20700. An improved electrical fire-alarm. William Timms, 15, Effingham-road, Reigate.

20755. Electrical controlling apparatus for electrical motors and the like. Oliver Imray, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London. (Sprague Electric Company, United States.) (Complete specification.)

20756. A protecting hood for preventing the spread of contagious diseases, applicable to telephone receivers. Edouard Bardac and Pierre Albert Martin, 1, Queen Victoria-street, London.

SEPT. 24.

20772. Improvements in and relating to the electrical ignition apparatus for motor-driven vehicles. Alfred Watson, jun., "Bridlemere," Maney Hill-road, Sutton Coldfield.

20794. A "wire-finder" for the overhead wire on electric tramways. Thomas Turner, 184, Blomfield-terrace, Harrow-road, Paddington.

20803. An improved terminal for electrical connections. George Edward Carr, 44, Penn-street, Scotswood-road, Newcastle-upon-Tyne.

20805. Improvements relating to prepayment instruments for use with telephones and other electrical instruments. Herbert John Dawes, 14, Conington-road, Lewisham, London.

20863. Improvements in means or apparatus for attaching electric sconces and the like to walls, ceilings, and other places. Adrian von Hooydonk, 23, Southampton-buildings, Chancery-lane, London.

SEPT. 25.

20866. Time-limit device for electrical circuit-breakers. Bertram Thomas and Eustace Thomas, the Cornbrook Telegraph Works, Hulme, Manchester.

20871. Improvements in or relating to electric storage batteries and the like. Malcolm Sutherland and Elias Marcuson, 61, Chandos-street, London.

20886. An automatic lifeguard to be attached to electric cars. Ernest Palmer, 12, Murano-street, Firhill, Glasgow.

20887, Improvements in and connected with electric railways and signalling apparatus therefor. Robert James Sheehy, 70, Market-street, Manchester. (Complete specification.)

20923. Improvements in means for adjusting the height of suspended electric lamps. Albert Huber, jun., 18, Buckingham-street, Strand, London. (Complete specification.)

20931. Improvement in automatic electric fire-alarms, and generally applicable to heat-operated signalling and controlling devices. Robert Francis Sidebottom Venner, 37, Essex-street, Strand, London.

SEPT. 26.

20939. Incandescent glow lamp. Thomas Quartermaine and Howard Knight, 48, Spring-gardens, Buxton, Derbyshire.

20940. Improvements in dynamo-electric machines. James Atkinson, Benavie, Marple.

20970. An improved insulator. Heinrich Kerkmann, jun., 100, Wellington-street, Glasgow. (Complete specification.)

21019. Improvements in connection with submarine or other vessels, torpedoes, and the like, for controlling and operating them by electricity. Lida Wilson, 47, Lincoln's-inn fields, London. (Complete specification.)

21021. Improvements in or connected with the poles or electrodes of electrolytic apparatus and the like. George John Atkins, 115, Cannon-street, London.

SEPT. 27.

21037. Mechanical telegraph transmitter. Joseph Wesley McDonald, 62, St. Vincent-street, Glasgow. (Date applied for under Patents Act, 1901, Jan. 27, 1902, being date of application in United States.) (Complete specification.)

21047. Improvements in and in appliances for use in connection with certain drums for holding electric cables. Henry Sutcliffe, 18, St. Ann-street, Manchester.

21051. "Automatic (instantaneous release) switch" for electrical purposes. Rowland Hughes Jones, Abergele-road, Colwyn Bay.

21075. An improvement in flexible metallic tubing for armouring insulated electrical conductors. William Henry Kanzon Bowley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

21076. Improvements in flexible metallic tubing. William Henry Kanzon Bowley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

21077. An improvement in flexible metallic tubing for armouring electrical conductors. William Henry Kanzon Bowley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane. London.

21090. Improvements in perforators more particularly for use with automatic telegraph transmitters. John Gell, 21, Finsbury-pavement, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 16.

1901.

15087. Electric percussion drills or tools. Loring.

16712. Automatic apparatus for controlling the speed of tramcars, automobiles, and other electrically or mechanically propelled vehicles. Verbury.

18990. Electrical ignition devices for internal-combustion motors. Nicholson.

19224. Electricity meters. British Thomson-Houston Company, Limited, and Holden.

20732. Means for regulating electric currents applicable to the lighting, heating, and ventilating of railway trains and other structures. Preston.

21600. Electric time-reminder clocks. Dubinski. (Date applied for under International Convention, April 1, 1901.)

23166, Devices for use in electric wiring. Robertson.

23659. Hoisters for suspended electric lamps. Graetzer.

1902.

9503. Dimming attachments for electric incandescent lamps. Pogue. (Date applied for under International Convention, April 29, 1901.)

12688. Polyphase-current transformers. Thompson. (Berliner Maschinenbau Actiengesellschaft vorm. L. Schwartzkopff.)

15674. Electric motors. Holson. (Date applied for under International Convention, July 15, 1901.)

17811. Insulating apparatus for electric currents of high tension. Lemstrom.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-⅜
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	8-8½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 5 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	103-105
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16¼
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2¾-3
—— 5 per cent. Debentures	100 ..	101-106 p.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1¾-2¼
—— 5 per cent. Debentures	100 ..	77-82 xd
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102 xd
W. T. Henley's Telegraph Works, Ordinary	5	16-17
—— 4½ per cent. Preference	5	5½-5⅝
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20¼-21¼
—— 4 per cent. Debentures	100	99-102 xd
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅛-4⅜ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅛-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9 9½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £240 each	40	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12½-13⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12¼-13
—— 5 per cent. Perpetual Debenture Stock	100	124-127 xd
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅛-1⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜-5⅛ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5⅛ xd
—— 5 per cent. Deb. Stock, Red.	100	104-107
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4⅜-5⅛
—— 4 per cent. 1st Mortgage Debentures	100	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11⅛-12⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10	14⅛-15⅛
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98 xd
Imperial Tramways, Ordinary	all	22-22⅛
—— 6 per cent. Cum. Pref.	all	14⅛-15⅛
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4⅜
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. } Within 1-82,500	10	11⅛-12
—— " " " " " " } Within 1-82,500	5	8¾-9⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	108-110
—— " " Prov. Crts.	50	82-84
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10⅜
—— 5 per cent. Cum. Pref.	10	11¼-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8¼-9⅛
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	14s.	⅝
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	70 p c.	70 p.c

Electric Railways.—

Central London, Ordinary	100	103-106
—— 4 per cent. Pref.	100	106-109
—— " " deferred	100	103-106
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	71-73
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	123-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	90-93

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	103-106 xd
Bournemouth and Poole, Ordinary	10	12-13
—— 4½ per cent. Cum. Pref.	10	9¼-10¼
—— Debenture Stock, Red.	100	102-105
Brompton and Kensington, Ordinary	5	10¼-10⅜
—— 7 per cent. Preference	5	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7⅛-8⅛
—— Nos. 20,001-30,000	5	7⅛-8⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " £10 Ord.	6	10⅝
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	105-106
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4⅜-5⅛
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5⅛-5⅜
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	9-10
—— 6 per cent. Cumulative Pref.	10	12¼-13⅛
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London and Brush Provincial, Ordinary	10	8⅛-9⅛
—— 6 per cent. Cum. Pref.	10	11¼-12⅛
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	111-114
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5⅜-6¼ xd
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10¼-11⅛
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10½
London Electric, Ordinary	3	1⅜-2¼
—— 6 per cent. Pref.	5	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	110-115
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6⅜
Notting Hill Electric Lighting	10	13¾-14¼
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104 xd
Oriental, 1879	1	1¼-1⅜
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6¼-6⅜
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1⅜-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5	15-16
—— 7 per cent. Pref.	5	8¼-9¼
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	2⅛-2⅜ xd
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	2⅛-2⅜ xd
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	6-6½

Telephones.—

National Telephone, Preferred	100	93-95
—— Deferred Stock	100	55-57
—— 6 per cent. Cum. First Pref.	10	12-13
—— 6 per cent. Cum. Second Pref.	10	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	4⅞-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	96-99
—— 4 per cent. Deb. Stock, Red.	100	102-106
Oriental Telephone and Electric Company	1	⅛-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sept. 27	995	850	+ 145	+ 4,684	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	" 27	5,402	5,305	+ 97	+12,977	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23¼	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	" 26	831	781	+ 50	+ 3 802	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	" 25	1,616	1,543	+ 73	− 194	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	" 27	1,013	923	+ 90	− 446	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 28	1,707	1,568	+ 138	+ 2,725	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	" 28	3,584	1,358	+2,228	+ 74,268	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57[a]
Bristol Tramways Company	" 26	4,934	4,123	+ 811	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	" 20	195	180	+ 15	+ 450	—	—	" 31	8,675	2,010,873	323,044[h]	1·03	6·46	—	4·65
Central London Railway	" 27	6,599	5,902	+ 697	+ 6,943[h]	12	12	" 31	335,086	41,188,383	1,243,730[a]	1·88	64·29[a]	27,923	34·89[a]
City and South London Railway	" 28	3,028	1,938	+1,090	+12,035	12½	9½	" 31	62,601[a]	7,008,842[a]	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	" 26	801	488	+ 313	+ 4,313	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	" 27	252	268	− 16	+ 114	4½	—	" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 28	1,790	1,789	+ 1	— [h]	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	" 26	3,972	3,529	+ 443	} —	46	46	" 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	" 26	932	803	+ 29											
Dundee City Tramways	" 17	787	689	+ 98	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	" 27	13,081	14,277	−1,196	—	104	95	" 31	582,146[e]	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	" 24	1,253	1,209	+ 44	+ 1,866	27¾	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	" 27	1,382	1,199	+ 183	—	—	—	" 31	49,011	7,624,865	1,001,033	1·54	11·7	—	13·90
Hull Corporation, E. S.	" 27	1,718	1,702	+ 16	+ 1,924	19	9½	" 31	72,331	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	" 13	10,430	9,650	+ 780	+28,990	93	78	Dec. 31	87,707	21,065,993	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	" 28	1,472	1,589	− 117	− 1,316	15½	15½	June 30	69,152	8,426,976	787,010[a]	1·97	21·07[a]	4,450	15·94[a]
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	" 20	1,831	1,003	+ 828	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	" 28	4,233	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·62[f]
Southampton Corporation	" 25	1,107	969	+ 137	—	11	—	" 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	" 28	1,180	1,177	+ 3	—	19	17	" 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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NOTES.

The Proposed Electric Post.—It is stated that the Postmaster-General has decided to send an engineer to Italy to report upon the electrical postal system proposed by Mr. Piscicelli Taeggi. The system by which the inventor hopes to dispatch letters and parcels at the rate of 250 miles an hour by means of overhead wires on the telpherage method was briefly described in a recent issue.

Scholarships.—The Clothworkers' Scholarship of £60 a year for three years, awarded on the results of the matriculation or entrance examination of the Central Technical College has been awarded to W. H. Grinsted, from Horsham Grammar School, who obtained first place at the examination. Free studentships have been awarded by the institute to W. M. Hooton, from King's Lynn Municipal Technical School; L. G. Morse, from Marlborough College; and H. K. B. Reed, from the South-Western Polytechnic, who came next in order of merit.

Electric Traction in India.—We understand that the Allahabad Municipality have granted a concession to a Calcutta syndicate to construct and maintain an electric tramway in Allahabad. The first section of the line will not be more than 2½ miles in length, but it will run along the main thoroughfare of Allahabad, from which branch off roads leading to all the principal offices and places of business in the town. It is understood that when the first section of the tramways is in working order, other less important routes will be taken in hand until the town is in possession of a complete electric service.

Electric Furnace.—A form of electric resistance furnace has been used by W. C. Heræus in an interesting research. The apparatus consisted of a porcelain tube about two-thirds of an inch in diameter wound spirally with a strip of very thin platinum 5in. long, and a temperature of 1,300deg. C. could be reached in 10 minutes, careful attention to the resistance making it possible to observe the temperature to within 5deg. of absolute accuracy. The temperatures were recorded by a Chatelier thermo-element. With connections for passing hydrogen and a suitable telescope for watching the contents of the tube, the melting point of manganese was studied and found to be 1,245deg. C.

Electro-Harmonic Society.—The above society holds its first smoking concert of the season to-night in the Crown Room of the Holborn Restaurant, Mr. Alexander Siemens in the chair. The programme arranged promises an excellent evening's entertainment, and is quite up to the usual high standard of the society's concerts. Mr. Alfred E. Izard will be found at his customary place at the piano, while the vocalists engaged are Messrs. Alexander Tucker and Samuel Masters, and Masters John Prickett and Herbert Standring. There will also be some humorous songs and sketches from Messrs. Will Edwards and Herbert Harvey, and Mr. Acton Bond will give recitations. The programme is completed by two violoncello solos, standing in the name of Mr. B. Patterson Parker.

Post Office Appointment.—The appointment is announced of Mr. E. Trenam as controller at the Central Telegraph Office. During practically the whole of his professional career Mr. Trenam has been engaged in telegraph work, and should be eminently suited to fill his new position. He was in the service of the British and Irish Magnetic Telegraph Company when the telegraphs of the kingdom became the property of the State in 1870, and from that time forward he has held various positions under the Post Office. Mr. Trenam's first appointment was in the engineer's department of the North Midland district, but he was soon after promoted to the superintendentship of Leeds, which office he held until 1892. In that year the new controller was appointed chief superintendent of the Manchester district, which includes all South Lancashire. In 1900 Mr. Trenam was promoted to one of the newly-created offices as traffic manager, and he occupied that position until June, 1901, when he was appointed deputy controller at the central office.

Free-Wiring Agreements.—A case of great importance to those electric lighting undertakers who wire a few lights for their consumers free of charge in order to induce them to try the electric light was decided last week in the Lambeth County Court. As a rule, these free-wiring agreements are made for a period of at least three years, as it would obviously be unreasonable for the undertakers to go to the expense not only of erecting the lamps and wires but also of connecting up the same on to the mains unless the supply be taken for a considerable period of time. In the instance reported elsewhere in this week's issue, the consumer discontinued the use of the light after a few months, and then refused to abide by the terms of the agreement until he was compelled to do so by a judgment summons. Under the agreement, a minimum sum for current had to be paid each quarter, and as the light was not used this minimum sum alone became due. It is always difficult to persuade a man that what he gets for nothing is valuable, but this decision will convince the few discontented electric light consumers that the undertakers are not in business solely for the benefit of their health.

Platinum Supply.—There appears to be a likelihood of the world's platinum supply, which at present is almost stationary, while the demand is rapidly increasing, being enriched by contributions from both the States and Canada. Hitherto, the chief source of supply has been the Ural Mountains, and the total yearly amount mined there is but a few tons. It is stated, however, that two other sources of supply have been discovered in the States, one in Washington, near Princeton, and the other at the Olympia Mine, on Kennedy Mountain. The ore from one of these districts has been assayed, with the result that it has been found to contain platinum in commercial quantities. Operations will probably be commenced in the early spring next year. It is also reported that discoveries of platinum have also been made in Klondyke by an expert of the Canadian Government, who detected the metal in considerable quantities in certain consignments of gold received from that region. Should these anticipations be realised, the supply of platinum may be very largely increased, which will naturally have the effect of lowering the present price of the metal, which is already higher than that of gold.

Electric Haulage on Canals.—Some time ago we briefly referred in these columns to a scheme for applying electric traction to the propulsion of boats on the Miami and Erie Canal in the States. The proposal was to put down tracks along both sides of the canal on which the electric tractors would run, and so tow the boats either up or down the canal. Current would be taken from an overhead trolley wire in the same way as is done in the case of electric tramways. We now learn that the work of laying the track has been in progress for some months, and it is expected that by the end of the year the system will be in operation from Cincinnati to Toledo, a distance of about 200 miles. According to the intention of the promoters of the scheme, the principal traffic will be raw material transported to large manufacturing establishments located along the banks

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of the canal. Electric haulage on waterways is, of course, not new, although its application on a commercial scale is of comparatively recent date. For some two years now there has been in successful operation on a canal between Brussels and Charleroi a system of electric haulage, but in this case the distance covered is only 50 miles. Details of this system were given in a recent issue.

Johannesburg Lighting and Trams.—The municipalisation of the electric lighting and tramways in Johannesburg is, we believe, an assured fact, and the Corporation are thinking of a scheme for extending the tramways a long way outside the municipal boundaries. It will be remembered that under the Boer Government the introduction of electric trams was hindered on account of the fear that the Boer farmers would find in consequence less demand for horses and forage. The present governors of Johannesburg have no such scruples, and we are pleased to see that they are looking to English electrical engineers to advise them as to the best course to pursue. Mr. R. A. Dawbarn, of the firm of Messrs. Mordey and Dawbarn, is now on his way to South Africa in order to look into the question of the best arrangements for a large power station which is ultimately to supply electrical energy throughout the town and tramways over a much larger area. The whole system will be in the hands of the Corporation, and we presume that there will not be the trouble over the running rights in the surrounding districts which is experienced in this country when a Corporation tramway scheme has to be extended over the borough boundary.

Obituary.—We regret to hear of the death of Dr. J. H. Gladstone in his seventy-sixth year. The deceased gentleman was an able worker in the field of science. At the comparatively early age of 26 he was made a Fellow of the Royal Society and received the Davy medal of that institution for his optical and electrical researches. For some three years Dr. Gladstone was Fullerian Professor of Chemistry at the Royal Institution, and chose the "Voltaic Battery" as the subject of the juvenile lectures. In 1874 he became first president of the Physical Society. Among his contributions to the scientific literature of the day may be mentioned a paper on "Thermal Electrolysis," which he published with Mr. Tribe as joint author. Again, in conjunction with Mr. Tribe, Dr. Gladstone issued a small book on "The Chemistry of the Secondary Batteries of Planté and Faure," and later on, in 1892, Dr. Gladstone and Mr. Hibbert communicated to the Institution of Electrical Engineers a paper on "The Cause of the Changes of E.M.F. in Secondary Batteries," in which they showed the great influence of the strength of the sulphuric acid that is against the working surfaces of the plates. A more recent paper by these two gentlemen was entitled "The Molecular Refraction of Dissolved Salts and Acids." The late scientist was also an enthusiastic worker in the cause of education.

The Telephone Conference.—The dispute between the Battersea Borough Council and the Postmaster-General with respect to the proposed connecting of the Post Office telephone system with that of the National Telephone Company was referred to a conference of London borough councils at the Battersea Town Hall on Tuesday evening for consideration. Only about 12 delegates attended, despite the fact that no less than 27 public bodies in the Metropolis were invited to send representatives. From the beginning the proceedings took quite an unexpected turn—and one which we hope will result in the dispute being settled amicably. Several resolutions protesting against the Postmaster-General "entering into any agreement with the National Telephone Company which may give the latter the right to use cables laid under powers possessed by the Postmaster-General" had been entered on the agenda; but before any of these were reached a letter was submitted to the conference from the Postmaster-General offering to suspend the application to the magistrate to dispense with the permission of the local authority to lay the mains in question, with a view to having a consultation with representatives of the Battersea Borough Council in the matter. The proposal naturally met with the approval of the conference, and delegates were elected to form a deputation to wait on the Postmaster-General. It is expected that the interview will take place within the next few days.

Electric Power in New York.—Mr W. F. Wells presented a valuable statistical paper to a recent meeting of the American Association of Edison Illuminating Companies, in which he gave a comparison of the five principal power stations in Greater New York. These are owned respectively by the Metropolitan Street Railway Company, the Manhattan Railway Company, the Metropolitan (Kingsbridge) Street Railroad Company, the Rapid Transit Subway Company, and the New York (Waterside) Edison Company. The total rated generator-kilowatt capacity at the Metropolitan station is given as 38,500, of the Manhattan station as 40,000, of the Kingsbridge station as 28,000, of the Rapid Transit station as 50,000, and of the Edison Waterside station as 56,000. The working pressures adopted by these stations are put down at 150 for the Metropolitan, 160 for the Manhattan and Kingsbridge, and at 175 for the Rapid Transit and Edison stations. Both the Metropolitan and the Kingsbridge stations use vertical cross-compound engines, the Manhattan and the Rapid Transit double-compound engines, and the Edison station combined vertical and horizontal engines. The plant at the first-named station includes 11 generators, while the Edison station contains no less than 16 generators. The Manhattan and Kingsbridge stations each have eight generators, and the Rapid Transit 10. The Metropolitan, Kingsbridge, and Edison stations generate at 6,600 volts, while the Manhattan and Rapid Transit have adopted the higher pressure of 11,000 volts.

Electric Lighting in South Africa.—At the present time there are several electric lighting schemes awaiting fulfilment in South Africa. In addition to the big electrical scheme which the Corporation of Johannesburg have in hand, many other towns in the Colony are taking steps to obtain a supply of electricity for lighting and power purposes within their areas. In some cases the work is being carried out by the corporations themselves; in others it has been entrusted to companies. For instance, a company has just been formed at Newcastle, Natal, to take over a concession obtained from the Town Council some months ago for the sole and exclusive right for a period of 10 years to the use of the streets and roads of the borough for electric light and power purposes. It is proposed at once to commence the erection of a central power station. The installation will be on the direct-current, three-wire system, supply being made at a pressure of 220 volts. The plant has already been ordered, together with the poles and wires for seven miles of overhead work. It is estimated that the demand from private consumers will in the first place amount to 2,500 incandescent lamps of 16 c.p., but it is also proposed to supply power and light to many of the outlying collieries, mills, and workshops of which Newcastle is the centre. Bloemfontein is also going in for an electric lighting scheme, and tenders for the carrying out of the work have been sent in. It is expected that the contract for the installation will shortly be placed. The Town Council of Ladysmith are amongst the last to

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adopt an electric lighting scheme. In this case the tender for the service has already been accepted, and the terms of the contract call for the completion of the work in seven months' time.

Transmission of Telegrams in London.—In the transmission of telegrams within the metropolitan area to-day considerable delay must necessarily arise from the fact that all messages from one part of London to another have to be retransmitted at the central office. This has always seemed to us to be a waste of valuable time and energy, which should be avoided, and we are pleased to hear now that the Post Office is contemplating the introduction of an arrangement by which two telegraph offices in any two districts within the metropolitan area will be able to exchange telegrams direct without the messages being first "taken off" at the central office and retransmitted to their destination. The principle involved is apparently that which is employed in the telephone service. Every telegraph office in the metropolitan area will be numbered. At the central telegraph office will be installed a switchboard, with which each office will be electrically connected. Then, if Clapham, for instance, should desire to send a message to Islington, the operator at Clapham touches a special indicator key, which causes a small electric lamp on the switchboard to glow immediately under Islington's number. The operator at the central office answers the call, and immediately switches on in the ordinary way, thus connecting Islington and Clapham, and the message is transmitted directly from the one office to the other. When the message has been transmitted, both offices depress their indicator keys, which light a clearing lamp at the central office, when the operator there at once disconnects. The whole system will be worked by one set of accumulators at the Central Office, but at first only about a quarter of the total number of sub-offices in London will be included in the experiment, the intention being to introduce the arrangement gradually until it is in use in every office in the Metropolis.

Electrolytic Manufacture of Cyanides. — We understand from an article by Mr. J. W. Richards, in our American contemporary *Electrochemical Industry*, that the Ampère Electrochemical Company, of Niagara, are now working on the commercial instalment of the process for the manufacture of cyanides in the electric furnace. The process is thus described: By heating a mixture of barium oxide or carbonate with carbon in the electric furnace, barium carbide, quite similar to calcium carbide, is obtained. Its formula is BaC_2, and it is very probable that it is an unsaturated compound of the same type as acetylene, H_2C_2 and, therefore, containing two carbon atoms, which temporarily neutralise each others affinities. Such compounds easily form additional compounds, and it has been found that by heating the barium carbide, and passing nitrogen gas over it, the latter joins on to the carbon and forms barium cynanide, BaC_2N_2. Air will not do for this reaction, of course, because its oxygen would oxidise both the barium and carbon, but the oxygen must either be first removed or else rendered inert, which may be done by converting it into carbonic oxide, a process amounting to using producer gas. With this gas as the reagent, the cyanide can be formed with but little oxidation. The mass being bleached with water, the cyanide goes into solution, and may then be treated with a soda salt, such as the carbonate, to precipitate barium carbonate and leave in solution the sodium cyanide. Another alternative is to treat the barium cyanide in a closed vessel with dilute acetic acid, under reduced pressure, and passing the hydrocyanic acid gas into caustic soda solution, to produce the cyanide, leaving barium acetate behind. The mere evaporation and distillation of the latter in a closed vessel leaves behind barium carbonate, and distils off very pure acetone, much purer than is commercially obtained from calcium acetate. Experimentally, the process above outlined has given very good results.

The Grenoble Conference. — The conference of engineers at Grenoble, which was organised for the early part of last month with respect to the transmission of electrical energy from water-power plants in France, was a most successful one. We gather from our contemporary, *L'Industrie Electrique*, that some 550 delegates joined the conference, and that over 500 were present on the opening day. The interest in the proceedings was so well sustained that more than 300 took part in the last meeting at Chamonix. Our contemporary's editorial impression from the communications to the congress and from the visits to the various works in the Grenoble district is that sufficient attention has not been paid to the application of the electric power produced by the waterfalls. In other words, the generating works are well designed and executed, but the market for the use of the power has not been properly cultivated. In one case a dividend of 10 per cent. is earned, but, as a rule, we gather that commercial success has yet to be attained. Also, our contemporary complains of the numbers of works to which those present at the conference were refused entrance to view the processes carried on there. We agree that this refusal is to be regretted. When passing through works with a large party of others it is impossible for one to get sufficient information on a secret process to be of any detriment to the owners of the works. Of course, a certain amount of detail information may, perhaps, be obtained, but it is to the interest of the whole profession that these details should be freely known and discussed amongst those interested in any particular branch of industry. This interchange of ideas between rivals in the same branch of the engineering profession is carried to an extreme in the States, and in this country the number of works closed to visitors to day is exceedingly few compared with the number a few years ago. We hope to refer in other notes to the communications which were discussed before the members of this congress.

Electrolytic Production of Chlorate.—In the current number of *Electrochemical Industry*, of Philadelphia, Mr. J. W. Richards, Ph.D., describes the electrolytic process adopted by the National Electrolytic Company for the manufacture of potassium chlorate at Niagara. The process used consists in principle in the electrolysis of a solution of potassium chloride, using a copper or iron cathode and a platinum anode, the electrodes being but a very small distance apart, and a high-current density, a temperature above 40deg. C., and no porous partition. As to the efficiency of the operation, the first experiments with the process were said to yield 55 to 60 per cent. of the theoretical amount of chlorate, but present practice is somewhere nearer to 70 per cent. efficiency. The apparatus employed consists of rectangular wooden frames, alternating with lead plates, placed together in a frame like a filter press, with rubber gaskets between. One side of the gasket is against the iron or lead plate, the other against the copper or iron cathodes. The anodes are platinum foil, supported on the lead or iron plates. Solution of potassium chloride runs into each cell continuously, at the rate of about one cubic foot each 30 minutes, at a temperature of 20deg. C., and its flow is so regulated that the temperature of the cell remains above 40deg. C. and averages 70deg. C. Any number of cells may be put into one frame, in form like a

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BELLISS AND MORCOM'S WORKS, BIRMINGHAM.

In response to an invitation by Messrs. Belliss and Morcom, Limited, we journeyed down to Birmingham last week to see a Crompton-Belliss 750-kw. combined steam dynamo under steam at their Rotton Park Street works. The set, of which a view is given in Fig. 1, is one of two of this size which will be installed at the new works of the Calcutta Electricity Supply Corporation, Limited. The engine is of Messrs. Belliss and Morcom's patent self-lubricating, quick-revolution, triple-expansion type, having only three cylinders—viz., high, intermediate, and low pressure—thus ensuring simplicity of design. By means of valveless pumps driven off the engine crankshaft, and arranged in an oil-well in the crank chamber, the firm's automatic system of forced lubrication is applied to all the bearings at a pressure of 10lb. to 15lb. per square inch. The plant runs at 230 revolutions per minute with a steam pressure at the engine of 160lb. per square inch, and is arranged to work non-condensing at present. With regard to the generator portion of the set, we have already fully described this, it being one of the dynamos recently under test at the Arc Works, Chelmsford, and reported upon in our issue of Aug. 1 last. There is no need to recapitulate beyond stating that it is of Messrs. Crompton's well-known multipolar type, fitted with a slotted drum-wound armature 7ft. in diameter and weighing 13 tons. The magnets are compound wound, the outside diameter of the yokes being approximately 12ft. The commutators are fitted with carbon brushes, and all bearings are self-oiling.

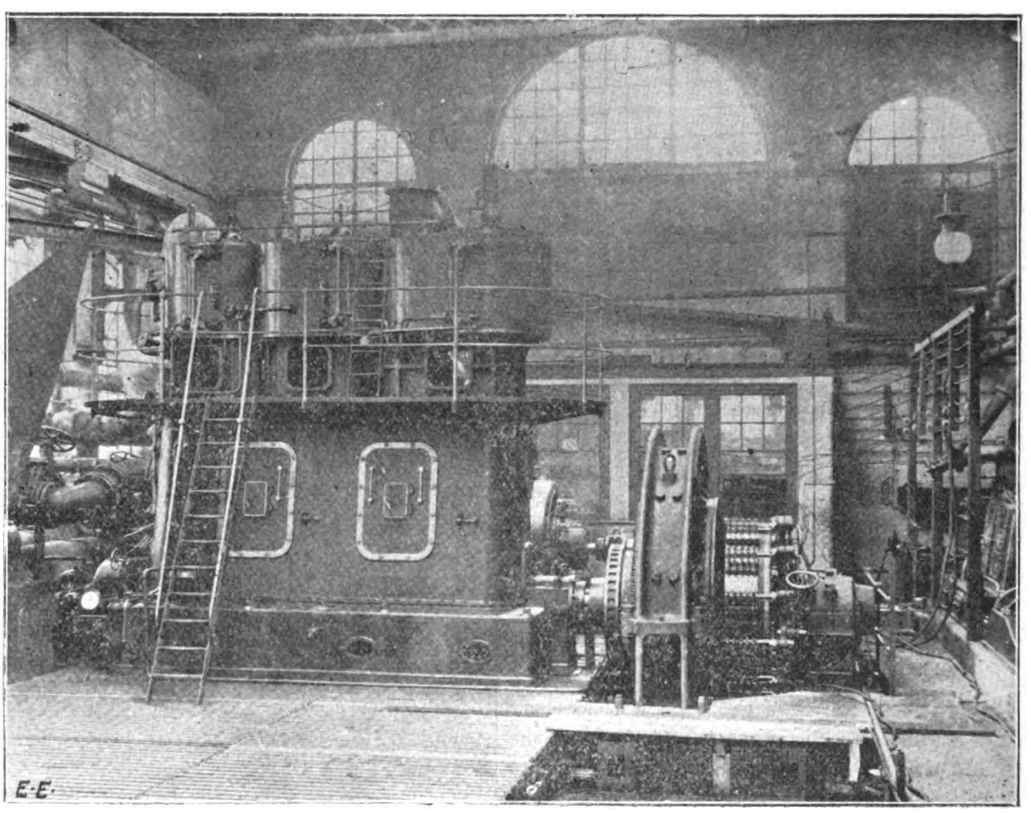

FIG. 1.—Crompton-Belliss 750-kw. Set for Calcutta.

Although primarily designed for lighting purposes, the plant embodies all the essential qualities for traction work, and will, therefore, be equally suitable in that capacity if necessary at a future date. It may be mentioned in this connection that three 250-kw. similar sets have been recently supplied to the Calcutta Electricity Supply Corporation for power purposes. We were greatly impressed by the steady and extremely quiet running of the large set on load, a testimony to well-proportioned and balanced parts, apart from the excellent foundation provided by the test bed. Unfortunately, no figures are available as so the results of the combined test, the figures not having been fully worked out up to the time of going to press, but we understand that the guarantees have been fully maintained in every respect. The second of the 750-kw. sets, which completes the order for Calcutta, will shortly also be ready for dispatch, the generator part being finished and the engine already in an advanced stage of erection.

In addition to seeing the above-described set under steam, we were afforded an opportunity of looking through Messrs. Belliss and Morcom's Rotton Park Street works, which constitute the firm's "electrical machinery department." It is not, however, our intention to attempt more than a cursory description of this department in the present article. It represents an overgrowth of the firm's Ledsam-street works, but judged by the immense amount of work in various stages of completion which it contains, recent erection would hardly be suspected. Although an overgrowth, the new department is practically self-contained, consisting of a machine shop, erecting shop, and foundry. The shops and foundry are remarkably fine examples of their respective kinds, as will be appreciated on referring to the accompanying illustrations, and their equipment throughout is of the most modern description. We would not imply by the latter statement that America has been resorted to for machine tools. On the contrary, with a few isolated and unimportant exceptions, the tools installed bear the nameplates of well-known English and Scotch firms, and may be instanced as a refreshing testimony to the maintained superiority of British manufacturers in this special branch of engineering, the chatter of irresponsible critics notwithstanding. It was indeed a treat to see some of the home-made tools at work, and to witness the skill with which they were tended by British labour.

The foundry (Fig. 2) is 225ft long by 55ft. wide, and its capacity 70 tons per week. It is served by three electrically-driven overhead travelling cranes capable of lifting 25 tons, 15 tons, and 5 tons respectively. Electrical power is also used for sand-mixing, blowing the cupola, and for driving the air-compressors used for machine moulding purposes. All the big castings, such as bed-plates, casings, etc., required for the engines are made in this foundry; the lighter castings of a special nature, including cylinders, being made at the Ledsam-street works. Close to the foundry is the pattern stores, where patterns for standard sizes of engines up to 2,000 h.p. are kept. Passing out of the foundry we cross a space in which the castings are checked and deposited until

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required for machining, and then enter into the main machine shop (Fig. 3), which is 320ft. long and 100ft. finally all assembled for erection. Two electrically-driven overhead travellers, one of 15 tons and the other of 5 tons

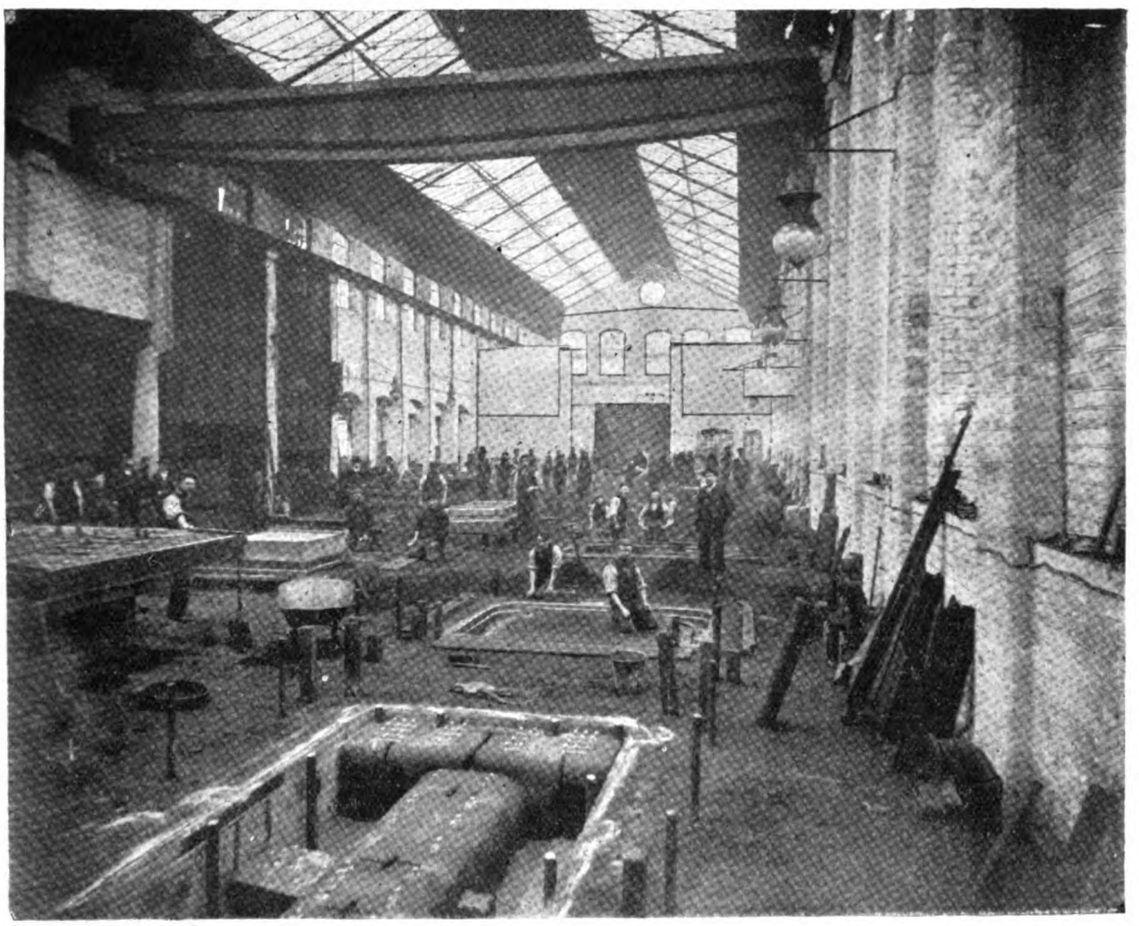

FIG. 2.—Foundry, Belliss and Morcom's Rotton Park Street Works, Birmingham.

FIG. 3.—Main Machine Shop, Belliss and Morcom's Rotton Park Street Works, Birmingham.

wide. In this shop the tools are arranged on the principle of the progression of parts from tool to tool, until they are capacity, serve the main floor, while the side galleries are each served by a number of jib cranes for handwork,

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and a two-ton single-rail electric travelling jib crane of an extremely handy pattern, and capable of travelling 300ft. a minute. Parallel with the machine shop is the erecting shop, which includes a testing department for cylinders and another for finished sets. The machine-testing department will allow of eight engines of various sizes being tested at once. In Fig. 4 the 750-kw. Crompton-Belliss set for Calcutta is seen in the background, and a number of smaller sets in front. The foundation plates to which the engines are bolted are of cast iron attached to a bed of solid concrete. They are arranged at two levels to enable large generators to be set up without the trouble of packing up the engines. Tests are made with either brake or electrical load, water brakes of the Froude pattern being provided for the former, while the electrical load is taken up either by water resistance or by resistance frames, the connections being arranged to carry voltages up to 3,000. As regards the water resistance apparatus, this consists of large wooden tanks containing cast-iron electrodes. The temperature is regulated by means of a steady flow of canal water into the tanks. It is worthy of mention that no acid has to be added to this water, its conductivity being good enough as drawn from the canal, owing to the convenient presence of acids in solution. The works generating plant is installed opposite the testing departments off the erecting shop, and consists of two Belliss-Parker sets, which supply energy for power and lighting purposes throughout the works, the lighting being by means of arc lamps.

Passing through the erecting shop we noticed a great variety of makes of dynamos, either coupled to finished engines or destined for coupling to engines yet in the erecting stage. As regards work in hand, mention may be made of a few of the very large number of orders going through the shops. Our attention was particularly called to one of three 400-h.p. engines on order for the Worcester Corporation. This engine is of the Belliss triple-expansion three-cylinder type, and was recently tested with 140lb. steam superheated to 550deg. F. by means of a Schmidt superheater, the result being a consumption of 18·4lb. of steam per kilowatt-hour over a six hours' run—a splendid performance. On the occasion of our visit this engine was opened out for inspection. There was not the slightest indication to the eye of injury through the action of the superheat on the lubricant used in the cylinders, all the surfaces being in first-rate condition. Of the other engines in an advanced stage of erection, apart from those already mentioned or actually under test, we noticed the following: one of 650 h.p. for Vickers, Sons, and Maxim; one of 850 h.p. for Siemens Bros., Stafford Works; one of 650 h.p. for London and North-Western Railway, Wolverton Works; one of 750 h.p. for Plymouth Corporation; four of 500 h.p. each for Lancaster Corporation; one of 400 h.p. for Grimsby Corporation; one of 550 h.p. for Hull Corporation; and four of 120 h.p. each for H.M.S. "Berwick." The above list is very incomplete, representing only a few of the engines in course of erection which attracted our attention.

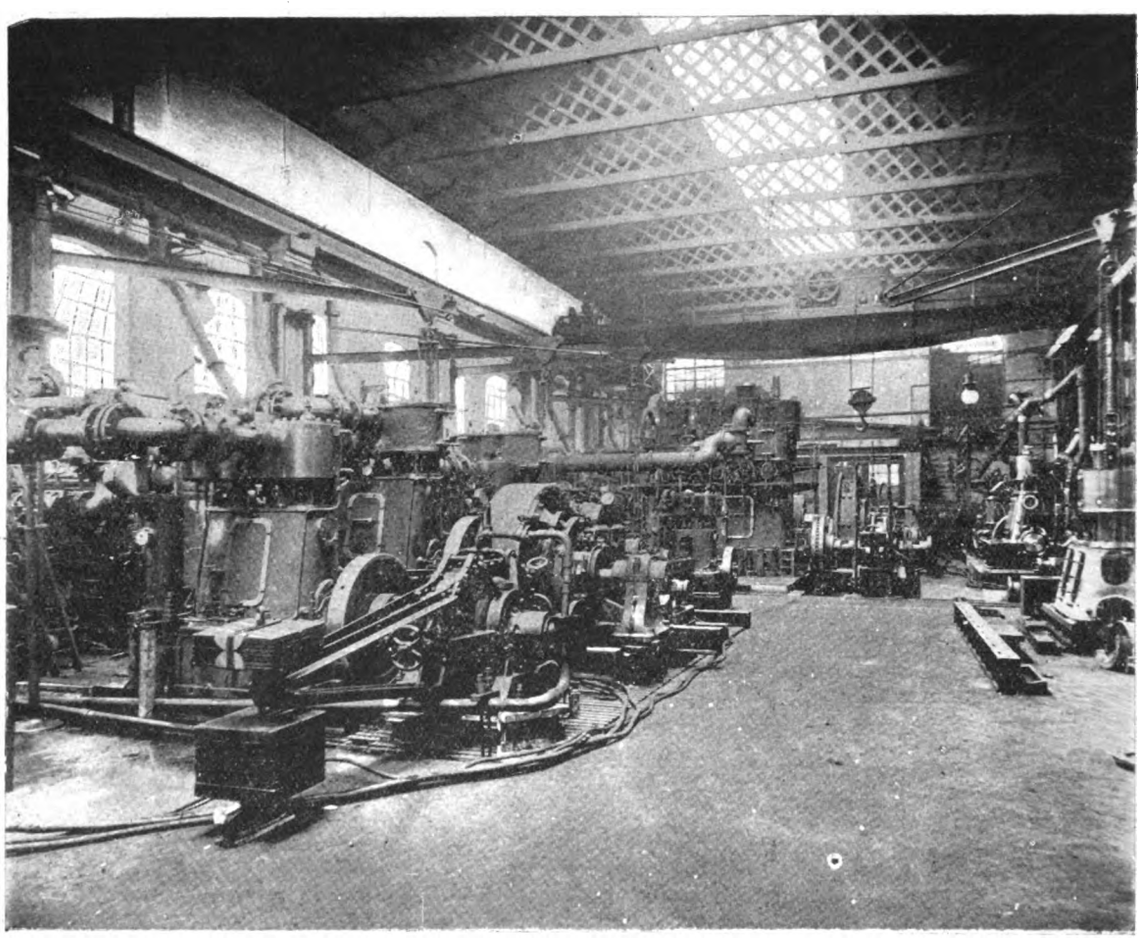

Fig. 4.—Engine-Testing Department, Belliss and Morcom's Rotton Park Street Works, Birmingham

To convey cylinder castings, etc., from the Ledsam-street works an electrically-driven motor trolley is used. This trolley is constructed to carry 7½ tons, and was designed and built in the works. It is equipped with accumulators of the Chloride type and has been in use for about 3¼ years, during which time it has continued to give complete satisfaction. It may be mentioned, in conclusion, that Messrs. Belliss and Morcom, Limited, employ on an average about 1,000 hands, engines aggregating from 60,000 h.p. to 70,000 h.p. being turned out each year. We were impressed with the evident care which is taken to obtain perfection in each department of the works and stage of manufacture. Apart from good mechanical design and exceptional workmanship, it is probably largely owing to the care in selecting and testing materials from which it is produced that the success of the Belliss engine is due.

New York.—A New York message says that the militia has been ordered out to protect the property of the Huron Valley Railway Company, on the electric road, where a strike of motormen has been in progress for some weeks.

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ELECTRIC LIGHTING AND TRAMWAYS AT WEST BROMWICH.

(Concluded from page 483.)

TRAMWAYS.

The tramways in West Bromwich were constructed in 1882, and formed part of the tramway undertaking owned and worked by the South Staffordshire Tramway Company, Limited. Steam power was introduced in 1883. The lines have a total length of 10 miles 1 furlong 132 yards, and a route mileage of 5 miles 1 furlong 132 yards. There are also single lines with passing places in Spon-lane and Bromford-lane and Paradise-street of a total length of 2 miles 1 furlong 156 yards, and a route of 1 mile 7 furlongs 43 yards owned and worked by the Birmingham and Midland Tramway Company, Limited. In March, 1898, a sub-committee of the Highway Committee was appointed to obtain information as regards the various systems of traction, and to report to the Council on the matter generally. After visiting various towns, the committee recommended the Council to purchase the undertakings, and to reconstruct them for electric traction on the overhead system. In 1900 the Corporation obtained parliamentary powers to reconstruct, equip, and work the tramways, and after due consideration the Council decided to lease the lines when constructed and equipped to the South Staffordshire Tramway (Lessee) Company, Limited, on terms agreed upon between the company and the Corporation.

Purchase of Existing Lines.—The Corporation paid for the existing lines of the South Staffordshire Tramway Company, Limited, a sum of £32,000; such sum included compensation for the company foregoing their rights to sell to the Corporation a portion of the whole of the equipment of their undertaking. The Corporation also paid to the company who had leased their undertaking to the Lessee Company a sum of £538. 15s., compensation for loss of rent in respect of that part of the South Staffordshire tramways situate in the borough owing to the company selling the lines before they were obliged to do so under the terms of the provisional order. For the lines owned by the Birmingham and Midland Tramway Company, Limited, the Corporation paid the sum of £5,500. The total cost of purchase, therefore, was £38,038. 15s. After the purchase had been completed the Corporation instructed the author and Mr. Quin, M.I.M.E., M.I.E.E., consulting engineer, to prepare the necessary plans and specifications for the reconstruction and electrical equipment of the various lines. In due course these were submitted to the Council and approved by them, and as part of the agreement was that the Lessee Company should approve of the scheme, they were submitted for their approval, and an arrangement was arrived at between the company and the Corporation for the work to be carried out at a cost not exceeding £100,000. Contracts were then entered into, and the works are now in hand. The following are the details of construction.

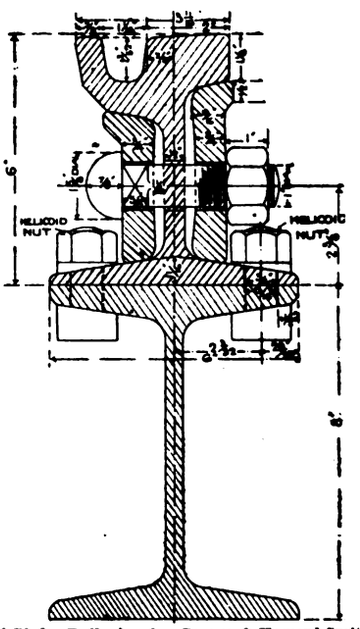

FIG. 6.—Section of Girder Rail, showing Cooper & Howard-Smith's Anchor Joint

Permanent Way.—The rails (Fig. 6) are of the girder type, 6in. deep, 45ft. in length, weighing 97½lb to the yard, the chemical composition being as follows.

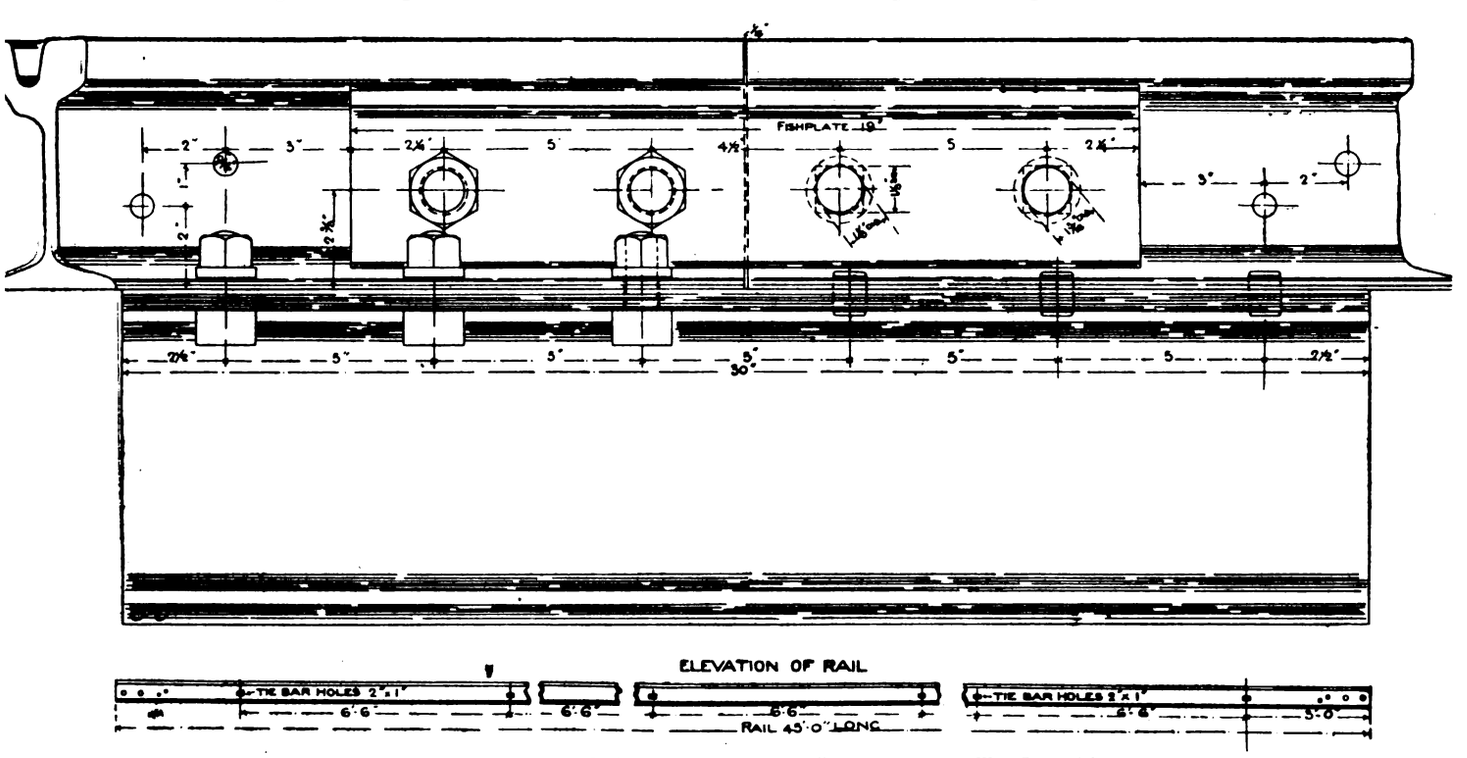

FIG. 7.—Details of Girder Rail, Joints, and Fishplates, Electric Tramways, West Bromwich.

Carbon	from ·50 to ·60	per cent.
Manganese	,, ·80 ,, 1	,,
Silicon	maximum ·15	,,
Phosphorus	,, ·06	,,
Sulphur	,, ·05	,,

The rails are tested for tensile strength, the requirement being that the ultimate tensile strength of the metal shall not be less than 40 tons per square inch, with an elongation of 15 per cent. in a length of 8in., and also for tupping test as follows: Six lengths from each rolling

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(each 6ft. long) are taken and tested in the following manner: each is placed on supports 3ft. apart, and a weight of one ton is allowed to fall upon the rail at its centre from a height of 20ft. Under these conditions there shall be no fracture of the rail. The tiebars are made of Staffordshire B.B.B. iron, 1½in. by ⅜in. double screwed. At each end a modified form of Cooper and Howard Smith's anchor joint (Fig. 7) is used, consisting of a 2ft. 6in. rolled-steel joist, 8in. by 6in. of a weight of 35lb. to the foot, the rails being bolted to this joist by means of 12 ¾in. steel bolts with shaped heads, malleable iron bevel washers, and helicoid nuts, and the joint is embedded in concrete. In laying the rails the joints are kept as close as possible, not exceeding $\frac{1}{16}$in. in clearance, reliance being placed upon the elastic limit of the steel and the strength of the anchor joints to prevent dislocation of the track or fracture of rails. The steel fishplates are 19in. long by ¾in. thick, the chemical composition being

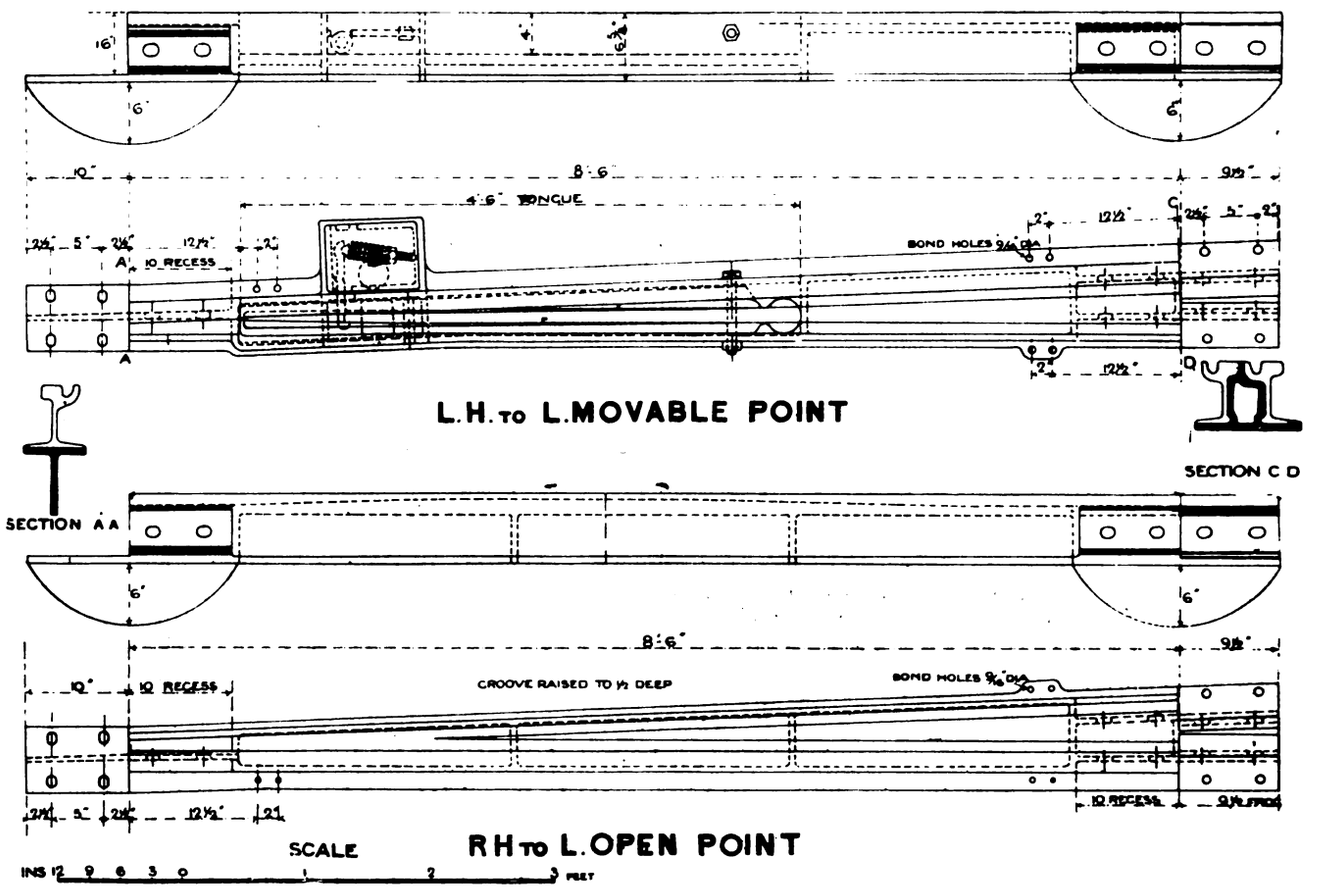

FIG. 8.—Details of Track, Electric Tramways, West Bromwich.

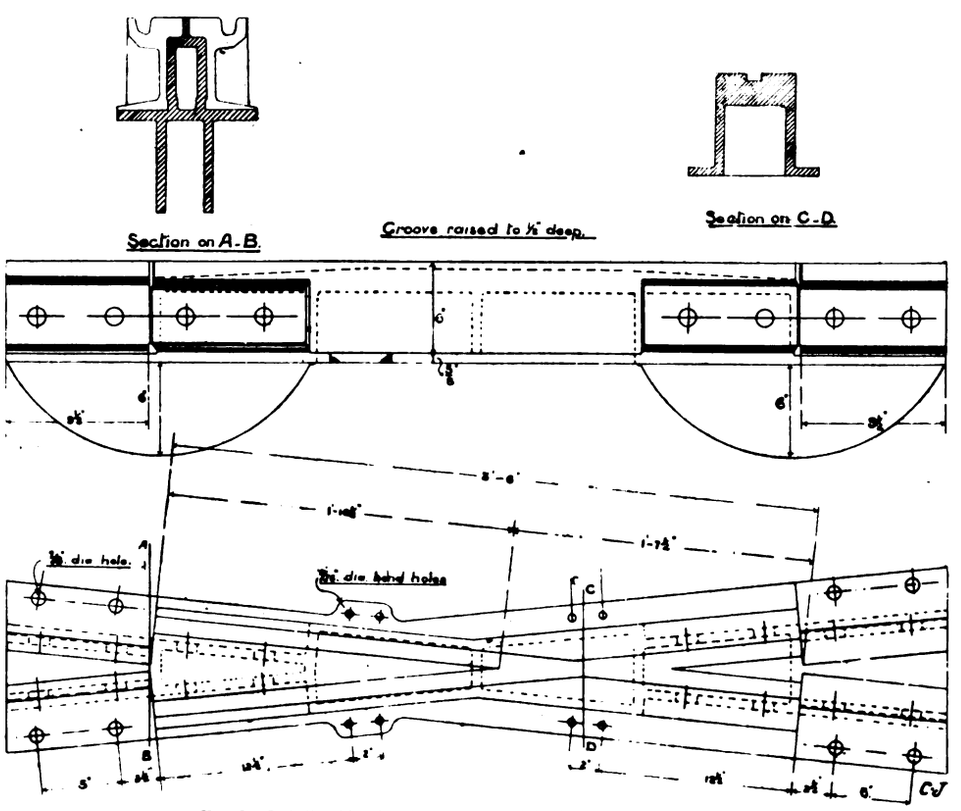

FIG. 9.—Details of Typical Crossing, Electric Tramways, West Bromwich.

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Carbon	·45 to ·55	per cent.
Manganese	·6 ,, ·9	,,
Silicon	·06 ,, ·1	,,
Phosphorus	·08 ,, ·1	,,
Sulphur	not exceeding ·06	,,

These weigh 32½lb. per pair, and are bolted to the rails by four 1in. bolts with helicoid nuts. The points, crossings, setts, such of the existing setts as are suitable are being redressed and used again. In front of the town hall and all places of worship wood paving is being laid. This is of jarrah and American redgum, 9in. by 4in. by 3in. blocks, laid in the usual way. The rails are bonded with Neptune 000 bonds, two to every joint, and opposite each of the supporting posts (average distance apart 110ft.) all

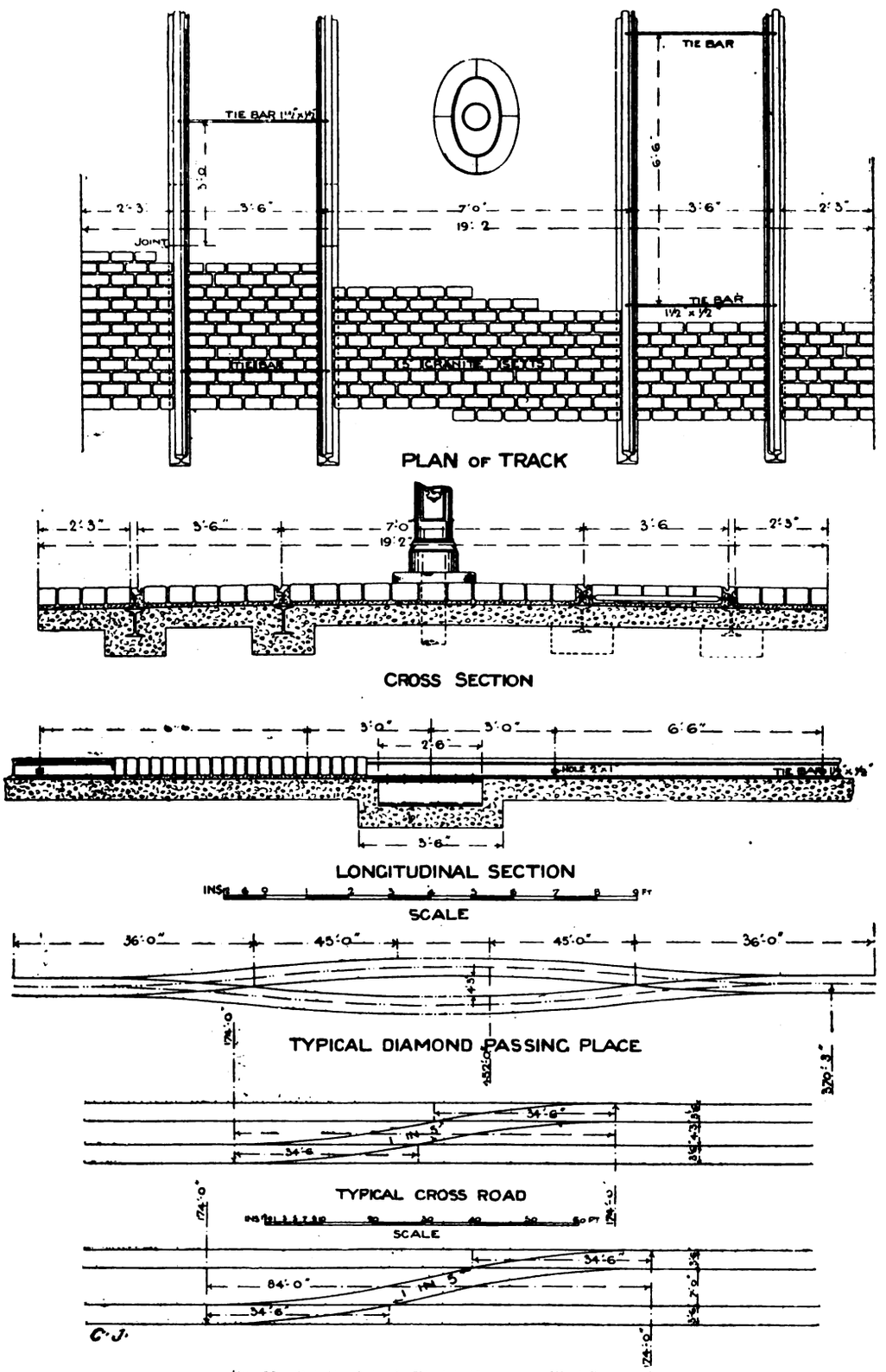

FIG. 10.—Details of Track, Electric Tramways, West Bromwich.

and drain rails (Figs. 8, 9, and 10) are Messrs. Hadfields' patent manganese steel, of designs made by the engineers. The permanent way is being carried out under contract by Mr. George Law, of Kidderminster; the existing concrete is left in, except in places where it is bad or has been cut up for drainage and other connections. All new concrete consists of one measure of cement, two of sand, and four of broken bricks, slag, or broken concrete, and is 6in. thick. The new granite setts are 5in. Mountsorrel four rails (where double track exists) are cross-bonded together and to the post, where span-wire construction holds. The outer rails of each track are taken alternately to one of the supporting poles for the overhead line.

Electrical Equipment.—The poles (Fig. 11) are of steel, constructed in three lengths, each length of parallel bore. They are inserted into one another for a length of 18in. and then welded. They are tested by dropping vertically from a height of 5ft. on hard ground, and have to with-

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stand this test without fracture of welding or splitting of tubes. The centre poles have a total length of 30ft. 6in., of which 6ft. is root. The bottom length is 17ft. long by 10in. outside diameter, ½in. thick; the middle length 7ft., exclusive of allowance for welding, 8½in. outside diameter and ·4in. thick; and the top length 6ft. 6in., exclusive of allowance for welding, 7in. outside diameter and ·3in. thick. The strength of these poles is such that when treated as a horizontal beam, held rigidly for 6ft. from the end of the larger section, and with a weight of 2,000lb. supported at a distance of 24in. from the smaller end, the temporary deflection shall not exceed 6in. and the permanent set shall not exceed ½in. Every pole of this class is provided with a cast-iron baseplate and an elliptical base (so arranged for the purpose of street-lighting). On each of the long sides of the base are cast the coat-of-arms of the borough, and at each end a door. The bases are provided with a bottom plate bolted to the base and pole, and with space for cables to pass through. Inside the base at each end there are two vertical ribs with cored holes for attaching switchgear. Each pole is fitted with two 5ft. by 1¾in. solid steel-drawn tubes and wrought-iron scroll work, cast-iron finial, etc., as shown on the detail drawing. The straining poles have a total length of 32ft., of which 7ft. is root. The bottom length is 18ft. 6in., 13⅛in. diameter, and ·56in. thick; the middle length 5ft. 6in., exclusive of allowance for welding, 11½in. diameter and ·43in. thick; the top length 8ft., exclusive of allowance for welding, 10in. diameter and ·37in. thick. These poles have to stand a strain of 5,000lb., treated in a similar manner to the centre poles, and have circular

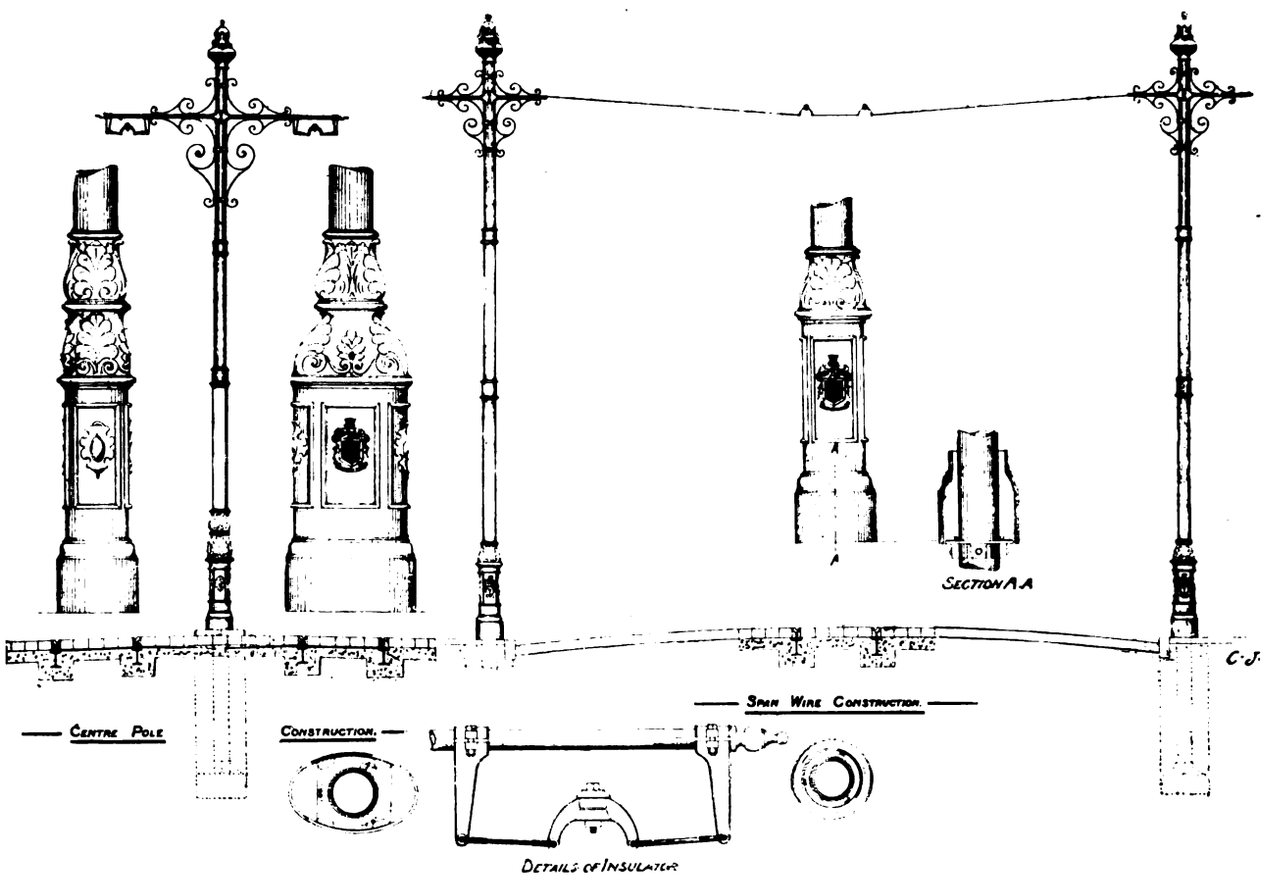

FIG. 11.—Details of Electric Tramway Poles, West Bromwich.

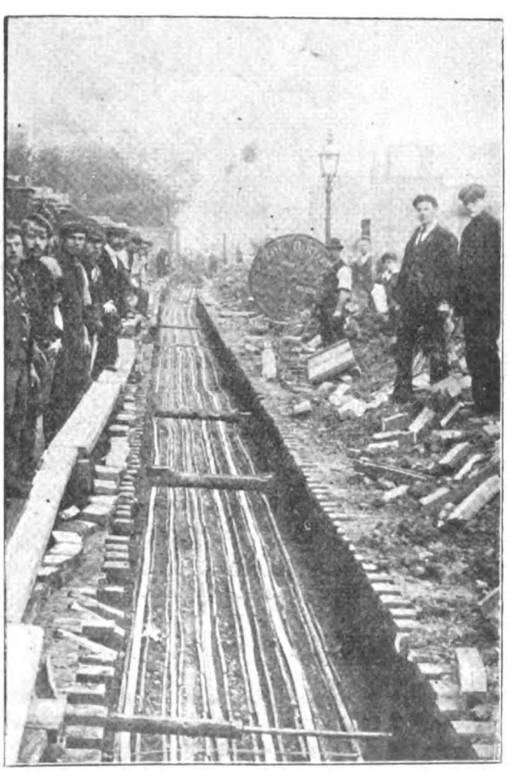

FIG. 12.—Laying Cables, Electric Lighting Scheme, West Bromwich.

STATEMENT SHOWING COST PER MILE, DOUBLE AND SINGLE TRACKS, FOR RECONSTRUCTION AND ELECTRICAL EQUIPMENT OF TRAMWAYS IN WEST BROMWICH.

Permanent way.	Single track.	Double track.
	£	£
Rails (97½lb. per yard), concrete, tiebars, fishplates, joints, points and crossings, paving, etc. The margins are paved for a distance of 2ft. 3in. from the rails, and the space between the tracks is 7ft. for centre-pole construction — total width over all, double track 19ft., single track 8ft. 4in.	5,800	12,000
Bonding, labour, and materials...	150	340
	Span-wire construction.	Centre-pole construction.
Poles, bases, and planting.....	1,930	1,030
Electrical equipment.		Route mile.
Cables and laying	—	1,560
Overhead equipment	—	660

NOTE.—All the above items include for superintendence.

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bases, etc., of the same design. The span wire poles have a total length of 31ft., of which 6ft. is root; the bottom length is 17ft., 10in. outside diameter, and ·65in. thick; the middle length 7ft., exclusive of allowance for welding, 8½in. outside diameter, and ·4in. thick; the top length 7ft., exclusive of allowance for welding, 7in. outside diameter, and ·3in. thick. These poles have to stand a strain of 2,500lb., treated in a similar manner to the centre poles, and have circular bases, etc., of the same design as the others. Each pole is fitted with two 2ft. 6in. by 1¾in. solid-drawn steel tubes, having a radical depth of metal of not less than ·25in., and each screwed at one end into a malleable iron socket clamp for attachment to the poles. One arm of each pole is formed with a clevis and with bolt for span wire attachment; the other arm is provided with a cast-iron ornamental finial; they are also provided with wrought-iron scrollwork, as per detail drawing. Every pole is drilled with two $\frac{9}{16}$in. holes 6in. below the ground level for the purpose of electric bonding. All the poles and ironwork will be painted on completion.

Trolley Wire.—The trolley wire is circular in section and equivalent to 000 S.W.G. The insulators are of the type shown on details with gunmetal fittings; the section boxes are of special pattern, and each box will contain two of "Quin's" patent automatic safety switches, in order to cut off the current in case a trolley wire breaks or any telephone wires fall on the live trolley wires (for full description of this apparatus see paper by Ed. Manville, read at annual meeting at Leicester, June 27, 1901, vol. xxvii., p. 239); with very few exceptions the whole of the telephone wires have been removed from the tramway routes. The boxes also contain telephone apparatus.

Cables.—The feeding cables are placed under the footpaths in socketed earthenware troughs (Fig. 12), with blue brick covers, the compound for filling the troughs being composed of dry sand, Stockholm tar, and amber resin, and the work of laying the cables has been carried out departmentally under the supervision of the engineers. The length of cable and pilots, etc, is about 25 miles. When the tramways are reconstructed and electrically equipped, the Corporation are under agreement to lease them to the companies as before stated, the terms of which have been settled between the Corporation and the respective companies, the companies in each case providing the cars and taking the current for driving them from the Corporation generating station.

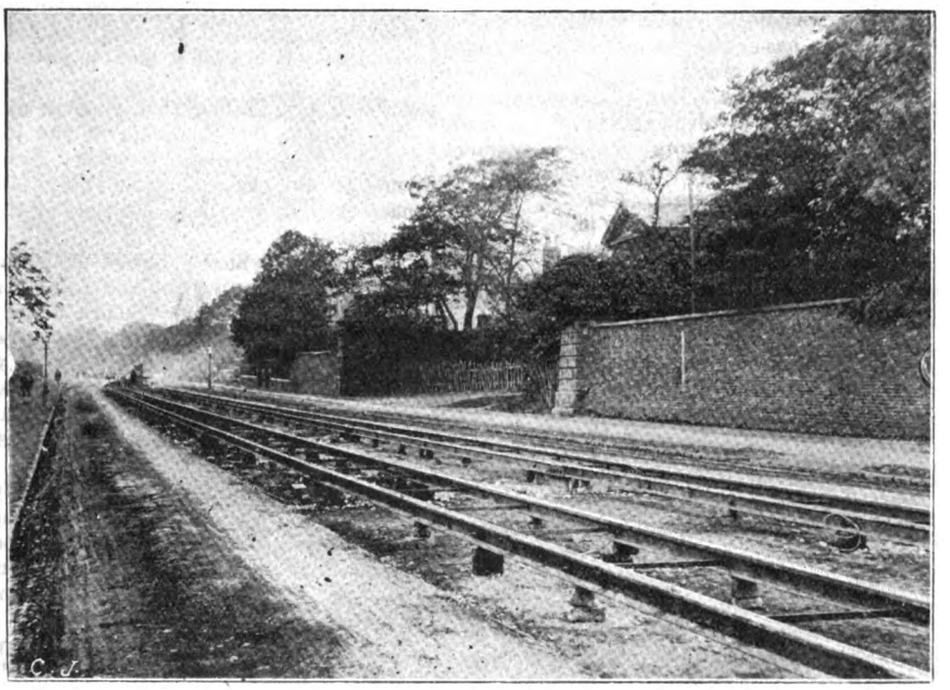

FIG. 13.—Laying Tramway, West Bromwich.

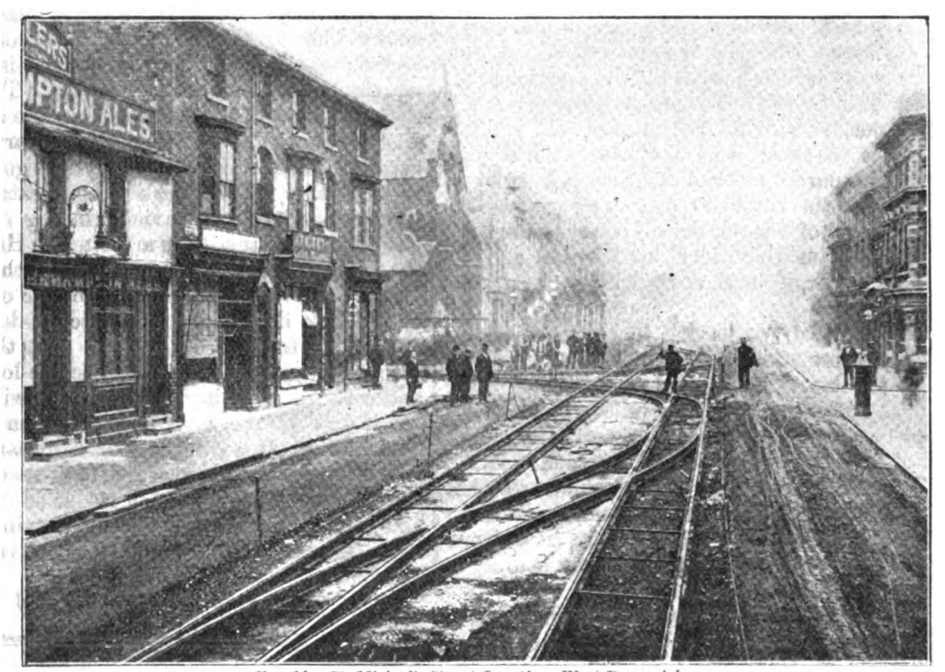

FIG. 14.—St. Michael's Street Junction, West Bromwich.

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LEAVES FROM A TESTING ENGINEER'S NOTEBOOK.

BY FRED. W. DAVIES.

Introductory Remarks.—Those electrical engineers who have had experience in the testing and running of dynamo-electric machines will probably, in the course of their work, have met with machines having faults and defects of various kinds. When a fault develops in, or is inherent in the design of, a machine working on mechanical principles, such as a steam-engine, gas-engine, pump, etc., the cause of it is usually apparent to the practised eye of the engineer when he examines the machine. But with a machine in which electrical principles are involved this is not so. Such faults as occur in dynamos and motors—for it is intended in these articles only to deal with continuous-current machines—are often of obscure origin. For their ready detection it is necessary not only to have an understanding of the principles involved, but also to have a fund of previous experience to draw upon. Often it is only after much cogitation and inductive reasoning that the cause of a fault is discovered. The causes of such faults are rarely made a note of. They are continually recurring, yet generally no systematic study is made of them. Of course, one can remember the causes of many of the faults which occur so as to be able to immediately locate them. It will, clearly, be of advantage to give a systematic catalogue of some of the faults which occur—together with their causes They can then be studied at leisure; and this study will afford an insight into the actions and reactions which take place in continuous-current dynamo-electric machines. The time spent in such a study will be well repaid in the ease of diagnosing any defect that may occur which will be attained thereby. With this end in view, the present articles have been written. Electrical engineering is a very wide subject, and it is obviously impracticable to cover the whole ground; but the cases given below are fairly typical ones. A brief statement of some of the faults which have occurred, together with an explanation of them and the method adopted for their remedy, will be given; and in this way it is hoped to give not only the results of experience but the experience itself. For the sake of brevity and conciseness, as well as with the idea of presenting the matter in as readable a garb as possible, the various notes and comments have been classified under the headings of the parts of a machine to which they refer. These notes, of course, do not embrace all the faults which may occur in a dynamo or motor; but they deal, at all events, with those which are most likely to be met with in actual practice, and will, no doubt, be of service to those who may have to deal with such machines. The purely mechanical parts of a machine, such as the shaft and bearings, do not, strictly speaking, come within the scope of the electrical points treated of in these articles; yet, as they form an integral part of every dynamo and motor, a brief space will be devoted to their consideration.

Shafts.—The shafts of dynamos and motors are usually, in the small and medium sizes of machines, at any rate, of mild steel. For the larger sizes, steel forgings are used. Various empirical rules, more or less reliable, have been given, by means of which the dimensions and proportions of a shaft suitable for a given size of machine may be determined. With regard to the sizes of shafts suitable for the smaller machines, the ideas of the makers seem to vary somewhat. In this, as in all other matters, experience is a safe guide. It is always better to err by making a shaft too large rather than too small.

Except in machines having armatures of the disc type, a little end play should be allowed for the shaft of all dynamo-electric machines. The total end play which it is advisable to allow is given by the formula, $e = \frac{\sqrt{d}}{8}$ (where e = total end play—both ends of the shaft, and d = diameter of journals, in inches; if they are of different diameters at the two ends of the machine, the mean diameter should be taken). The object of allowing this end play is to prevent the wearing of grooves in the commutator, and also to ensure the smooth wearing and running of the journals themselves.

It is bad practice to have sharp corners at the shoulders of shafts. It occurred on one occasion that a shaft broke off at one of the shoulders owing to the corners being sharp and the shaft rather weak. To avoid this possibility, they should be rounded at the corners with as large a radius as possible. This may seem to be a small matter, but it is, nevertheless, an important one.

The oil from the bearings is sometimes thrown out from the shafts near the bearings by centrifugal force. This is entirely avoidable if the shafts and bearings are properly designed. It is a good plan to have an oil-throwing disc fitted on the shaft. This may either be shrunk on or caulked on. Failing this, grooves may be turned in the shaft close to the shoulders at the journals. The ridges thereby formed must be sharp, otherwise the oil will "creep" along the shaft. This plan suffices for small machines, but for the larger sizes oil-throwing discs are to be preferred.

A machine which splashed oil rather badly was much improved by turning out the corners of the shaft at the journals more sharply. Before doing this, the radius at the end of the bearing step and the radius at the corner of the shaft were the same. Owing to this, the oil was sucked up to the larger diameter of shaft, and from thence crept along to the outside of the bearing, where it was thrown off. For a new machine it is better, as already stated, to have an oil-throwing disc.

Bearings.—Small machines are usually provided with but two bearings. For the larger sizes of machines it is necessary to have either a larger shaft and bearing at the pulley end (if the pulley is an overhung one), or else to have three bearings. The latter plan, although somewhat more costly, is certainly to be preferred wherever possible. Bearings get unduly hot sometimes because they are too small for the pressure that comes upon them. In designing a new machine it is important that the bearings should be of ample size. The length of the bearing bush may be made from $2\frac{1}{2}$ to $3\frac{1}{2}$ times the diameter of the journal, the greater lengths being for the higher speeds. The number of oiling rings in a self-oiling bearing depends, of course, upon the size of the bearing. It is better to have several small oiling rings than a few large ones, as then the oil is distributed more evenly.

Armature Cores.—These may be either of the ring or the drum type, and may be either plain, toothed, or iron clad. The type most favoured for ordinary continuous-current machines at the present time is the drum, usually of the plain or toothed variety. The ironclad type is difficult to wind, and, besides this, the commutation is not so good as with a plain or toothed armature. The plain type of armature, in particular, yields good results as regards commutation, but, owing to the greater length of airgap required, requires a heavier winding on the field magnet than does a toothed-core armature. Heating is the trouble that is most likely to be met with in the core of an armature. When such heating of the core occurs it will usually be found to be due to some defect in design. One possible cause in a toothed armature is that the teeth may be of insufficient section. In that case the losses from hysteresis and eddy currents in the core discs will be unduly great. Or, it may be, the internal ventilation of the armature is insufficient. It is necessary, it need hardly be said, for the cool running of an armature, that there should be a free access of air to the inside of it—at any rate in the medium and large sizes of machines. Certainly all armatures of over 12in. diameter should be constructed with internal ventilation.

(To be continued.)

THE USE OF ELECTRICITY IN IRON AND STEEL WORKS.*

BY F. KYLBERG, BENRATH, NEAR DUSSELDORF.

(Concluded from page 490.)

Cogging Train with Electrically-Driven Live Roller Gear, Roll Screwing Gear, Upsetting and Transferring Gear, and Ingot Cradles (Figs. 9 and 10).—The cogging train shown

* Paper read before the Iron and Steel Institute at Düsseldorf.

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in Fig. 9 with live rollers is designed exclusively for electric driving. A novel arrangement in connection with this cogging mill, which, so far as the author is aware, has never hitherto been put in operation in Europe, is the electric screw gear for the adjustment of the upper roll. This arrangement was first designed in 1895 by the firm of Mackintosh, Hemphill, and Co., in Pittsburg, for the various rolling mills of the Bethlehem Iron and Steel Company. At first the arrangement consisted of an electric motor, placed between the two housings, for the adjustment of the upper roll. A great difficulty was, however, experienced in keeping the motor cool on account of the proximity to the heavy slabs and the exposure to the great heat which radiated from these. In 1889, when the Bethlehem steelworks were taken over by the Carnegie interests, and were re-erected in Homestead, it was soon found necessary to alter the method of driving, and the whole of the motors for actuating the screwing gear were placed at one side of the building, the motion being transmitted by means of belts. This system was further modified by the Wellman Seaver Company, who constructed an electric adjusting gear in which one motor only was employed, which was fixed on the outer side of the housing. These adjusting gears were inspected by the author on the occasion of a visit to Alabama, near Birmingham, and their working was all that could be desired. The driving was effected by means of an electric motor of 100 h.p. The arrangement described in the present paper has the advantage, as compared with the present design, that the driving of the screw adjusting gear is effected by means of two motors, one on either side of the housing. Either motor can be cut out, or they can work together in the same manner as described in the earlier portion of the paper, by which means the speed of adjustment can be varied as desired. The system of two motors ensures, besides, a greater precision of action, and in case either motor is incapacitated from any cause, the other would still be sufficient to perform the necessary work of adjustment.

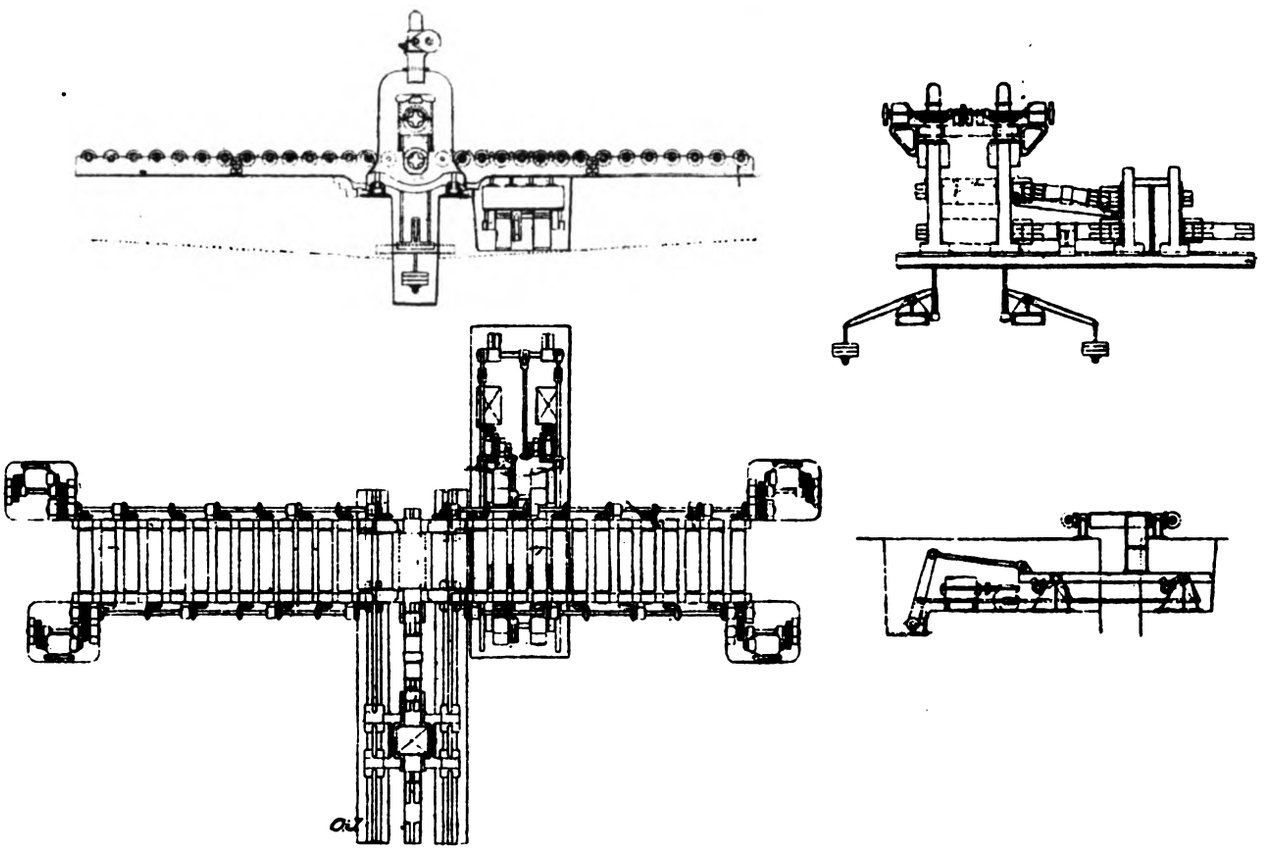

FIG. 9.—Cogging Train.

The upsetting and transferring gear is also electrically operated in many instances, and the hydraulic arrangements hitherto in vogue have been superseded An electric ingot cradle, shown in Fig. 10, is also of novel design, and has many advantages over the older hydraulically-worked appliances hitherto used for placing the ingots upon the live roller table.

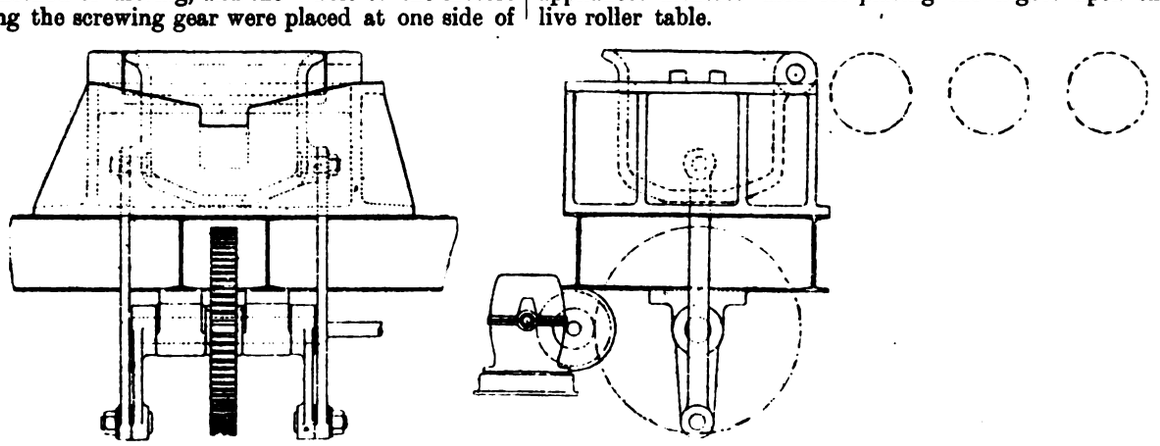

FIG. 10.—Electrically-Driven Ingot Cradle.

Electrically-Driven Hot Saw.—For cutting the sections as they come from the finishing rolls, various kinds of swinging saws have been invented driven by steam. In all these arrangements the advancement of the saw was always effected by means of the hydraulic cylinder. An electric counterbalanced hot saw is made intended to replace the hydraulic cylinder, the saw itself being also driven by an electric motor. With this hot saw girders of a depth of 550mm. (22in.) can be cut. The diameter

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of the disc is 1,500mm. (4ft 11in.), and the velocity at the periphery is 60m. per second (198ft.). The power necessary for driving the saw is about 60 h.p., and it is capable of making five cuts per minute.

Adjustable Stop for Regulating the Length of Girders Cut by the Hot Saw.—This arrangement is exceedingly convenient for adjusting the length of the material to be cut and the length of the different sections; it permits a variation in the size of the bars of 5m. A 7-h.p. motor is used for adjusting the stops which determine the length of the girder, and the stops can be traversed throughout their entire range within half a minute. The bars and girders can, therefore, be dealt with with absolute regularity as they come finished from the mill.

Hot Bed with Electric Transferring Gear (Fig. 11).—The transport of the sections upon the hot bed can also be effected by an electric transferring gear, which is actuated by wire ropes driven by a motor. An appliance of this kind presents no striking novelty, but is worthy of mention in order to complete the enumeration of the various mechanical devices employed in a steelworks. These gears can be constructed to handle light or heavy sections, and several such transferrers can be provided in one hot bed. They should, however, be independent of each other, and a separate motor of 2 h.p. can be supplied for driving them. By their means girders can be turned over and placed upright if desired.

Electrically-Driven Lifting Table for Plate-Rolling and Wire-Rolling Mills (Figs. 12 and 13).—Fig. 28 represents a universal three-high rolling mill with an electrically-driven lifting table and a central roll adjustable by electrical means. Lifting tables of this kind have been in successful operation for several years past in America, and in the author's opinion the employment of such apparatus in European steelworks would be extremely advantageous. A rolling mill equipped with lifting tables

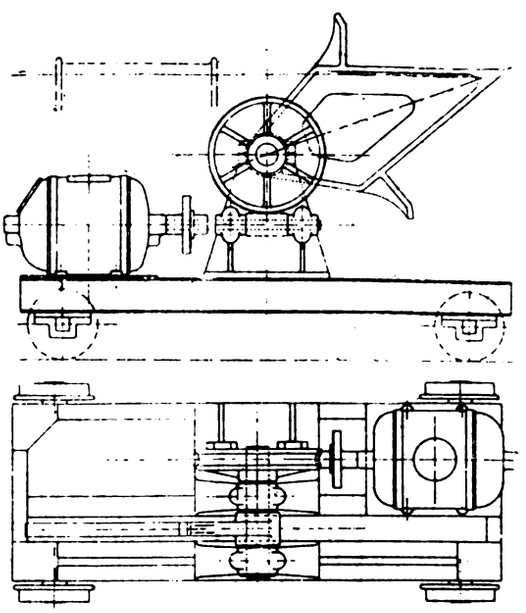

FIG. 11.—Hot-Bed Trolley.

drawing is driven by one motor only, and the capacity of the mill amounts to 35 tons of wire of 5mm. diameter in 10 hours. The driving of the rolling mill illustrated in Fig. 30 is effected by means of three motors. The initial outlay is therefore somewhat more considerable, but on the other hand a greatly increased output is secured. In general, the following principle may be taken as applicable in the standard practice of electric driving in iron-works: that the motors should be of as nearly as possible the same power and type. By this means the cost of

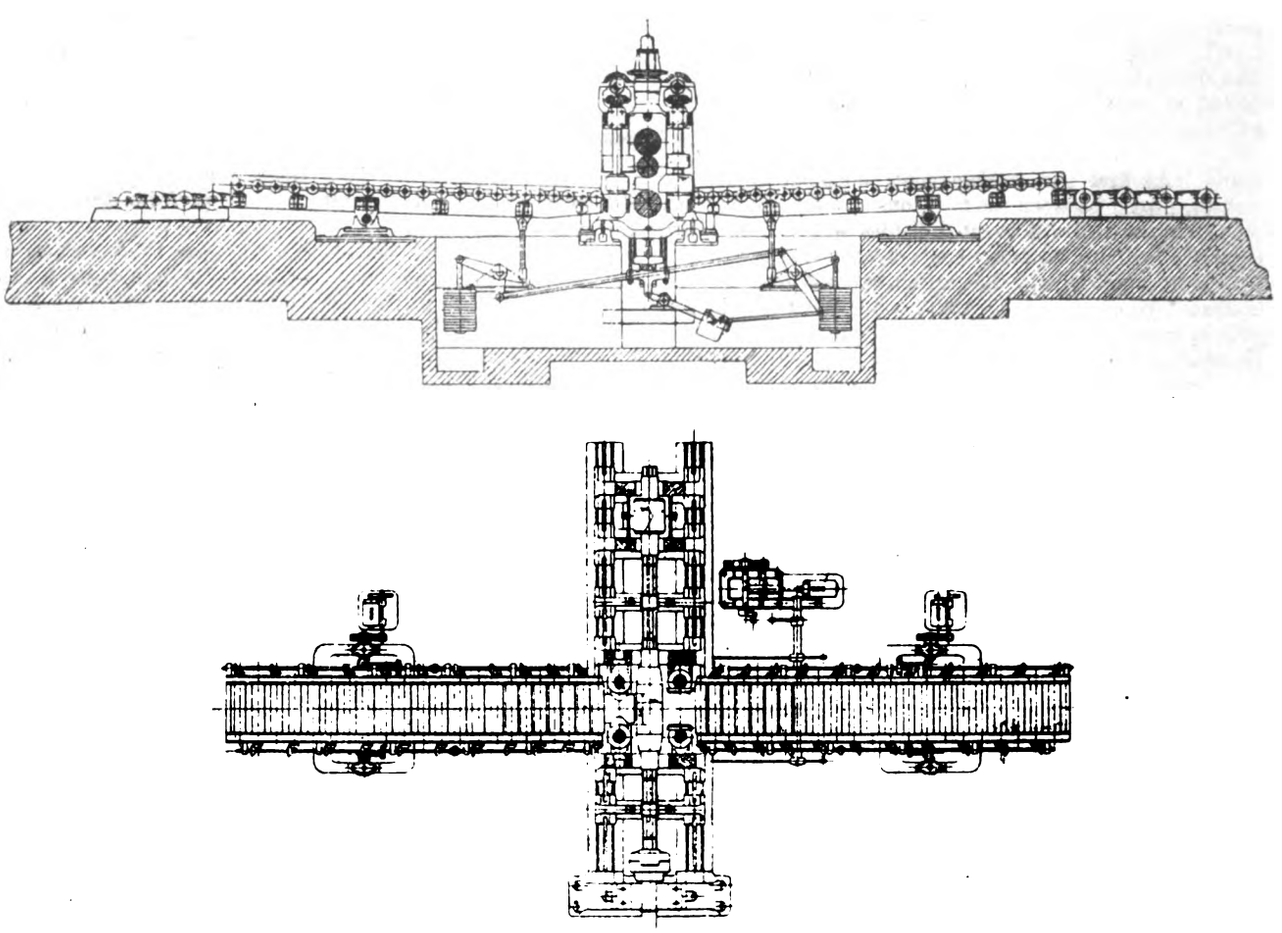

FIG. 12.—Universal Three-High Rolling Mill.

of this description is at work at the Carnegie Steel Company's works in Pittsburg, and the author noted on the occasion of his visit that they were capable of being reversed 20 times per minute without overstraining the motors in any way. The roller train illustrated in the repair is lessened, and the changing of the working parts when worn out can be more easily effected.

Before concluding this paper, mention should be made of two appliances of special construction where a great advantage is secured if electric driving is adopted. All

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works which are engaged in the manufacture of tyres or of rolled pulleys have experienced the difficulty producing

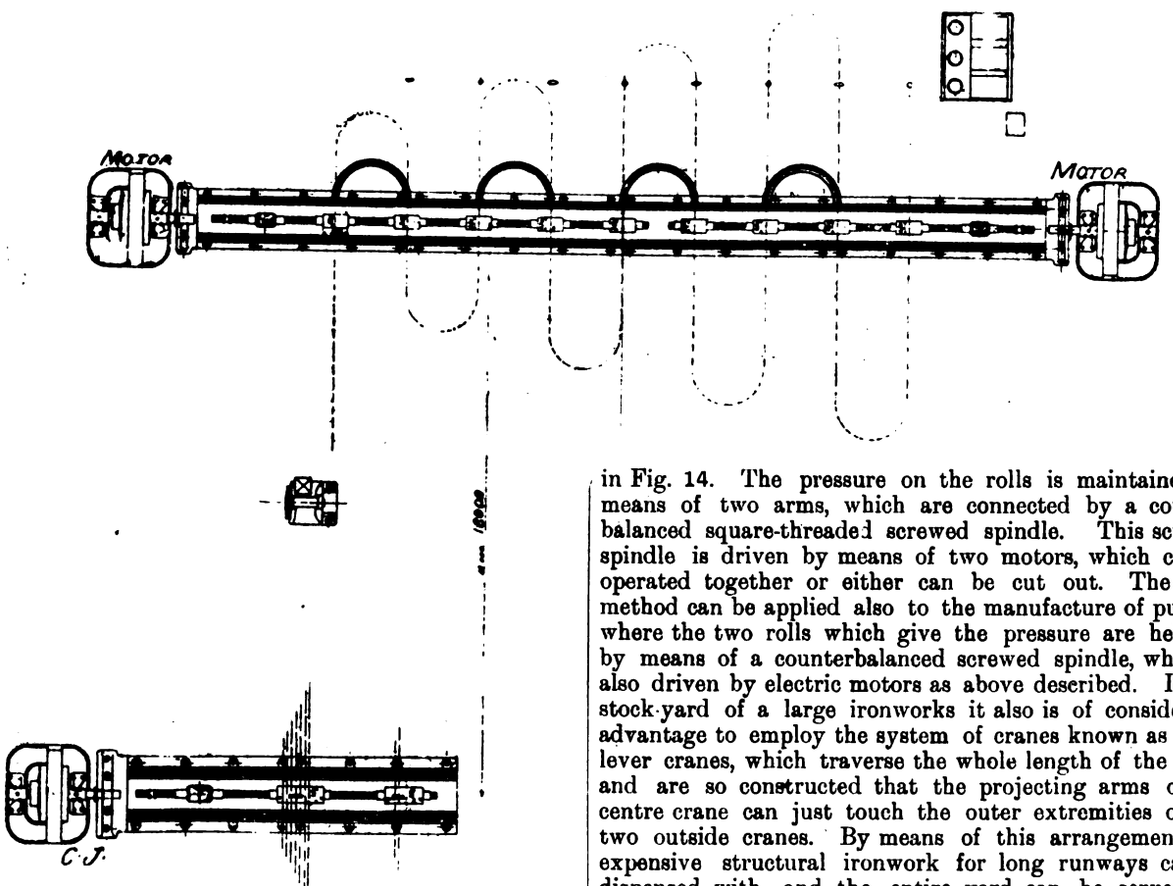

FIG. 13.—German Wire-Rolling Mill.

a uniform thickness in the material of the tyres and wheels when using rolls held up by hydraulic power. The material

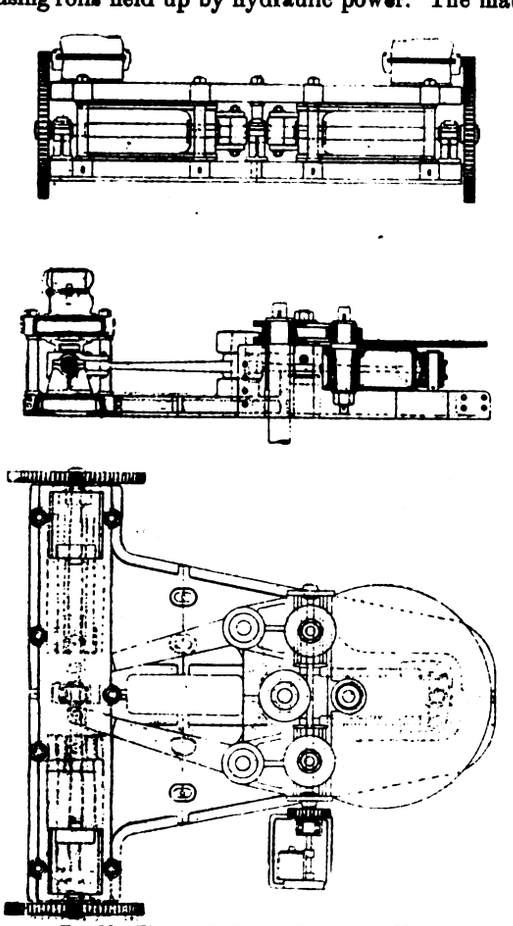

FIG. 14.—Electrically-Driven Tire-Rolling Mill.

is often unevenly heated, and in consequence, on account of the even pressure of the rolls, an uneven thickness results in the colder parts of the rings. This defect is entirely overcome by means of the tyre rolling mill shown in Fig. 14. The pressure on the rolls is maintained by means of two arms, which are connected by a counterbalanced square-threaded screwed spindle. This screwed spindle is driven by means of two motors, which can be operated together or either can be cut out. The same method can be applied also to the manufacture of pulleys, where the two rolls which give the pressure are held up by means of a counterbalanced screwed spindle, which is also driven by electric motors as above described. In the stock-yard of a large ironworks it also is of considerable advantage to employ the system of cranes known as cantilever cranes, which traverse the whole length of the yard, and are so constructed that the projecting arms of the centre crane can just touch the outer extremities of the two outside cranes. By means of this arrangement the expensive structural ironwork for long runways can be dispensed with, and the entire yard can be served by means of this most simple arrangement. A further advantage also consists in the great economy of power in transporting comparatively light loads, since a single heavy crane need not be employed. In order to reduce as much as possible the great number of revolutions of the electric motors, a worm gearing can be employed with advantage. These have now been brought to so great a state of perfection that an efficiency of 90 per cent has been obtained. Of worm gears of this description over 4,000 have been constructed by the Benrath Engineering Company.

WINTER LECTURES AT CHELMSFORD.

We have received from Messrs. Crompton and Co. particulars of the courses of free lectures to be delivered at the Chelmsford works during the evenings of the coming winter. There will be four courses in all, the first by Mr. W. H. Booth on "Steam Engineering"; the second by Mr. A. Hutchings on "Some Practical Details of Dynamo Design"; the third by Mr. E. A. N. Pochin on "Arc Lamps and Alternating Currents," and the fourth by Mr. C. H. Wright on "The Theory of Direct Currents of Electricity." The first lecture was given last Monday evening, and they will be continued on Mondays, Tuesdays, and Fridays until the middle of March next year, with the exception of the four weeks from Dec. 19 to Jan. 19. These lectures are arranged by the company for the benefit of all classes of their employés and pupils, and the following awards for the best notebooks will be made at the conclusion of the courses: for the pupils—books, instruments, or apparatus to the value of £5 for the best notebook, and £2. 10s. for the next best; for all others—books, instruments, or apparatus to the value of £3 for the best notebook, and £1. 10s. for the next best. The notebooks must contain not only notes, sketches, diagrams, etc., concerning the lectures themselves, but also such other notes, etc., as are the result of intelligent observation during their daily work and study of the current technical journals. The awards will be made by Lieut.-Colonel R. E. Crompton, C.B.

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CONTENTS.

Notes	505	Correspondence	523
Belliss and Morcom's Works, Birmingham	510	Questions and Answers	524
Electric Lighting and Tramways at West Bromwich	513	Trade Notices and Novelties	529
Leaves from a Testing Engineer's Notebook	518	Legal Intelligence	530
The Use of Electricity in Iron and Steel Works	518	Companies' Meetings and Reports	530
Winter Lectures at Chelmsford	521	New Companies Registered	530
Excellent Education at Cromptons	522	Appointments Vacant	530
Forthcoming Events	523	Contracts for Electrical Supplies	530
The Construction of Practical Standards for Electrical Measurements	523	Traction Notes	532
		Lighting Notes	535
		Provisional Patents, 1902	539
		Companies' Stock and Share List	539
		Traffic Returns	540

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EXCELLENT EDUCATION AT CROMPTONS.

There are some things always with us, and one of these is the educational problem. Every now and again an enthusiast tells some home truths, but more often the talk is neither new, true, nor startling. What may be termed the modern technical education theory began with the work of Dr. Birkbeck at Glasgow nearly a century ago. He required certain apparatus to illustrate a course of lectures at the Andersonian Institution, and had to superintend their construction himself. We are told by an early writer that "by this means he was brought into immediate communication with the operative artisans of Glasgow, and during this intercourse his acute penetration discovered such evident indication of latent genius in the minds of the workmen, accompanied by a kind of intuitive anxiety for the acquisition of knowledge, that" Dr. Birkbeck felt a keen desire to put the means of acquiring such knowledge within their reach. Subsequently, after having elaborated a scheme, and finding no one disposed to aid, he decided to give a course of lectures and to invite and issue tickets to the "most intelligent operatives in each manufactory." He got seventy-five students to his first lecture, and so interested were these that two hundred attended the next lecture, three hundred the third, and five hundred the fourth, and thus commenced the modern crusade for technical education. Dr. Birkbeck's ideas fructified, and ultimately he succeeded in getting his views accepted, and mechanics' institutes sprang up like mushrooms all over the land. Their aim, in the words of Dr. Birkbeck, was "to make you acquainted with the principles of the several arts you practise; those who are interested in its formation [he was speaking at the introductory lecture at a particular institute] wish you to think as well as to toil [could Prof Perry put it better in 1902?] to present to you the principles of science . . . to put you in possession of every doctrine in theory which may tend to enlighten your practice." These words were preached in 1823; they have been preached many a thousand times since, and will be preached many a thousand times again. There is no new aim devised by the more modern commentators; the only difference is how to reach the goal. One might think that with the object clearly defined a system of teaching would have been stereotyped ere this, but the continuous criticism is, All who have worked before have worked imperfectly; only this is right. However, this simply means that continuous progress necessitates modification in method, and were the criticism referred to to cease or slacken, it would mean paralysis amongst the teachers. That is the one thing to avoid at all hazard. Better have an energetic teacher on the old lines, one that takes an interest in the future of his students, rather than one who lectures and teaches merely because he gets a salary of so many pounds. During recent years there has been a wide-spread view that technical training—that is, the knowledge of theory—should be obtained contemporaneously with practical work. In order to train the hand and the eye, various technical schools and colleges have been equipped with workshops, which, however, can never be more than a poor makeshift for the real thing. A far better plan is for theoretical and practical training to go hand in hand in the works of our large firms, and Messrs. Crompton and Co. must be congratulated in having successfully developed this plan. The actual date of Messrs. Crompton commencing theoretic training at the works we cannot state, but so long ago as 1886 Prof. J. A. Fleming gave a course of lectures at the works, afterwards published in book form and entitled "Short Lectures to

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Artizans." From 1886 we come to the present time and find that for the winter session 1902-3 no less than four courses of lectures have been arranged: (1) "Steam Engineering," by W. H. Booth, Esq.; (2) "Practical Details of Dynamo Design," by A. Hutchins, Esq.; (3) "Arc Lamps and Alternating Currents," by E. A. N. Pochin, Esq.; and (4) "Theory of Direct Currents of Electricity," by C. H. Wright, Esq. In the prospectus announcing these lectures it is stated that prizes will be given for the best notebooks, and we wish to point out how closely present-day efforts agree with those put forward by Dr. Birkbeck. The awards mentioned will give preference, among other things, to the books which show "that their owners are cultivating the power of accurately and completely observing and recording . . . also considering what they have learnt, noting its application to their daily work, and originating new applications and new ideas." This Dr. Birkbeck puts as "to think as well as to toil." Other firms more or less fully preach and practise what Messrs. Crompton so ably initiated and continued, and when, in addition, the workers have in most towns excellent courses of lectures on technical subjects at the technical schools during the winter evenings, it cannot be held that those who provide technical mental pabulum are shirking their duties. Many details of our technical educational system no doubt may be modified to advantage, but we must emphatically assert that the continued parrot cry in the non-technical Press as to our ignorance of technical requirements, as to the superior advantages of Swiss, German, and American procedure, is unwarranted and untrue. The continuance of this cry is largely due to a few ignorant professors and professional alarmists, who possess largely the characteristics of a child in thinking that everything they see away from home is better than what they get at home.

FORTHCOMING EVENTS.

SATURDAY, OCT. 11.

Municipal and County Engineers.—District meeting at Aldershot.

FRIDAY, OCT. 17.

Institution of Mechanical Engineers.—At 8 p.m., first monthly general meeting. Paper: "Oil Motorcars of 1902," by Captain C. C. Longridge.

SATURDAY, OCT. 18.

Municipal and County Engineers.—District meeting at King's Lynn.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BOLTON TRAMWAY DEPRECIATION.

SIR,—The report which you give in your last issue on the depreciation of tramway track by Mr. E Ll. Morgan, the borough engineer of Bolton, is one which is of great interest to tramway engineers and managers. An examination of this report leads me to the conclusion that Mr. Morgan has neglected one important item which completely changes the conclusion arrived at. I am, therefore, submitting to you the following calculation, the data for which are the figures given in the report you published on page 494 last week. In it Mr. Morgan recommends an 8 per cent. depreciation charge on the cost of the track. In the first column, at the bottom, he suggests that in 12 years this will reduce the capital for the track by 62·23 per cent., and in the second column he assumes that it will reduce it 96 per cent. in that time. In neither case, however, does he take into consideration that the money taken from the revenue account each year for this 8 per cent. depreciation will have to be used in some way. Presumably it should be put in the bank at compound interest, to be again expended when the track requires renewal at the end of 12 years. The problem, therefore, resolves itself into ascertaining what annual sum should be put by out of revenue each year, so that if invested at, say, 3½ per cent. compound interest it will provide a completely new track. According to Mr. Morgan's figures, the actual expenditure for this new track will be £3,500, but the old materials displaced will be worth £340, so that only £3,160 will be required. The annual amount put by each year would in each case be invested in a bank at 3½ per cent. Calling this amount A, we then get the equation:

$$£3{,}160 = A \times 1{\cdot}035^{11} + A \times 1{\cdot}035^{10} \ . \ . \ . \ A \times 1{\cdot}035 + A.$$

Summing up this geometrical progression in the usual way we get that

$$A = \frac{£3{,}160 \times {\cdot}035}{1{\cdot}035^{12} - 1}.$$

Working this out by logarithms it will be found that A equals £217, which is slightly over 3·6 per cent. per annum on £6,046, the original cost per mile. If this figure—*i.e.*, £217—is taken from revenue each year and put to a special track renewal fund, it will provide for the periodical renewal and relaying of the tramway tracks without any further capital being required. I would suggest that this is the proper course to adopt, and that it should be quite independent of the annual repayment of interest and capital on the tramway loan. In fact, such a fund, which is less than half of the depreciation recommended by Mr. Morgan, will enable the tramway track to be maintained efficiently from revenue, in which case no further depreciation is required, except on the supposition that the tramways have a limited life as a means of transport. The repayment of capital, which is obligatory on all municipalities, provides against this contingency, and ensures that, subject to repairs and renewals being made out of capital, the corporations will have an undertaking free of capital charges at the expiration of the loan period. This will leave them exceedingly well off in the event that tramways are not superseded, and quite solvent if the reverse should be the case.—Yours, etc., P. T.

THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

The following is the annual report of the British Association Committee appointed to experiment on the improvement of practical electrical standards. The committee consists of Lord Rayleigh (chairman); Mr. R. T. Glazebrook (secretary), Lord Kelvin, Profs. W. E. Ayrton, J. Perry, W. G. Adams, and G. Carey Foster; Sir Oliver J. Lodge, Dr. A. Muirhead, Sir W. H. Preece; Profs. J. D. Everett, A. Schuster, J. A. Fleming, and J. J. Thomson; Mr. W. H. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. J. Rennie, Mr. E H. Griffiths, Sir A. W. Rücker, Prof. H. L. Callendar, Sir W. C. Roberts-Austen, and Mr. George Matthey.

During the past year the apparatus belonging to the association has been removed to and set up at the National Physical Laboratory at Bushy House. A room in the basement has been fitted for accurate resistance work. By means of a thermostat the temperature can be kept under very complete control, and the room has proved very suitable for its purpose. In it the resistance standards of the association have been set up, and a number of comparisons have been made by Mr. F. E. Smith. Particulars as to the results of these comparisons can best be given at a later date, when the mercury standards now in course of construction have been set up. The work of setting up these mercury standards of resistance has been further advanced. A number of tubes, both of verre dur and of Jena glass, 16‴, have been calibrated by Mr. Smith. When the final corrections to the weights used have been obtained from the Bureau International it will be possible to complete these, and to determine the values of the

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platinum, silver, and manganin standards in terms of the mercury unit. From the resistance-room a cellar—formerly the wine cellar of Bushy House—opens, and in it work requiring an extreme constancy of temperature can be carried on. In this room Mr. Smith has set up a number both of Clark and also of Weston cells, and comparisons between these have been carried on systematically. Discrepancies of a considerable amount have been found between cells set up in the same manner, but from materials supplied by various makers, and these have been traced to the mercurous sulphate. The observers at the Reichsanstalt have come to a similar conclusion. Dr. Carpenter and Mr. Smith are now engaged in experiments at the National Physical Laboratory, the results of which, it is hoped, will enable them to specify a method of preparing mercurous sulphate which will lead to consistent results for the E.M.F. of the cells.

The air condensers belonging to the committee have been set up, and a number of determinations of their capacity have been made by Mr. Campbell. The results of these, though at present they are only to be treated as provisional, show that the condensers are in good order, and have suffered no damage by their journeys first to Liverpool and then to Richmond. The capacity of one is nearly the same as when at Cambridge; that of the other has altered very slightly. With a view of establishing a standard of capacity a number of other comparisons between the standards of the association and those of Dr. Muirhead are in progress. In this comparison work some difficulty has arisen from the fact that all the resistance boxes belonging to the association are of platinum-silver. The small temperature coefficient of manganin gives that material a very distinct advantage, and the secretary has been endeavouring to use it whenever possible. It would be of great service for this part of the work to have a subdivided megohm box in manganin, and the committee trust that funds for this may be forthcoming. They hope in their next report to give a detailed account of the condenser experiments.

The construction of platinum thermometers as standards for high-temperature thermometry has made some progress. The National Physical Laboratory was not opened until March, and the work of setting up the apparatus, carrying out the necessary calibrations, etc., has occupied most of the time of the assistants since then. After some further experiments, however, to test the purity of the wire it was proposed to use had been carried out, a stock of 8oz. of wire of the highest purity and of a thickness varying from six to eight mils has been bought from Messrs. Johnson and Matthey, while 4oz. of the same wire, but of 22 mils in thickness, suitable for leads or for drawing down to special sizes, have also been secured; and 16 thermometers are in course of construction in the workshops of the laboratory under Dr. Harker's supervision. Of these six thermometers two of five ohms fundamental interval will be hermetically sealed in glass tubes, and will serve as standards for low-temperature work; a second pair, having an interval of one ohm, in tubes of hard glass, probably Jena, 59''', will serve for temperatures up to 550deg. C., while the third pair, also of one ohm interval, in porcelain tubes, will be employed up to 1,100deg. C. or 1,200deg. C. It is hoped by the use of quartz to extend the range of temperature considerably, and some experiments are in progress with this object. Two electrical resistance ovens have been built by Dr. Harker for high-temperature work, and these serve their purpose admirably. The grants voted during the past two years have been expended on the purchase of the materials for the platinum thermometers, and additional sums are necessary to complete their manufacture.

With regard to the construction of the ampere balance, the committee are sorry that they cannot report progress. They have learnt with extreme regret of Prof. Ayrton's ill-health during part of the year, but are glad to know that he now feels able to continue his investigations into this important question. In this work the late Principal Viriamu Jones was closely associated with Prof. Ayrton, and it is a source of great pleasure to the committee to know that, through the generosity of the Drapers' Company, his name and connection with electrical measurements will be perpetuated at the National Physical Laboratory. The company had promised to Principal Jones the funds for the construction of an improved Lorenz apparatus for the determination of the ohm, and they have intimated to the committee of the laboratory their intention to place £600 at the Executive Committee's disposal for the construction of such an apparatus in his memory. The secretary states that steps have already been taken to obtain designs for the instrument.

In conclusion, the committee recommend that they be reappointed, with a grant of £75, to be used for the establishment of a standard of capacity, and for the construction of standard platinum thermometers; that Lord Rayleigh be chairman and Mr. R. T. Glazebrook secretary.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

523. At the back of a certain switchboard there is a row of sealed-up small iron boxes—one for each machine in the station—and from one of these boxes (which belong to a 150-kw., 250-volt., direct-current shunt machine, and has a label attached to it with the reading—500 ohms, to take 0·5 amperes momentarily) two wires lead: one direct away from the board and apparently to the dynamo, and the other leads out of sight to some connection on the shunt field regulator. The ordinary shunt-regulating resistance is on a frame at the back of the board. State the use of this high resistance. Why is it kept sealed up separate from the ordinary regulating resistance? And make a drawing of the connections of this resistance with regard to the dynamo.—IMPROVER.

524. A small continuous direct-driven set is used for lighting an alternating-current station during the evening. This set is run up slightly higher than its normal voltage, and the lights are then put on to it by plugging over a two-way switch. This operation causes a momentary increase of the volts and then a gradual drop. Explain the reason of this momentary increase.—E. L.

ANSWERS.

[N.B.—The answers to Question No. 517 are being held over until next week in consequence of the large number to be adjudicated on. We would remind those who contribute to the "Questions and Answers" column that, as stated above, matter must be written on *one side of the paper only*.—ED. *E. E.*]

Question No. 516.—Which is the best way of coupling circuits on a three-phase system—star or mesh? Explain advantages or disadvantages of one system over the other.

Best Answer to No. 516 (*awarded* 10*s.*).—The two general ways of combining polyphase circuits are known as *star* and *mesh*, but combinations of the two are sometimes, though rarely, used. These two groupings are shown diagrammatically in Fig. 1. In order to compare them, let us take a constant line current of C amperes and a line voltage of V. Then the current in each phase winding and the volts between the terminals of each phase will be as follows:

	Phase current.		*Phase volts.*
Star.....	C	.....	$\frac{V}{\sqrt{3}} = \cdot 578$ V.
Mesh	$\frac{C}{\sqrt{3}} = \cdot 578$ C.....		V

From this it appears that mesh winding has only to carry

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about '58 per cent. of the current carried by the star winding, hence, if we are working at a given current density the section of the conductors need only be 58 per cent. of that of a star winding. On the other hand, however, the star winding has only to generate 58 per cent. of the volts per phase of the mesh winding, hence it only requires 58 per cent. of the number of conductors. We thus see that the weight of copper for each winding works out to about the same. As, however, the number of turns is greater with a mesh winding, the cost of winding will be more, and also the cost of insulation. The copper factor—*i.e.*, the ratio $\frac{\text{area of copper}}{\text{area of slot}}$—will also be worse in a mesh winding, especially if the voltage, and hence the number of conductors per slot, is high. This means larger slots, and hence narrower teeth, in order to keep our copper current density right, and hence we have to raise the flux density, which, in turn, increases the excitation watts and the iron loss.

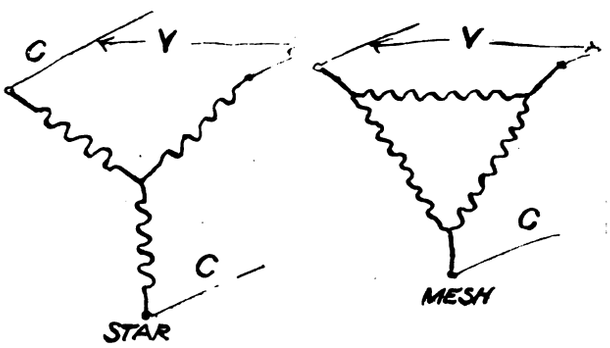

FIG. 1.

From the above it would appear that mesh windings should preferably only be used with low-pressure machines. As a matter of fact it is best, whenever possible, to use a star winding in all cases. This is because, with a mesh winding, should the E.M.F. wave differ slightly from a pure sine wave, injurious internal circulating currents will be set up around the closed circuit formed by the mesh, which will tend to unduly heat up the machine. Much the same effect is produced if the three phases of the line are loaded unevenly (as, for instance, with a combined lighting and traction load, having lamps connected across each phase which are not evenly balanced), causing the volts at the phase terminals to be slightly different. It is easy to test for these currents if due to the first cause given—*i.e.*, to the machine being inherently out of balance. All we have to do is to connect any two phases through a voltmeter, as shown in Fig. 2, and run the machine fully excited without load. If the effect is present there will be a reading on the instrument, which should otherwise indicate practically nothing. These circulating currents not only waste energy in overheating the machine, but they also impair the pressure

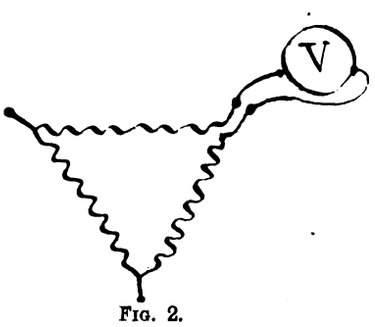

FIG. 2.

regulation of the machine, and tend to prevent good parallel running. For these reasons a star winding is always used whenever possible in preference to a mesh for the armatures of alternators, synchronous and asynchronous motors. In the last case—*i.e.*, with induction motors—the star winding is also used for the rotor as well as the stator if the former is supplied with starting resistances. This is because the ends of the three phases in a star winding are so easily adopted for bringing out to slip rings.

So far we have only considered generators and motors, we have still transformers to deal with. The remarks as to current and volts per phase hold equally good here of course, and also the argument about the "copper factor" and cost of winding. It is, however, interesting in the case of transformers to consider what happens when one of the phases break down—for instance, a primary high-pressure winding goes to earth and blows its fuse. If we have a lighting load on the secondary, the mesh connection is evidently superior to the star, as the two remaining phases will continue to furnish a three-phase current in the secondary. It will, of course, be an unsymmetrical arrangement with a large drop of pressure, but the supply of current to the three secondary phases will not be interrupted, and the two remaining primary phases will probably manage to carry the extra load until a spare transformer can be connected up. If the load consists of three-phase motors we are better off still, for the reactions of these will tend to make the arrangement symmetrical, and to balance the phases. Had the transformers been star connected, it is clear that the failure of one phase will cause a single-phase current only to be delivered by the secondary. Hence, only the lights connected across the particular phase would continue to burn, while as for the three-phase motors (two phases), not being supplied by transformers, would be supplied only by the back E.M.F.'s of the motors, which would usually be insufficient to enable the motors to carry anything like their rated load. Transformers supplying current to rotary converters should always be mesh connected for the above reason. And, in general, it may be said that for most classes of heavy work up to 10,000 or 12,000 volts, it is preferable to use mesh connections for transformers.

Whichever method is selected, however, it is best to use the same on each side if the phases are the same in number. If this is not done it is sometimes found that the individual transformers, or sets of transformers, do not work in parallel well—*i.e.*, they will not share the load equally, or in proportion to their size, as the case may be.—T. SQUARE.

Answer to No. 516 (*awarded* 5*s.*).—The difference between the star and mesh methods of interconnecting the three

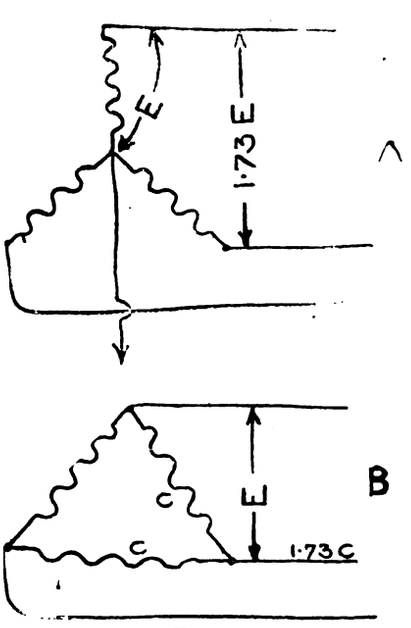

FIG. 1

circuits of a three-phase machine is this: In a star-wound machine the terminal E.M.F. is 1·73 times the E.M.F. induced in any one phase, the current in one line being the same as that generated in one phase. In a mesh-wound generator the terminal E.M.F. equals the E.M.F. induced per phase, but the line current is 1·73 times the current in one phase (Fig. 1).

I. Comparison of Star and Mesh Connected Generators.—Experience has shown that for generators the star method, with the neutral point earthed, is the better for coupling

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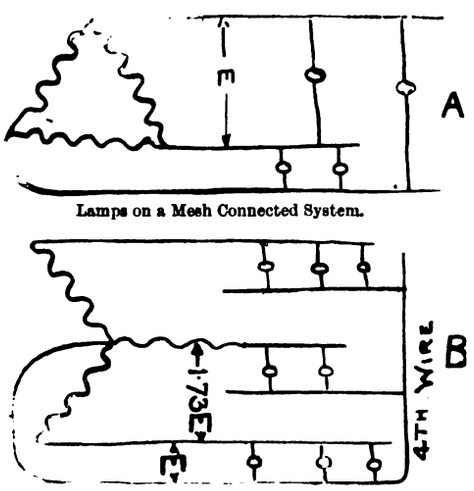
up the three phases, and most modern machines are connected in this way. The following advantages are obtained by using star-connected windings:

(*a*) *Better Pressure Regulation and Parallel Running.*—If the three windings of the machine are mesh-connected, and (as is usually the case) the E.M.F. wave is not a pure sine wave, the internal cross currents circulate through the windings. These currents, besides wasting energy in heating, tend to prevent both good pressure regulation and good parallel running. With star-coupled windings, these cross currents not being present, better pressure regulation and parallel running is obtained.

(*b*) *Less Risk of the Insulation Breaking Down to Earth.*—As is seen in Fig. 1, with star connection, the potential difference between the windings and earth is only 58 per cent. of the voltage between the lines. With mesh winding the potential difference between line and earth is the same as between line and line. Thus, if, for example, the current is generated at 5,000 volts, in the first case the insulation between line and earth has only to withstand a pressure of 2,885 volts, whilst in the second case it has to withstand the full 5,000 volts pressure.

(*c*) *Advantage of Being Able to Use a Fourth Wire.*—For low-pressure distribution the voltage of supply is limited by the incandescent lamps. With a mesh-connected machine, the voltage across the lines would have to suit the lamps, but with a star-connected four-wire system the supply voltage could be raised 1·73 times, still keeping the voltage between one main line and the fourth wire suitable for the lamps (Fig. 2). The result of being able



Lamps on a Mesh Connected System.

Lamps on a Star Connected System.

FIG. 2.

to raise the supply voltage in this way is great economy in copper. Comparing the weight of copper mains for the same power, drop, and lamp voltage—with star-connected windings, four wires, 38·9; with mesh-connected windings, three wires, 100.

II. Comparison of Star and Mesh connected Transformers.—Three-phase transformers have usually mesh-connected windings. The great advantage of the mesh connection in transformers is that if, from any cause, one phase fails, the two remaining coils will continue to supply three-phase current, thus giving the attendant a chance to connect up a "spare" without stopping the supply. If a coil breaks down with a star-connected transformer, only single-phase current will be supplied, and if any motors are running heavily loaded they will probably stop. For the above reasons, transformers supplying rotaty converters are always mesh wound. The one advantage of star winding for transformers, is that as the pressure per winding is only 58 per cent. of the pressure between the lines, there is less likelihood of a breakdown of the insulation. For this reason, transformers working at 10,000 volts or over are usually star wound. For lower pressures, the general practice is to use mesh winding.—R. W. G.

Answer to No. 516 (*awarded* 5*s.*).—Of course, there are arguments in favour of each system, and every case must be judged according to its own requirements, but I think that perhaps on the whole the star connections are the better. These are shown in Fig. 1, and the mesh in Fig. 2. I have given the superior place to the star system of connections because, by using this method, you can get two voltages to work with at the same time by connecting the middle or neutral point to a fourth wire, or else to earth. This fourth wire, like the neutral in the three-wire continuous-current system of distribution, can be of considerably less cross-section than the other lines, as it only has to carry the out-of-phase current when the system is not symmetrically loaded. When, however, the neutral point be not connected to a fourth wire or to earth, you do not get the advantages of the two voltages, but only have the one which is the same as the voltage in a similar mesh-connected system—*i.e.*, the voltage between any two of the three lines—and in this case I see no particular advantage of the star over the mesh connections.

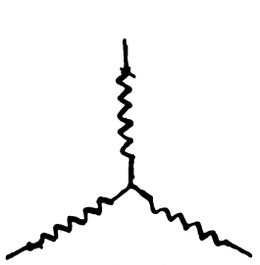


FIG. 1.

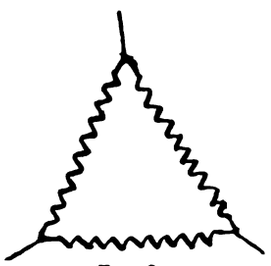


FIG. 2

The advantage of the star with the neutral earthed is that by using it you may get a voltage of, say, 200 volts between any line and the neutral, which would be used for incandescent lamps, and then a voltage of $\sqrt{3}$ ($= 1{\cdot}732$) times this, which in this case is practically 350 volts between the lines, which is better adapted for a motor load. In connecting up a mixed system like this the lighting circuits would be connected to the lines, and the other pole of each lamp earthed or connected to the neutral, endeavouring as far as possible to have an equal load on each phase; then the motors would be simply connected to all three lines, and their neutrals earthed. Fig. 3 is a diagram showing the connections on a mixed system like this.

There is also an advantage in using star connections from a constructional point of view in motors, as the stator winding does not have to be so highly insulated, as it has only to resist $\frac{1}{\sqrt{3}}$ ($= {\cdot}58$) of the line voltage. Hence, though thicker winding has to be used as there is necessarily more current to carry, less space has to be given to insulation, and also fewer turns are required. This has the effect of simplifying manufacture, also making machines smaller, and, therefore, the cost is reduced. If the current be for lighting alone, there is a saving in copper for the line if star connected, as if mesh

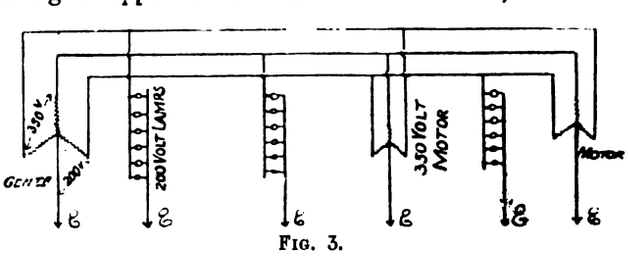


FIG. 3.

be used your line voltage must be that at the lamp terminals, whereas if Y (star) connected, the line voltage—*i.e.*, voltage between any two line wires—is $\sqrt{3}$ times this, because your lamps are not connected straight across the mains as in Δ (mesh), but are across one main and the neutral. Of course, if a fourth neutral wire has to be run the whole way, this copper saving will not be anything like so great in extent. Another point is that if the three phases be not symmetrically loaded, the light is not so much affected if Y with neutral earthed is used as if Δ were used. For equal power transmission:

In Y you transmit C amperes at $\sqrt{3}$ V volts.

In Δ you transmit $\sqrt{3}$ amperes at V volts.

Hence there is here a saving in copper in using Y connec-

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tions. If the voltage between any two lines must not exceed a maximum, then the advantage lies with Δ connections, as the voltage between a line and the neutral in the star is only ·58 $\left(\frac{1}{\sqrt{3}}\right)$ of this; so for equal power more current is required for the Y, and hence extra copper is required in the windings of the motor, but the line wires do not have to be larger than those for Δ, as in either case the line voltage is the same, so the amperes per phase must also be the same. If there is a stipulated maximum voltage between any one line and earth, the copper advantage lies with the Y, as if line voltages are the same in Y or Δ, the voltage to earth is only ·58 that of Δ in Y connections. Hence a higher line voltage may be used in Y, and so smaller lines are required. If, however, the neutral be not earthed, this does not apply, and lines are the same size in either case. Y connections should not be used if the consumer is to be connected all on one phase. In a three-phase sub-station converting the current by the use of rotary converters it is best to use Δ connections, as if a fault should occur on one phase the other two keep the converter running, which itself tends to make the system symmetrical. If Y connections were used, in the case of a breakdown of one phase the other two would simply deliver single-phase current to the converter, which would spark terribly at the commutator on the continuous-current side, and would necessitate it being shut down. So it is seen that Δ connections are best for transformers.

From all the above considerations I think it will be seen that each case must stand for itself, but, nevertheless, star seems to me the better for an average sort of case on account of the ease of obtaining two voltages, and also that the insulation strain to earth is only $\frac{1}{\sqrt{3}}$ of the line pressure or of that of a Δ connected system.—E. R. ALEXANDER.

Answer to No. 516 (*awarded* 5*s.*).—The advantages are, on the whole, on the side of the star connection, provided that it can be arranged with a fourth wire to the neutral point, and the good points of this connection may be stated thus:

1. Lamps can be connected between the neutral and any one of the mains leads at, say, 200 volts, whilst motors can be connected between any two of the main leads at 350 volts, and thus a motor supply at 73 per cent. higher voltage than the maximum lamp voltage is obtained. When any considerable amount of motive power is supplied this produces a decided economy in the cost of mains in spite of the use of four instead of three wires.

2. At the same time the neutral connection renders the three phases as independent of one another as in the case of a mesh connection—*i.e.*, a given increase in lamp load on one phase has a minimum effect on the voltages of the other two phases.

3. The absence of a closed circuit in the windings of motors and transformers which are star connected, prevents all possibility of idle internal currents, due to unsymmetrical magnetic circuits or to slightly unequal numbers of turns per phase. Such currents are known to occur sometimes in mesh-connected apparatus.

When circumstances are against the use of a fourth neutral wire, as in the case of a long high-tension line, in which the expense of running a fourth wire would be considerable, it is more advantageous to use the mesh than the star connection, for should one phase of a mesh-coupled alternator armature or transformer burn out, the remaining two phases will continue to work perfectly satisfactorily alone. Lights on these two phases will not go out, and three-phase motors will continue to run on the two phases. In the case of a three-wire star connection, on the other hand, the burning out of one phase incapacitates two phases. On this account it is usual to arrange the step-down transformers at the end of a high-tension line, with a mesh-coupled primary and a four-wire star-coupled low-tension secondary (Fig. 1). In the case of transformers supplying rotary converters it is impossible to put in the fourth wire connection on the converter armature, so that it is usual to mesh-connect both the primary and secondary of such transformers, as the converter can then continue to work, at least for a short time, even should one phase burn out.—Q.

Question No 518.—Describe fully the circumstances under which boosters are used in connection with rail-return cables in tramway work, and give diagram of all connections.

Answer to No. 518 (*awarded* 7*s.* 6*d.*).—The object of rail-return boosters is to reduce the maximum difference of potential existing between any two points of the rail. This potential difference is not allowed to exceed seven volts by the Board of Trade on account of possible damage to gas and water pipes by electrolysis due to any large proportion of the return current passing through the earth. In the case of lines of any considerable length—say, three or four miles—it becomes difficult and expensive to keep the drop of volts in the rail and its feeders within the limit. By inserting a booster in series with a rail-feeder cable and arranging the booster to add volts (in the same direction as the main supply volts) in proportion to the current in rail and feeder, it is possible, without any additional outlay on cables, to maintain the potential difference between the two ends of the rail or feeder within the seven volts, or even to reduce it to zero. It may be suggested that the same result might be attained by increasing the section of the feeder, but this can be easily shown to be a far more expensive method. Suppose the drop in a certain feeder and in the rail in parallel with it to be 14 volts instead of seven, and suppose the feeder carries half and the rail the other half of the current. Then, in order to reduce the drop to seven volts, the rail must only carry one-quarter of the current, and the section of the feeder must be increased, so that when carrying three-quarters of the current the drop in it will only be one-half what it was when carrying one-half the current previously—*i.e.*, the section must be increased to $2 \times \frac{\cdot 75}{\cdot 5}$ = three times its former value.

If the same result is to be attained by the use of a booster in the feeder, the section of the feeder will not need any increase (unless the current density with three-quarters of the current is too high for safety), and the drop in the feeder will become $14 \times \frac{\cdot 75}{\cdot 5} = 21$ volts The booster must, therefore, add 14 volts, so that the net voltage difference between the two ends of the feeder is 21 – 14 = 7 volts. If the length of feeder is anything like three miles, the cost of a cable of three times the section will far outweigh the expense of a small motor booster capable of generating 14 volts at a current equal to three-quarters of the total current in feeder and rail, even allowing for the increased number of watts lost in the feeder and the losses in the booster itself. The connections of a rail return booster are shown in Fig. 1. The motor driving the booster is a plain, shunt-wound one, running at practically constant speed. The booster itself is series wound so as to give volts approximately proportional to

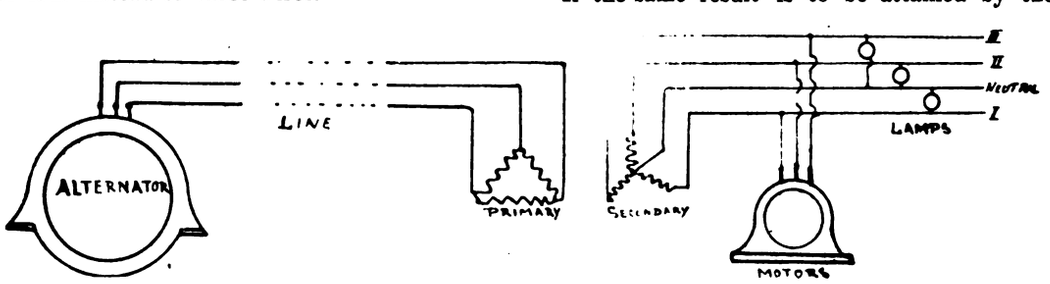

FIG. 1.

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the current round the field, but the series winding is usually connected not in series with the armature, but in series with the overhead trolley line, or, better still, in series with one of the trolley feeders if there is such a feeder connected to the line at some point near that at which the return feeder containing the booster armature is connected to the rail. With this arrangement the booster armature adds volts in proportion to the current actually flowing into the trolley, whilst if the field winding were in series with the booster armature in the rail return feeder the number of volts given by the booster would depend to a certain extent on the amount of

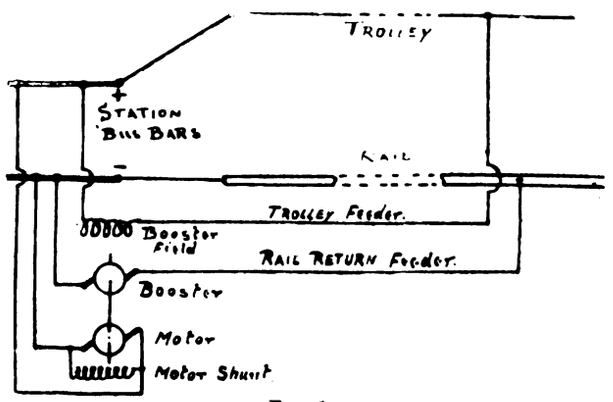


Fig. 1.

leakage from the rail to earth. Thus, on a wet day, when a larger proportion than usual of the return current leaked to earth instead of passing through the feeder, the booster would add less volts than usual, and thus instead of reducing the stray currents it would indirectly increase them. The actual voltage given by the booster with a given current in the trolley feeder can be adjusted by hand regulation of a resistance shunting more or less of the current from the series winding.—Q.

Answer to No. 518 (*awarded* 7*s.* 6*d.*).—It is well known that unless the rails of a tramway system are insulated it

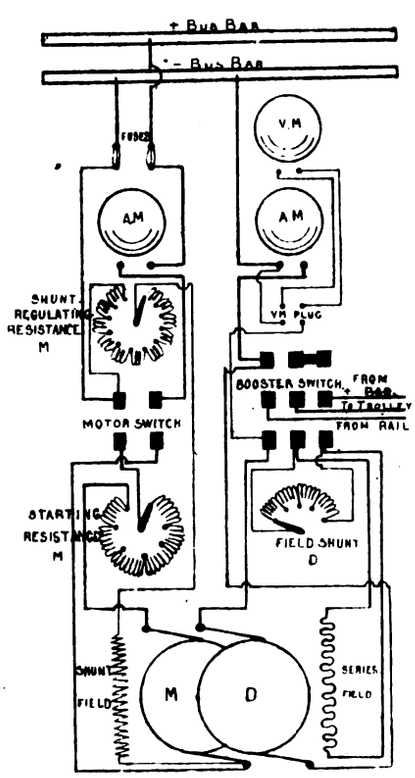
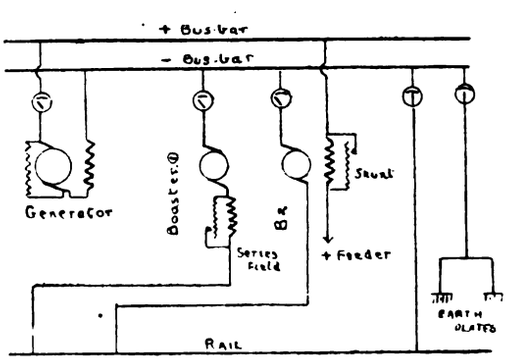


Fig. 1.

is impossible to get perfect protection from earth return, in many places the rail potential being five or six volts above earth; but, of course, the amount varies with the length of the route, long routes, such as six, eight, or ten miles, having a much greater drop, and it is for these that we instal the negative booster. By the employment of this method it is possible to bring the rail to zero potential at the point where the booster cable, which is insulated, is jointed to the rail, and in some cases it is taken so far as to make it negative to the generator; or, in other words, making the rail at the booster cable connection below earth potential. In this way the booster sucks back the current to the generator, and thus obviates to a great extent the loss in volts on the earth return, and in so doing minimises the action of electrolysis in the neighbouring water and gas pipes, a thing of great importance, and enables long tramway routes to be run with a drop of potential well under the seven volts specified as the maximum allowable by the Board of Trade. The negative booster (the connections of which are given in Fig. 1) is a motor-generator, the motor being shunt wound and the dynamo being separately excited by a coil in series with the trolley feeder or the armature of the positive booster, if one is used in conjunction with the negative, as is often the case in long traction lines, so that the voltage generated by the armature of the negative booster is proportional to the current output to the trolley—that is, of course, if the field magnets are not too well saturated. It will be found that the arrangement will work perfectly automatically, and the voltage drop can be limited to a certain range by adjusting the rheostat marked "field shunt" in Fig. 1. As will be seen from the diagram, the left-hand panel has the connections of the motor, M, on it and is started up in the usual way of shunt-wound motors. On the motor being up to speed the booster switch, which consists of three chopper switches fixed together at the top by an insulating strip, can be put in on the bottom contacts, and the amount of work done can be regulated to within a little by the field shunt (Fig. 1), which is in parallel with the series field, and, therefore, shunts a certain amount of the current; the more the resistance is reduced the more current is shunted, which weakens the field and, therefore, does not allow the negative booster to do so much. In the case of the machine breaking down, the booster switch must then be changed over to the top contacts which puts the trolley and rail return feeders respectively straight on to the trolley and rail, cutting out the negative booster altogether, and by doing so enabling that section of the tramways which is thus operated to continue working while repairs are being done.—R. N. T.

Answer to No. 518 (*awarded* 5*s.*).—Negative boosters need only be used when the amount of current returning through the rails is large enough to cause the fall of potential between the points of the uninsulated return furthest from and nearest to the generating station to exceed the Board of Trade limit of seven volts. This may take place on either a long line with perhaps only a few cars running, or a short one with a heavy traffic, especially if the rails are at all badly bonded. To remedy this a booster, which is really a sucking dynamo, sucks the current from the rails and returns it to the negative 'bus-bar. It can either be (1) a series-wound machine, with its armature and field coils all in series with a feeder from that part of the track whence current



is required to be tapped off. There is also a shunt across the field coils which can be adjusted so that the potential difference across the terminals may be regulated to compensate for the drop (see B 1 on diagram). B 2: Some engineers adopt this second method—*i.e.*, a booster with a separately excited field in series with the trolley circuit (or

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group of positive feeders), so that the voltage generated by the armature is directly proportional to the current output, provided that the fields are not saturated. The armature is in series with a feeder at whichever point it is necessary to take off current. This type of booster is quite automatic, and the drop on the earth return may be limited to any desired extent by an adjustable shunt in parallel with the field coils, as in the first type of machine. The potential of the earth return should, if possible, be positive to the neighbouring water and other pipes, so that whatever electrolysis takes place will be in the rails themselves. This condition can be more or less obtained by a judicious arrangement of boosted return feeders. The booster field should be so regulated that some current returns by the earth or direct rail connections to the negative 'bus bar. These last-named should have a centre reading ammeter in circuit, so that the direction of current through them may be ascertained. Otherwise the booster may, if the field strength is not regulated to suit the load, be taking current from the rails and sending it back again throngh the earth and direct rail either real or problematical, are constantly being introduced. We illustrate herewith some switches designed by Mr. D. R. connection. Care must be taken that this is not so. The diagram shows connections for both types of machine.—M. H. VOLK.

TRADE NOTICES AND NOVELTIES.

New Switches.

There is plenty of scope for ingenuity in the design of switch-gears, and it is doubtless due to this fact that improvements, Broadbent, 5, Albert-street, S.W. One of them (shown in Figs. 1 and 2) the inventor calls the "Splay" switch. It is a high-tension main switch, and improvement is claimed in the method of effecting the "make" and "break." The bridge piece or brush of the switch does not touch the contact studs when brought down to the level of the latter. Contact between the brush and the contact studs is made after the brush has been inserted between the studs, the operation being effected by turning an oblong piece of metal or splay-piece from its normal position to one at right angles. This splay-piece has also a locking device attached to it, locking the switch when in the "on" position. Both splay-piece, locking device, and brush are drawn back when the switch is in the "off" position, as shown in Fig. 2. To switch "off" merely necessitates turning the handle when the break is effected in a quick manner by the action of the brush. The current passes directly from stud to stud through the splay-piece. In Figs. 3 and 4 are shown what the inventor calls the "cam-lever" switch. This is a double-pole high-tension change-over switch, having a right-angle square spring break in either direction. The switch has a pivotally arranged handle, which in the "off" position hangs as shown in Fig. 4, thus enabling a reduction

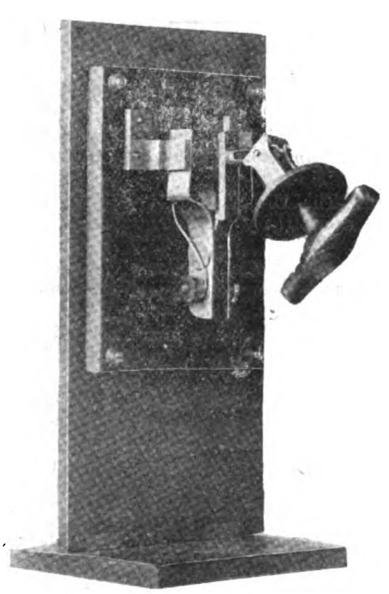
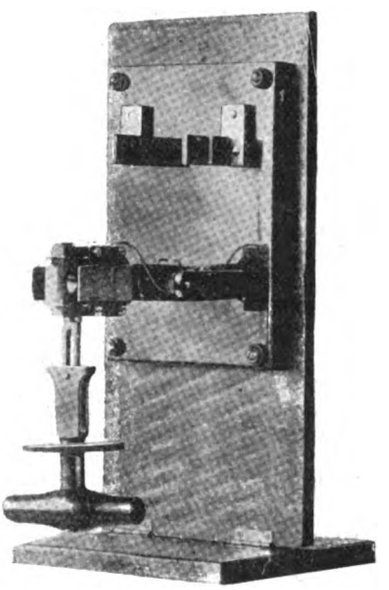


FIG. 1.—"Splay" Switch, Closed.

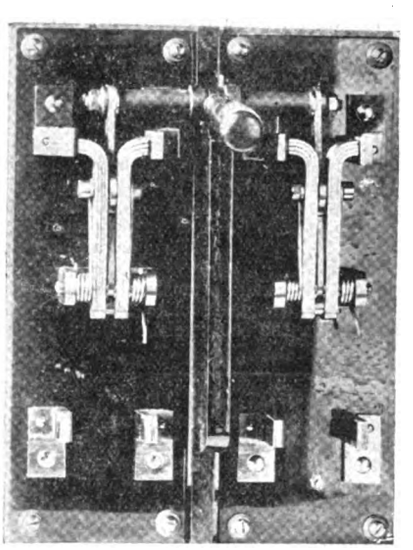
in the depth of the case. A reduction in metal and other parts, thereby lessening the cost of production, is also claimed for the switch.

Catalogues.

From the Western Electric Company, Bridge-chambers, 171, Queen Victoria-street, E.C., we have received a copy of their descriptive price-list of telephones for private line installations.



.—"Splay" Switch, Open.



3. 'Cam-Lever' Change-over type Switch, Closed.

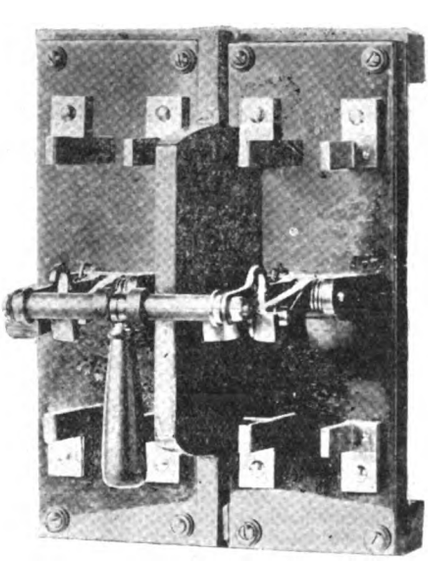


FIG. 4.—"Cam-Lever" Change-over type Switch, Open.

The Lighting Corporation, Limited, 4, Bloomsbury-street, W.C., have sent us a copy of their illustrated catalogue of "Wenham" incandescent and arc lamps.

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LEGAL INTELLIGENCE.

LONDON UNITED TRAMWAYS.

On the 2nd inst., Mr. Justice Jelf, sitting as vacation judge, heard a motion in the matter of the Urban District Council of Teddington and the London United Tramways Company. The District Council asked for an injunction against the tramway company, who are at present laying down tramways in Teddington urban district, to restrain them from interfering with the level of the roads. About 200 men are now engaged at the work, and the District Council contend that the tramway company had no right to proceed without first obtaining the approval of the plans by the surveyor of the Council. The case for the defendant company was that any disputes, such as that in question, should be dealt with by arbitration, as provided by the Tramways Act.

His **Lordship** refused to grant an injunction, and made, without prejudice, no order on the motion, at the same time remarking that, however they might be objected to, tramways had come to stay.

A TELEPHONE AGREEMENT.

Before Judge Smyly, K.C., at Bow, on Monday, the National Telephone Company sued Mr. John Lang, of South Woodford, for £3. 7s. 6d., or the return of a telephonic instrument belonging to the company. Defendant counterclaimed for £4. 15s.

Mr. Allsopp, for plaintiffs, said the Telephone Company entered into an agreement with defendant for the supply of an instrument at an annual subscription of £13, the agreement to run for five years. The company connected the line to defendant's premises on July 4, 1900, and continued the service for a little over two months. Then strong objection was taken by the neighbours to the line crossing their premises, and such pressure was brought to bear on the company that they had to remove the line, and were subsequently unable to supply the connection. In April last the company, finding they could not carry out their agreement, wrote terminating it, and asking for the return of the instrument.

Mr. Willis, for the defendant, said his client had had no notice terminating the agreement, which was still running.

Mr. Allsopp, in answer to Judge Smyly, said he could not prove the service of the motion terminating the agreement.

Judge Smyly: Then you cannot proceed. The probability is that the company did not get the necessary wayleave from the neighbours to go over their premises, and that is the root of the whole matter.

The counterclaim was then proceeded with, **Defendant** stating that he had had to pay about a sovereign to notify people that he was no longer on the telephone, while he had had an unsightly pole standing in his garden ever since.

Judge Smyly said the company must fail, as they could not prove service of notice. There would, therefore, be judgment for the defendant on the claim. On the counterclaim he awarded Mr. Lang £3 and costs.

FREE-WIRING AGREEMENTS.

In the Lambeth County Court on Friday Judge Emden heard the case of the South London Electric Supply Corporation, Limited, *v.* Morris Gouldston, trading as a tailor under the name of M. Gouldston and Co., at Princess-mansions, Coldharbour-lane, Brixton.

It appeared that the defendant entered into an agreement with the plaintiff company to use the electric light, and to pay as rent for the fittings at the rate of £1 per quarter and 3s. for the meter. The agreement was for a period of three years. After some time, owing, as alleged, to the bad quality of the light, which necessitated him burning candles, the defendant returned to gas, paid the corporation their account, and asked them to remove their fittings. They now sued under the agreement for the last quarter's rent of the fittings, amounting in all to £1. 3s.

Judge Emden asked did the corporation intend to hold defendant to the agreement for three years?

Plaintiff's **Manager** replied in the affirmative. They had to get back the expense of installation. They had had no complaints except this one of bad light.

Judge Emden: Do not say that. I have had a similar case to this before me previously. Under the agreement, I must give judgment for the corporation, but I will make no order as to costs.

COMPANIES' MEETINGS AND REPORTS.

CHILIAN ELECTRIC TRAMWAY AND LIGHT.

The report of the directors for the year ended Dec. 31, 1901, to be presented at the meeting on the 16th inst., states that the profit and loss account for the year, after payment of interest accruing on advances for construction, shows a balance to debit of £6,657. This amount deducted from the balance to the credit of profit and loss account carried forward from the year 1900, £9,959, leaves a net balance to the credit of profit and loss account to be carried forward to next year of the sum of £3,301. The net profits for the year 1901 on the operation of the tramways amounted to 292,696·04dol. against the net profit for 1900 of 243,055·26dol., showing an increase of 49,640·78dol. The great fall of exchange, however, during the year under review (on Dec. 31, 1900, the value of the peso was 17 1/16d., on Dec. 31, 1901, it had dropped to 14 1/16d.), together with the increased interest payable, have more than neutralised the increase of profit shown above. At the close of the year 1901 the reconstruction to electric traction had been nearly completed, and it may be added that on Feb. 28 of this year the contractors finally withdrew from Santiago, and handed over what work remained to be done to the general manager for completion. During the 12 months ended Dec. 31, 1901, there were carried 43,831,591 passengers, earning 1,965,660·10dol., as against 42,071,049 passengers, earning 1,830,268·08dol. for the preceding year. During the year 1901, although progress was made in the development of the use of electric lighting amongst the inhabitants of Santiago, great opposition was experienced from the Municipality. Under the terms of the Company's concession, the Municipality is compelled to take the Company's electric current for the public lighting of the town. That body, however, endeavoured to evade this obligation, and the Company was at length compelled in self-defence to submit their case to arbitration. The arbitrators decided in the Company's favour in June of the current year in terms of an agreement already made with the Municipality, by which, within a period of four years, this Company is to provide a complete installation for the public lighting of Santiago. Meantime 334 arc lamps of 500 c.p. each are now in course of being installed in the central district of the town. The directors anticipate, therefore, that having now come to an amicable arrangement with the Municipality, and the public also showing an increased desire to adopt the new illuminant, the returns for the current year will show a gradually increasing development.

NEW COMPANIES REGISTERED.

Howstrake Estate, Limited.—Capital, £1,000. Objects: to acquire any property in the Isle of Man, the United Kingdom, or elsewhere, to develop, deal with, and turn to account the same; to construct and maintain railways and tramways, etc.

Nottinghamshire Electric Tramways, Limited.—Capital, £100. Objects: to construct, maintain, and work tramways, light railways, electrical and other railways, motors, etc.

Autocar Construction Company, Limited.—Capital, £25,000. Objects: to acquire and carry on the business of the Pollock Engineering Company, etc.

APPOINTMENTS VACANT.

Junior Assistant Engineer, Hanley Town Council, £100 per annum, Oct. 10.

Chief Assistant Engineer, West Bromwich Corporation Electric Light and Power Department, £2. 5s. per week, Oct. 13. See advertisement.

Chief Electrical Engineer, Glasgow Corporation Tramways, £500 per annum, Oct. 22.

Assistant in dynamo testing department. See advertisement.

Assistant, Ferranti, Limited. See advertisement.

Switchboard Attendant, 28s. per week. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Wigan.—The Corporation invite tenders for 18 bogie cars, double-deck, four-motor equipment. Tenders by Oct. 20. See advertisement

Bury.—The Tramways Committee of the Corporation invite tenders for rails bonds and compressors. Tenders by Oct. 14. See advertisement.

Aston Manor.—The Urban District Council invite tenders for condensers for their electricity generating station. Tenders by Oct. 31. See advertisement.

Belfast.—The Gas and Electric Committee invite tenders for the supply of electric motors for a period of 12 months. Tenders by Oct. 10. See advertisement.

Great Western Railway.—The Directors invite tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1903. Tenders by Oct. 20. See advertisement.

Batley.—The Corporation invite tenders for the supply, delivery, and erection, at the electricity works, of one re-cooling tower and tank. Tenders by Oct. 28. See advertisement.

Tientsin (China).—Mr. A. W. Harvey Pellingham, secretary of the British Colony at Tientsin, China, invite tenders for installation and working of electricity works. Tenders by Nov. 30.

Abacete (Spain).—The Municipality invite tenders for the installation and working for 20 years of electric lighting. Tenders to the above at Abacete, Province of Bonillo, Spain, by Oct. 20.

Wigan.—The Corporation invite tenders for the electrical equipment of a short length of new tramway and of a portion of their existing tramways. Tenders by Oct. 20. See advertisement.

Cambridge.—The Saxon Portland Cement Company, Limited, require tenders for the supply of calcium carbide in weekly quantities of 8cwt. for a period of six months commencing Oct. 31, 1902.

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Ipswich.—The Corporation invite tenders for main switchboard, motor boosters, connections in generating station, and overhead construction for tramways. Tenders by Oct. 22. See advertisement.

Batley.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Batley, Yorks, of 240 accumulator cells and accessories. Tenders by Oct. 10. See advertisement.

Wigan.—The Corporation invite tenders for the construction of a short length of new tramway and for the reconstruction of a portion of their existing tramways. Tenders by Oct. 20. See advertisement.

Rome.—The Italian Government Railways require immediately tenders for the installation of electric lighting in 100 new railway wagons, and for transforming 175 old wagons from gas to electric lighting.

Paris.—The Municipal Wood Paving Factory at Javel requires five electric motors of 7 h.p. to 30 h.p. Particulars may be obtained at that factory. Tenders will be opened at the Town Hall, Paris, at 2.30 p.m., on Oct. 22.

Rotherham.—The Corporation invite tenders for steam pipes and valves, feed pipes and valves, feed pump and economiser, exhaust, water, and drain pipes and valves, and extension switchboard. Tenders by Oct. 16. See advertisement.

Bootle.—The Corporation invite tenders for the wiring of the refuse destructor in Pine-grove for the purposes of electric lighting. Specification, etc., may be obtained at the Borough Electricity Works, Pine-grove. Tenders by 10 a.m. on 14th inst.

Dudley.—The Corporation invite tenders for supply of arc lamp carbons. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on 18th inst.

Tunbridge Wells.—The Town Council invite tenders for the construction of main flues at their central electric light station, Tunbridge Wells. Specification, etc., can be obtained on application to the Borough Surveyor, Town Hall, Tunbridge Wells. Tenders by Oct. 18.

Barrow-in-Furness.—The Corporation invite tenders for two batteries of accumulators and two automatic reversible boosters, switchboards, etc. Specifications, etc., can be obtained from Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness. Tenders by Oct. 15.

London, S.W.—The Fulham Borough Council invite tenders for installing the electric light at the mortuary and coroner's court, Munster-road. Full particulars may be obtained on application to Mr. R. M. Prescott, town clerk, Town Hall, Fulham. Tenders by 5 p.m. on 15th inst.

Paris.—The French Government have decided to invite tenders for the supplying and laying of the following cables: (1) from Brest to Dakar; (2) from Tamatave to Réunion and from Réunion to Mauritius; (3) from Saigon to Pontianak, at Borneo. Tenders must be sent in by Oct. 21 next.

Bootle (Lancs.).—The Corporation invite tenders for the wiring of the new fire station in Strand-road for the purposes of electric lighting. Specification, etc., may be obtained at the office of the architects, Messrs. Anderson and Crawford, 36, Dale-street, Liverpool. Tenders by noon on 18th inst.

Edinburgh.—The Corporation invite tenders for the electric lighting installation at the public wash-houses, Stockbridge. Specification, etc., can be obtained at the office of the Resident Electrical Engineer, Electricity Supply Station, Dewar-place, Edinburgh. Tenders by 10 a.m. on 13th inst.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of two electric car traversers at certain of the Council's depôts in the south of London. Specification, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 21.

Manchester.—The Electricity Committee invite tenders for the steelwork in the construction of coal bunkers at their Stuart-street generating station, Bradford. Manchester. Specification, etc., may be obtained on application at the City Surveyor's Office, Town Hall, Manchester. Tenders by 12 noon on 16th inst.

Wakefield.—The Guardians invite tenders for the electric lighting of old workhouse buildings, including supply and erection of steam dynamo, pipe work, switchboards, and wiring. Specifications and particulars may be obtained from Mr. H. Beaumont, clerk, Union Offices, Tetley House, Wakefield. Tenders by 18th inst.

Blackpool.—The Corporation invite tenders for the supply and erection of coal elevator, bunker, and automatic weigher in connection with their electricity works, West Caroline-street, Blackpool. Particulars and forms of tender may be had on application from Mr. Charles Furness, borough electrical and tramway engineer. Tenders by 15th inst.

Gefle (Sweden).—The City Architect requires tenders for supply and erection of electrical machinery, accumulators, etc. Drawings, specifications, etc., may be obtained from the Gefle stads byggnadskonter against payment of 25 kroner, which will be refunded. Tenders by Oct. 15, addressed Anbud a elektriskt maskineri, Drätselkammare Stads, Gefle, Sweden.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for Lancashire boilers, economisers, surface condenser, and pumps, etc., steam, feed, blow-off, and drain pipes, etc., and travelling crane. Specifications, etc., can be obtained from Mr. F. Schofield, clerk to the Board, Town Hall, Stalybridge. Tenders by Oct. 13.

Shanghai.—Messrs. Preece and Cardew are authorised to receive tenders for the supply and delivery c.i.f. of two 500-kw. steam alternators (the engines to be enclosed double-acting type and alternators to have stationary armatures, pressure 2,100 volts, periodicity 100), switchboards, and two condensers and circulating water pumps. Tenders by Oct. 30. See advertisement.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

Irun (Spain).—The Municipality invite tenders for the installation and working for 25 years of electric lighting. Tenders to the above at Irun. Amongst the conditions are the purchase for 150,000 pesetas of the already existing municipal central station. The following income may be expected: 300 pesetas per horse-power per annum for not less than 25 h.p. and not more than 50 h.p. for public lighting; and for private lighting 2½ pesetas per month for each 10-c.p. lamp, 1½ pesetas for each 5-c.p. lamp; 80 cmos. per kilowatt-hour for lighting, and 50 cmos, per kilowatt-hour for power. A deposit of 75,000 pesetas will be required. Tenders by Oct. 19.

Glasgow.—The Corporation invite tenders for the construction, supply, and erection, under one contract, of the whole of the machinery and accessories required for the mechanical equipment of the machinery buildings at the Dalmuir outfall works. Amongst the more items are: four Lancashire boilers, centrifugal pumping engines, screening and elevating machinery, penstocks, valves, electrical generators for lighting and power, electric motors, auxiliary pumps, steam and water pipe connections, lime-mixers, and other sewage treatment plant, overhead water-tank, etc. Specifications, etc, may be had on application at the Office of Public Works, City Chambers, 64, Cochrane-street, Glasgow. Tenders by Oct. 28.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tientsin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

Madrid.—The Directorate-General of Posts and Telegraphs, Calle de Caretas 10, Madrid, as well as in the offices of the civil Governments of the provinces of Barcelona, Cordoba, Valladolid, and Zaragoza require tenders by Oct 28, which will be opened five days afterwards in the Directorate-General of Posts and Telegraphs, Madrid, for the supply of 35 tons of galvanised iron wire four millimetres in diameter, 10 tons of galvanised iron wire three millimetres in diameter, three tons of copper wire two millimetres in diameter, four tons of copper wire ⅛ of a millimetre in diameter, and four tons of copper wire ⅛ of a millimetre in diameter, for the telegraph and telephone lines of the State, at the upset prices of 570 pesetas, or about £17, per ton for iron wire, and 2,890 pesetas, or about £86, per ton for copper wire. A provisional deposit of 5 per cent. of the amount of the contract at the upset prices is required to qualify any tender. A translation of the general conditions of the contract has been received through the Foreign Office from his Majesty's Embassy in Madrid, and, together with the particulars of the requirements which the wire must fulfil, may be seen by those interested on application to the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W., on any day between the hours of 10 a.m. and 5 p.m.

RESULTS OF TENDERS.

Sheffield.—The Tramways Department have given a large order for supply of dialite cable to the St. Helens Cable Company, Warrington.

Cheltenham.—The Town Council have accepted the tender of R. E. and C. Marshall for wiring the extensions at the electricity works, at £42. 12s. 6d.

Admiralty.—Belliss and Morcom have received repeat orders for electric light sets for the newest type of torpedo-boat destroyer, a total of nearly 20 vessels in all.

Gillingham.—The Urban District Council have decided to instal two 450-h.p. Willans engines and one of smaller size for direct coupling to dynamos by the British Thomson-Houston Company.

Stretford (Manchester).—The Urban District Council have accepted the tender of the Staffordshire Brick and Terra-Cotta Company, Hednesford, at £550, for work at the generating station.

Peterborough.—Crompton and Co., Chelmsford, have received a further order from the Corporation for the supply of a dynamo for direct coupling to a 450-h.p. Willans engine for supplying power to the tramways.

Stepney.—The Borough Council have received the following tenders for a centrifugal pump: Ernest Scott and Mountain, Close Works, Newcastle-on-Tyne, £82; J. and H. Gwynne, 81, Cannon-street, E.C., £58. 12s. (accepted).

Deptford.—The Court of Common Council have accepted the tender of the Maudslay Motor Company, Coventry, at £1,500, for a 73-h.p. petrol motor for use on the railway and tramways at the Foreign Cattle Market, Deptford.

Bury.—The Town Council have accepted the following tenders: St. Helens Cable Company, Warrington, for tramway feeder cables; J. Brunton, Hull, for the construction of the permanent way on the Fairfield, Bolton-road, Heywood-street, etc., and Knowsley-street sections.

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Battersea.—The Borough Council have accepted the tender of Barnes and Co. for the purchase and removal of the following material from the accumulators at the Town Hall electric lighting station—viz., soft lead at the rate of £9. 18s. 6d. per ton, and storage batteries and plates £6. 12s. 6d. per ton (total approximately £35).

Ladysmith.—The Town Council have received the following tenders for the electric lighting of the town: Messrs. Hubert Davies and Spain, £8,328 (accepted); Boult and Bradley, £13,880; Davey, Paxman, and Co., Limited, £11,952; Blane and Co., £9,978; W. Hosken and Co., £9,036; South African General Electric Company, £9,006; Reunert and Lenz, £8,957; Collins and Kessler, £8,830; Macartney, McElroy, and Co., Limited, £8,810; Silverton and Co., £8,750; and Hamilton and Co., £8,417.

Maidenhead.—The Town Council have accepted the tender of the Bastian Meter Company for meters of 2½-ampere capacity at £1. 10s. each, and the tender of Venner and Co. for ordinary meters of all sizes, the prices ranging from £2. 10s. for the 5-ampere size up to £3. 10s. for the 100-ampere size. The unsuccessful tenderers were as follows: Schattner Electricity Meter Company; Reason Manufacturing Company, Limited; Ferranti Limited; British Thomson-Houston Company, Limited; Geipel and Lange; Siemens Bros. and Co., Limited.

West Ham.—The Corporation have accepted the tender of F. Osman for permanent way and paving road margins in connection with the Corporation tramways. The amount of the tender is £114,243 if Guernsey, Leicester, Penmaenmawr, or the Welsh Granite Company's stone is used, £112,011 if Aberdeen stone is used, £105,313 if Norwegian is used, £103,081 if any other stone is used. The stone will be used in such quantities as may be agreed upon by the respective engineers. £2,818 will be deducted if foreign rails are used.

Reading.—The Corporation have received the following tenders for work in connection with the tramways—viz.: (Section A) comprising the supply, delivery, drawing-in and connecting up of all feeder cables, rail return cables, test wires, etc., with joint-boxes and jointing, and the carrying out of tests; (B) comprising the supply, delivery, erection, and connecting up of all poles, brackets, wires, cables, insulators, switch-boxes, and other fittings, and the carrying out of tests. Messrs. J. Bowen and I. E. Winslow, Town Hall, Reading, engineers:

Section A.

St. Helens Cable Company, Limited, Warrington	£2,467 16 10
Johnson and Phillips, Electric Cable Works, Old Charlton, Kent	2,875 2 6
J. G. White and Co., Limited, 22A, College-hill, Cannon-street, London	2,744 4 10
Siemens Bros. and Co., Limited, York-street, Westminster, London	2,692 12 5
W. T. Henley's Telegraph Works Company, Limited, 27, Martin's-lane, Cannon-street, London, E.C.	2,545 2 2
Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, London	2,746 16 2
R. W. Blackwell and Co, Limited, 59, City-road, London	2,746 16 2
W. T. Glover and Co., Limited, Trafford Park, Manchester	2,753 9 2
Anchor Cable Company, Limited, Leigh, Lancashire	2,661 19 1
British Insulated Wire Company, Limited, Prescot, Lancashire	2,545 17 2
Western Electric Company, North Woolwich, London	2,738 1 10

Section B.

British Electrical Equipment Company, 101, Leadenhall-street, London, E.C.	10,166 10 10
Macartney, McElroy, and Co., Limited, 53, Victoria-street, Westminster, London	12,159 10 0
M. A. Shepstone and Co., 9, Victoria-street, London, S.W.	11,472 16 3
J. G. White and Co., Limited	11,531 15 6
Callender's Cable and Construction Company, Limited	11,808 6 4
R. W. Blackwell and Co., Limited	10,932 0 10
British Insulated Wire Company, Limited	11,704 9 3

Tender recommended for acceptance for the whole of the work: R. W. Blackwell and Co., Limited, £13,477. 3s.

BUSINESS NOTES.

TRACTION.

Deal.—The Kent Electric Power Syndicate are preparing a scheme of light railways to run through this district.

Rowley Regis.—Mr. R. P. Wilson, of London, has been appointed engineer to the light railway scheme in this district.

Dundee.—A reduced tramcar service will be introduced on the Corporation tramway system during the winter months.

Wigan.—The purchase of the local tramways has been completed, and a cheque for £42 000 handed over to the vendors this week.

Dudley.—The tramways by-laws and regulations recently made by the Town Council were duly published in the *London Gazette* of Monday last.

Leicester.—The Light Railway Commissioners will open an enquiry here on the 29th inst. with reference to a proposed light railway scheme for Groby.

Penarth.—A special meeting of the Urban District Council has been called to deal with the question of the proposed tramway between Cardiff and Penarth.

Hastings.—It was stated at the last meeting of the Town Council that the work of constructing the proposed electric tramways would be commenced before Christmas.

Cleckheaton.—The agreement with the Traction Company with reference to the supply of electrical energy for the working of the tramways has been completed and sealed.

Darlington.—The Town Council have approved the plans of the proposed light railways. They are now in the hands of Messrs. Kennedy and Jenkin, the consulting engineers.

Elland.—The proposal that the Halifax Corporation should be asked to hand over their tramway rights in this district to the British Electric Traction Company has been withdrawn.

Newburn.—A deputation from the Newburn Council has been appointed to wait on the Newcastle Tramways Committee with reference to an extension of the tramways to this place.

Rochdale.—The Corporation have decided to call upon the Bury, Rochdale, and Oldham Tramways Company to sell to them such part of the company's undertaking as is within the borough.

Mumbles.—The electric accumulator cars recently acquired by the Mumbles Railway Company have started a regular service on the line. They will not at present, however, altogether displace the old steam trains.

Worthing.—The Town Council are in communication with the British Electric Traction Company, who intend to apply in the next session for powers to lay down and work tramways in Hove and Worthing.

Carlisle.—The directors of the tramways company have decided to try the experiment of ½d. fares over a portion of their system, and for the winter service, commencing Nov. 1, to run every 15 minutes instead of 10.

St. Marylebone.—The Borough Council have decided, by a considerable majority, to refuse their assent to the construction of a surface electric tramway from the Marble Arch, along Edgware-road, to Cricklewood.

The Potteries.—A meeting of the Potteries Electric Traction Company's employés has passed a resolution protesting against the large number of dismissals that have taken place, and the arrangement of the hours of labour.

Brighton.—At the last meeting of the Town Council it was decided not to include powers in the present Bill to construct a tramway from the Old-steine up St. James's-street, to connect with the existing line at Upper Rock-gardens.

Nottingham.—All the large bogie cars on the tramways are being fitted with four 25-h.p. motors each. The smaller cars are being fitted with two 35-h.p. motors in place of the two 25-h.p. motors that have hitherto driven the cars.

Birkenhead.—The Corporation tramways' finances were the subject of a lengthy debate at the Town Council meeting last week, during which it was stated that the undertaking would make a profit of £5,000 or £6,000 this year.

Audenshaw.—In the equipment of the tramways in this district for electric traction, it is not intended to entirely reconstruct, but only to strengthen where necessary. The conversion is being carried out by the Manchester Corporation.

West Bromwich.—The work of reconstruction and electrical equipment of the tramways in the borough has been hurried on, and it is hoped the new cars will be running along a section of the route by the early part of November.

Leeds.—A deputation representing the Tramways Committee of the Corporation is at present paying a visit to Dresden. The object of the visit is to see in operation a new process by which tramlines can be welded whilst they are being laid.

York.—Proposals have been received from the tramways company as to the extension of their lines, the working of the same by electrical traction, and other matters. The subject is to be brought before the Council early in the New Year for consideration.

Sowerby Bridge.—Major Druitt has refused to recommend the opening for traffic of the Sowerby Bridge tramway until the Pye Nest-road is widened. The Tramways Committee are now considering how best the necessary widening may be carried out.

Dartford.—A special meeting of the Urban District Council is called to consider the question of the extension of the light railway scheme to Gravesend and Swanscombe. Mr. Hawtayne, the consulting engineer, will probably be in attendance at this meeting.

Doncaster.—The Corporation propose to make several extensions and alterations in connection with their tramway system. Further borrowing powers are to be obtained; £11,000 for the tramways and electrical equipment, and £3,000 for five additional cars.

Hampstead.—The Borough Council have decided that they are not prepared to make a contribution of one-third of the net cost of the necessary street widenings in connection with the proposed scheme for constructing a tramway from the Marble Arch to Cricklewood.

Salford.—It is expected that the new tramway service between Salford and Prestwich will be opened in about eight weeks' time. On Wednesday the members of the two Tramways Committees took part in the ceremony of joining up the rails at the Salford boundary.

Buxton.—A scheme is being promoted to provide a tramway from Chinley to the Cat and Fiddle, the route being *via* Chapel-en-le-Frith, Dove Holes, Buxton, Poole's Cavern, and Burbage. The Fairfield Urban District Council have expressed themselves in favour of the scheme.

North-Eastern Railway.—Tenders for the electrification of North-Eastern suburban lines in the Newcastle district closed on Monday. The lines to be converted are 41 miles in length, and include the loop

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from Newcastle to Tynemouth on the sea shore, and back again by way of Gosforth.

Worcester.—The City Council was engaged on Tuesday in discussing the relative merits of double and single tramlines, in view of the conversion of the existing horse trams to electric traction. It was ultimately agreed that double lines be generally adopted, excepting only Broad-street.

Wednesbury.—At a special meeting of the Town Council, to be held early in November, a resolution will be moved that notice be given to the South Staffordshire Tramways Company requiring them to sell to the Corporation so much of their tramway undertaking as is within the borough.

Maidenhead.—Matters in connection with the proposed application for an order authorising the Corporation to construct light railways have been referred to the sub-committee appointed to oppose the application of the London United Tramways Company for powers to extend their lines to this district.

Southwark.—A deputation of Southwark traders has waited on the Borough Council to call attention to the injury caused to trade in the district by the way in which the roads are being pulled up for the purposes of the electrification of the tramway system. The matter was referred to a committee.

Cheltenham.—In spite of the decease of Mr. T. Nevins, who at the time of his death was promoting a scheme of light railways in this district, it is promised that all contracts and agreements entered into with the Corporation will be carried out. The scheme has been taken up by Mr. T. A. Nevins, his son.

Barnsley.—The first tramcar was placed on the metals on Monday, and taken to the car shed in Sheffield-road. It is expected that a trial trip will be made either to-day or on Saturday, and everything is being prepared as quickly as possible for the Board of Trade's inspection. The trams have to be running by Nov. 11.

Harrogate.—The proposal of the Corporation to adopt a system of tramways has caused considerable discussion in the town, and there is a strong feeling of opposition to the scheme. Several prominent townspeople have signified their intention of opposing any system which they claim will be detrimental to Harrogate as a health resort.

Alfreton.—The District Council have received a communication from Sir Bache Cunard intimating that he proposes to apply to Parliament for powers to construct a light railway through the district. It was resolved to take no steps in the matter until the Bill is before the Council. Another company also proposes to apply for similar powers.

Bury.—The Town Council have appointed Mr. T. J. Hutchinson as analyst in connection with the supply of rails for the tramways. The proposed extension of the Fairfield section has been postponed for two months. The Council have decided to appoint a clerk of works to superintend the construction of the track of the tramways now being laid down.

Lowestoft.—The deputation of members of the Town Council who went out recently to view sundry systems of electric tramways have prepared their report. It is probable that at the next meeting of the Council various recommendations will be made—amongst them one in favour of the overhead trolley system as against the conduit and surface-contact systems.

Clacton.—The promoters of the light railway scheme are anxious to take over from the Corporation their electric lighting order. In view of the fact that the recent decision of the Council to carry out the terms of the order themselves was only carried by one vote, it is now decided to call a town's meeting to ascertain the feeling of the ratepayers in the matter.

Yarmouth.—The electric tramways, which were laid down early in the summer at a cost of £40,000 have just completed the first quarters' working. The takings during that period have amounted to about £4,100, and the profits have reached the satisfactory figure of £2,125 for the three months. The Council now contemplate laying down some three miles of additional lines.

Willenhall.—On Friday a preliminary trial trip over the Willenhall section of the Wolverhampton tramways was made by representatives of the British Electric Traction Company. One of the large bogie cars was run from Bilston, and made several journeys from the Wolverhampton borough boundary to the Walsall-road Board Schools. The result was eminently satisfactory.

Birkdale.—A petition, signed by 116 residents, was read at the last District Council meeting, protesting against the use of the electric tramcars for Sunday traffic, and further protesting against the sending of any request to the Southport authority or any other authority for the employment on Sundays of the electric tramcars. It was decided that the petition be referred to committee.

Yeadon.—The District Council have passed a resolution in regard to the two schemes proposed by Messrs. Maitre and Parker, of Leeds, and Messrs. Dick, Kerr, and Co., of London, respectively for a tramway from Leeds to Guiseley, to the effect that the former is the one more likely to serve the best interests of the whole district. The Council have therefore agreed to support that scheme.

Halifax.—The feasibility of the Salterhebble "lift" scheme, which forms part of a suggested tramway extension route to West Vale, was recently referred to Sir Douglas Fox, C.E. He visited the locality a few days ago, and his report on the scheme was received by the town clerk on Tuesday. The decision is not to be made known until the report has been considered by the Tramways Committee.

Camborne.—The first electric tramway system to be completed in Cornwall is that which the Camborne and Redruth Tramway Company have laid down between those two places. A trial trip of the cars over the whole route was made one day last week. The cars, which are beautifully fitted, ran over the line very successfully, and it is hoped that in a week or so the full service of cars will be running.

Aberdeen.—As a result of a conference between the Tramways Committee and the Harbour Board, it is understood that the latter have agreed not to oppose the laying of a single line to Torry. The Aberdeen Suburban Tramways Company have asked the Corporation to enter into an agreement (1) for the supply of electrical energy to the company, and (2) for the working of the tramways within the city.

Lambeth.—It has been decided by the Borough Council to take advantage of the removal of the tramlines in Westminster Bridge-road in connection with the electrification of the London County Council tramways to repave the road with wood. The existing paving has a "life" of two years to run, but the Council propose to spend over £4,000 on the work now, and so avoid public inconvenience later on.

Anglo-Argentine Tramways.—The directors have declared an interim dividend of 2s. per share for the half-year ended June 30 last, carrying £3,288 forward. The work in connection with the conversion from horse to electric traction is proceeding satisfactorily, and will be practically completed by the end of the current year. The existing 260,007 shares will become 5 per cent. cumulative preference shares as from Jan. 1, 1903.

Geneva.—The tramway strike here has assumed serious proportions. The strikers are threatening the other tramway employés who continue to work, and are endeavouring to prevent the cars from running. In view of rumours of a general strike, and in order to prevent serious disorders, the Cantonal Government has called out troops to maintain order and to secure the protection of the men who desire to remain at work.

Stretford.—Delay has arisen in the conversion of the tramways at this place to electric traction owing to an appeal which is being made on the arbitrator's award. The Council have relegated the negotiations for the purchase of the Stretford tramways to the Manchester Corporation, by whom the tramways will be worked after the purchase is completed, under the terms of an agreement entered into between the Council and the Corporation.

Southampton.—With regard to the proposed extension of the tramways to the Brook Inn, Hampton Park, the borough engineer has reported to the Tramways Committee that he estimates the cost of the extension at £6,720, such amount being exclusive of electrical equipment and track bonding. The electrical engineer estimates the cost of the electrical equipment at £590. The committee have decided to make application to borrow the money.

Lourenco Marques.—A definite start is to be made shortly with the laying of the lines for the long-delayed electric tramway at Lourenço Marques, the concession for which is held by Mr. J. C. A. Henderson. A site has been obtained whereon to erect the generating station, the work on which will be commenced in two or three months' time. In the meantime the machinery has been ordered, and will be ready for erection by the time the station is ready to receive it.

Blackpool.—It is stated that the preparations for the entire reconstruction of the Blackpool, St. Annes, and Lytham tramway system are now complete and agreed upon. The contractor named is Mr. Nevins, jun., son of the late Mr. T. Nevins, head of an American firm, who recently died in Ireland. The scheme provides for the relaying and doubling of track from Blackpool to Lytham, and the substitution of overhead electric traction and cars for the present gas-motor system.

Devonport.—At the inquest on Monday on the victim of the fatal electric tram accident, reported in last issue, the jury returned a verdict that the car ran away through ignorance on the part of the driver in not stopping at the necessary stopping places, and not subsequently using the appliances for stopping. They also expressed the opinion that the instruction given to drivers was not sufficient to make them competent. Major J. W. Pringle has held an enquiry on behalf of the Board of Trade into the accident.

Bradford.—The balance-sheet for the half-year ended Sept. 30 last shows that the total income from the electric lines was £89,500, despite the fact that several sections were closed for weeks together for relaying or repairs. The ordinary expenditure for the six months amounted to £79,600, including proportion of profits of £11,650 to the old steam companies. The approximate profit, excluding any allowance for depreciation, is £9,900. After allowing for the fullest depreciation, the net profit will probably be between £3,000 and £4,000.

Harrow.—The Light Railway Commission will hold a public enquiry at Harrow on Oct 21 as to the expediency of granting so much of the application of the Middlesex County Council (Order No. 1) as relates to Railway No. 4 in the parishes of Wembley, Harrow-on-the-Hill, Northolt, Wealdstone, and Harrow Weald, and Railway No. 5 in the parishes of Edgware, Little Stanmore, Great Stanmore, and Harrow Weald, and also to the proposals to take additional lands for widening roads in the parishes of Wembley, Little Stanmore, and Edgware.

Middleton.—It was reported at the last Town Council meeting that the Manchester Tramways Committee had been able to secure all the material necessary for the overhead equipment on the Manchester New-road, and that it was hoped to have the work complete within a month. Through trams are to run from High-street, Manchester, to Middleton. It was also reported that an offer had been made by the Heywood Corporation, on behalf of a tramway company, to construct a new road between the two towns on condition that Middleton contributed a sum of £1,000.

Wolverhampton.—On Saturday night at about half-past ten the electric current was suddenly cut off along the whole tramway track from Queen-square to Tettenhall. All the cars were, of course, brought to a standstill, and the arc lights went out. The official explanation of the occurrence was the sudden stoppage of both suction pipes between the pumps and the water storage tank. It was some time before a temporary connection could be made between the water-mains

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and the pumps, with the result that a good portion of the Saturday night tram traffic was lost.

Reno Electric Stairways, Limited.—Notice is given in the *London Gazette* that a general meeting of the members of the above-named Company will be held at 70, Finsbury-pavement, on Nov. 3, at 12 o'clock, for the purpose of having an account laid before them showing the manner in which the winding-up has been conducted and the property of the Company disposed of, and also of determining, by extraordinary resolution, the manner in which the books, accounts, and documents of the Company, and of the liquidator thereof, shall be disposed of.

Warrington.—The Corporation electric tramway scheme, so far as the powers possessed at present are concerned, is almost finished. After a Board of Trade inspection, conducted by Colonel von Donop, the section from Bridge-street to Stockton Heath was opened on Saturday. The Manchester-road and Winwick-road lines are also nearly completed. The section between Latchford and Sankey Bridges, which was opened some time ago, has proved a great success. The question of constructing additional tramways in the town will probably be considered by the Council next June.

Swinton.—Sir Frederick Bramwell, the tramways arbitrator, has visited this district, with the result that an understanding has been arrived at whereby the construction of the tramlines for electrical traction may be proceeded with by the Salford Corporation, pending Sir Frederick's award, which will probably be given in November. Specifications and plans have been submitted to the Urban District Council for the laying of the new track through Swinton and Pendlebury, and as soon as these have received the sanction of that authority, the work will be commenced.

South London.—Such progress has been made with the work of electrifying the tramway system of the London County Council south of the Thames that eight miles of double track, 16 miles altogether, have been completed. The contract stipulates for 25 miles to be electrically equipped by the end of the year, and now only nine miles of the old routes remain to be dealt with. From Tooting to Clapham the lines are practically completed, portions of the Blackfriars-road and Kennington Park-road have been finished, and other routes are now being torn up for the continuance of the work.

Additional Traffic Returns.—Anglo-Argentine, £128 decrease; Barcelona Ensanche y Gracia, £61 increase; Barcelona, £940 increase; Brisbane, £920 increase (month of September, £9,757, increase £994); Buenos Ayres and Belgrano Electric, £6 increase (month of September, £12,476, decrease £150); Calcutta, £604 increase; Cape Town (month of August), receipts £15,450, expenditure £7,801; Isle of Thanet Electric, £82 decrease: Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £188 increase; Port Elizabeth (month of August), receipts £4,014, expenditure £1,979.

Swansea.—At the last meeting of the Tramways Committee a letter was read from the tramways company with reference to a suggestion that additional cars should be placed on the docks system, stating that experience had shown that up to the present an augmented service had resulted in no increase in the takings, and thus it was evident no additional accommodation was required. The chairman thought the company would have done well to have adopted the suggestion made—viz., the division of the journey into two sections at ½d. each. It was decided to ask the company to improve its service of workmen's cars.

Selby and Stamford Bridge Light Railway.—At a meeting of the Riccall and Escrick Rural District Councils on Thursday the proposed light railway from Selby to Stamford Bridge was considered. It was reported that the Light Railway Commissioners had granted an order for the construction of a light railway from Cliffe Common, near Selby, to Stamford Bridge, and a joint committee of the two councils was appointed to carry out the scheme. The engineer (Mr. Fenwick) reported that a survey of the line had been made, and it was resolved to approach the landlords on the route and secure their support for the undertaking.

Lewisham.—A petition, signed by between 300 and 400 ratepayers of the parish of Lee, which forms part of this borough, is to be presented to the London County Council asking them to construct an electric tramway from New Cross to Eltham, *via* Lewisham High-road, Loampit-hill, and Lee High-road. The Deptford Borough Council have already agreed to contribute their share of the cost of that portion of the proposed line which is within their area. The Lewisham Borough Council have hitherto declined to support the scheme, but they have decided to reconsider the whole question of tramways throughout their district.

Stourbridge.—An important extension has been made of the Dudley, Stourbridge, and District Electric Traction Company's lines by the construction at Stourbridge of a line two miles in length to Lye and a line nearly a mile long to Wollaston. The Dudley and Stourbridge system of lines is already some 23 miles in extent, and will link up with the South Staffordshire tramway system, which is in course of development by the British Electric Traction Company. Colonel Von Donop inspected the lines on Thursday last week on behalf of the Board of Trade, and required some few alterations to be made which may delay the opening of the line for about a week.

London County Council.—The London County Council, at their first meeting after the long vacation, on Tuesday, resolved to enter into an agreement to purchase the undertaking of the South London Tramways Company, and also to negotiate for the purchase of the undertaking of the London, Deptford, and Greenwich Tramways Company. As will be seen from our tenders columns, it was agreed to accept the tender of Messrs. E. Green and Co., at £4,092, for fuel economisers for the Greenwich electricity station. This was the lowest tender sent in, but it exceeds the estimate by nearly £550. Messrs. Green propose to sub-let to the British Thomson-Houston Company for the manufacture of the motors.

Sheffield.—It is proposed to include provision in the Bill to be promoted by the Corporation in the next session of Parliament for powers for the following extensions of the tramway system: (1) tramway commencing at Brightside-lane, proceeding along Meadow Hall-road, and terminating at a point near to Station-road, Wincobank, with the necessary curves and double junctions; (2) tramway commencing at Brightside-lane, proceeding along Newhall-road, and terminating at Carlisle-street, with the necessary curves and double junctions. It is proposed to apply a sum of £10,000 out of the tramway profits to the relief of the rates.

Yardley.—A letter was read at the meeting of the District Council on Tuesday from the City of Birmingham Tramways Company, asking the Council's consent to the construction of a tramway along the Coventry road from the city boundary to the Swan Hotel, the working of the same to be on the overhead electric system, and the adaptation of the existing tramway on the Stratford-road from the city boundary to College-road to the overhead electric system. It was decided to refer the letter to the Public Works Committee, in the meantime the clerk to ask the company what the maximum amount of the fares would be, the maximum time of completion, and what amount they would contribute towards the rates.

East Ham.—The tramway accounts for the nine months ended March 31 last show the total revenue to have amounted to £15,618, as against an expenditure of £10,960, leaving a gross profit of £4,658. After allowing for interest on loans (£2,180) and depreciation and capital repaid (£2,423), the result is a surplus of £55. The length of the lines open on March 31 was 7 miles 4 furlongs 2 chains. The number of Board of Trade units consumed in the nine months under review was 358,352; number of car miles run, 365,305; number of passengers carried, 5,298,476; number of passengers per car mile, 14·5; revenue per car mile, 10·26d.; total costs per car mile, 7·2d.; revenue per passenger, ·707d.; and total costs per passenger, ·49d.

City and Surrey Railway.—In a circular letter to the shareholders the National Electric Traction Company state that the resolution to amalgamate the City and Surrey Company with this company, which was unanimously passed at a meeting of shareholders held on Aug. 8 last, is being regularly carried out, and as soon as possible a Stock Exchange quotation for the shares will be applied for. An interim dividend at the rate of 6 per cent. per annum will be payable next month upon all the preference shares of the Traction Company which have been paid for in full, and upon which the calls are not in arrears. The bonus of 17½ per cent., as arranged at the meeting above referred to, will be distributed at the same time as the dividend.

Light Railway Proposals in Derbyshire.—A deputation from Bakewell and the district has waited upon the manager of the Midland Railway at Derby, their object being to lay before him three alternative schemes for light railways, with a view of getting a shorter route to Sheffield and Manchester. It appears that a line between Bakewell and Grindleford has been suggested as giving a short route. The schemes, which embrace a number of places, were submitted and the proposals fully explained. The general manager gave the deputation his views upon the matter as to the course he thought it would be best to adopt. The deputation afterwards withdrew, intending to prosecute their enquiries locally, and see if a light railway scheme could not be promoted.

St. Helens.—We understand that the Cheshire Lines Railway has completed arrangements for the opening of a new short route between St. Helens and Southport, *via* Knotty Ash electric tramcars. The scheme formulated by the company has received the support of both the Liverpool Corporation Tramways Committee and the New St. Helens and District Tramways Company, and passengers for Southport from St. Helens or Prescot can travel by any electric car to Knotty Ash, the Liverpool committee agreeing to a through ticket to embrace conveyance on their cars from Knotty Ash terminus to Knotty Ash railway station. This arrangement practically brings St. Helens and the intermediate districts up to Knotty Ash within easy reach of Southport.

Municipalisation of Tramways at Birmingham.—Mr. Arthur Chamberlain, one of the leading commercial figures in the Midland city, has taken a prominent part in the agitation which is being carried on against the policy of municipalisation favoured by the City Council. In another letter addressed by him to the secretary of the Property Owners' Association, he says that a better service and lower fares would be possible if those in charge of the trams knew their business. Let the ratepayers take the certainty—the sum the Electric Traction Company were prepared to give for the right to run the trams—and leave the speculation to the speculators. The price to be paid for the monopoly should be regarded as the ratepayers' profit. Mr. Chamberlain concludes by remarking that he has no interest in tramways—he merely speaks as a large ratepayer.

Oil for Dusty Roads.—A portion of the London and Southampton road between Farnborough and Aldershot was recently treated with crude petroleum, as a means of preventing a growing nuisance caused by the heavy dust clouds raised by motorcars and other traffic. The oil had to be spread with the aid of large watering cans, as the water-carts in use were found unsuitable. Two dressings were given, and the oil soaked quickly into the road, the surface being left well-knit and firm. The assistant surveyor of the county of Hampshire superintended the operation. The matters that have to be decided are the relative cost compared with watering and scavenging, how long a treatment with oil lasts under heavy traffic, and the effect of rain upon it. A stretch of about a mile was under experiment, and 1,000 gallons of oils were laid to every quarter of a mile. Many motorcars passed without raising much dust, but they disappeared in a cloud as soon as they left the portion of road treated.

Huddersfield.—The revenue account of the Corporation tramways for the six months ended Sept. 30 last shows that the receipts amounted to £26,506, and the miles run to 578,214. The receipts

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per car mile came out at 11d. The total expenditure was £26,339, averaging 10·93d. per car mile, the surplus of receipts over expenditure amounting to £167, or ·07d. per car mile. Maintenance and repairs, including generation of electricity, were responsible for £3,430 of this expenditure, and wages, etc., for another £6,307. From the steam trams the receipts were £2,554, as against an expenditure of £3,122, a loss of £568, or 2·85d. per car mile. The Town Council at their last meeting rejected by an overwhelming majority a proposal that, in view of the criticism on the borough engineer's report on the recent tramway accidents, a general committee should be appointed to enquire into and report upon the general equipment of the tramways, both as to traction and the laying of the track, if necessary with the aid of an expert.

Manchester.—A serious collision between two electric cars occurred in the early morning of Saturday last on the Corporation tramway system, resulting in injury to some 12 persons, mostly workmen. According to the official report, the collision was a violent one. It took place on the single line between Middleton and Rhodes. The two cars were going in opposite directions, and it appears that one of them failed to wait on the loop until the other had passed. When the accident occurred broken glass and wreckage was flying in all directions, and considerable consternation was caused in the cars, which were filled with men going to work. The morning was foggy, and the driver of No. 10 car, who was hurrying to get the men to Rhodes Works by six o'clock, evidently thought it safe to go on to the next loop, but not being able to see many yards in front of him ran into the other car. The damage to the cars was severe. If No. 10 car had been going at anything like an ordinary speed the consequences would have been disastrous. As it was the injuries received were all of a minor nature.

Cardiff.—The Corporation are about to apply for a provisional order for tramway extensions. The Tramways Committee inspected the power station at Roath last week, and decided to make similar inspections every three months. At the present time there are four engines in working order at the station, each capable of working up to 700 h.p. Two large engines are now being erected, each of a maximum capacity of 2,400 h.p. One of the four first engines is now on the lighting load and two on the tramways, the other being a stand-by in case of accident. The larger engines are to meet the heavy demands for power from big undertakings, such as the Mount Stuart Dry Dock Company, the newspaper offices, etc. The works have been so laid out that they can be extended, and accommodation is ample for installing 30,000 h.p. Various apparatus for automatically cutting off the current to avoid accident to persons after a breakdown of the tramway wires were shown to have worked perfectly, and Mr. Ellis, the engineer and manager, stated that the value of this invention was proved by the fact that two telephone wires snapped and fell on to the overhead tramway cable last week in Grangetown without injury to anyone.

South Shields.—The borough electrical engineer, Mr. J. H. Cawthra, has submitted to his committee an interesting report on the systems of traction for electrical street tramways under construction or in operation in the country at the present time. After discussing the merits of the various systems, including the overhead trolley, the conduit, and the surface-contact systems, he concludes: "The decreased cost of maintenance, added to the less annual charges which would have to be met for interest and sinking fund, are, to my mind, sufficient to convince you that in order to make a financial success of a tram scheme in this borough, the only system to adopt with that end in view is the overhead trolley." The opinion of Mr. Lewis Coward, K.C., has been taken regarding the clause proposed to be inserted in the Corporation's Tramways Bill, laying down that before it is decided either to lease or municipalise the tramways in the borough a poll of the ratepayers be taken. Mr. Coward expresses the opinion definitely that such a clause would never be accepted by the House of Commons Committee, and that if it were inserted the whole Bill would be jeopardised. He, however, is willing to discuss the question further with a deputation from the Parliamentary Committee of the Town Council.

The Paris "Tube."—The Paris correspondent of the *Daily Telegraph* speaks well of the future of the Metropolitan Railway. He says: "Within the memory of the Parisian, no public undertaking has ever proved so successful here as the tube. A regular spider's web of new underground lines has been planned beneath the city, and is being carried out as rapidly as possible. This week an auxiliary tube was opened to the public, and at half-past five on the opening morning there was already a crowd of workmen waiting to travel in the first train. The convoys which followed afterwards every six minutes were in nearly every case crammed throughout the day. The new line runs from the Arc de Triomphe, which is the grand junction of the Parisian tubes, along the so-called outer boulevards, past the Moulin Rouge, to the Place d'Anvers, not far from the Northern Railway station. It will be eventually prolonged. Like previous underground lines here, it is built on the high-level system, and runs almost throughout immediately beneath the street. The development of the Paris tube threatens the existence of the omnibus company, whose days are generally believed to be numbered. Several lines of omnibuses have already been suppressed, and drivers and conductors on the others wear a mournful look. Shareholders of the omnibus company, which is bound by contract to the town of Paris for a certain term of years, having obtained a monopoly in exchange for the obligations which it assumed, are likewise in a sorrowful state of mind."

London-to-Brighton Railway. — Mr. F. H. Cheesewright, the engineer to one of the proposals for the building of an electric railway from London to Brighton, has furnished the Hove Corporation with details of the scheme. The route differs materially from the old scheme. It is proposed that the London end of the railway (Waterloo to Croydon) shall be constructed on a viaduct, with a roadway for vehicular traffic underneath. The railway passes Clapham, the common being avoided, then Tooting Common, the L.B. and S.C. Railway being crossed about east of Norbury Station. Continuing from this point in a S.S.E. direction it reaches a position slightly to the east of Waddon Station, on the L.B. and S.C. Railway, where the first station—*i.e.*, Croydon—is situated. The railway runs on a short easy curve and then continues in a straight line south, leaving Purley on the west, passing Coulsdon and Alderstede Farm and Merstham, arriving at a point in Redhill, where the second station—*i.e.*, Redhill—will be erected. Powers under the Light Railways Act to make a railway to connect Reigate with this station will be applied for, and with the support of the Reigate Corporation should be easily obtained. From Redhill it proceeds parallel with the L.B. and S.C. Railway to the junction of two roads on the east side of the railway close to Horley Station, and here the third station—*i.e.*, Horley—will be constructed. Leaving Tinsley Green on the west it proceeds under Worth Park and Forest, crosses the L.B. and S.C. Railway at Balcombe, close to Kerap's Farm, until it reaches Haywards Heath, where it is proposed to erect a fourth station. Application for a light railway will be made to connect Lewes with this station. The railway then, keeping to the west of the L.B. and S.C. Railway, passes Burgess Hill and Clayton, and then enters a tunnel. On nearing Brighton it passes under the Dyke-road, ultimately reaching Queen-square, close to the Clock Tower, on the ground level. The stations along the line will be Croydon, Redhill, Horley, Haywards Heath, and Brighton.

LIGHTING AND GENERAL.

Bristol.—Mr. J. A. Crowther, of Leeds, has been appointed mains assistant.

Swindon.—The electricity works on Sunday last received their three new boilers.

Llandilo.—It has been decided to light Shide-hall with electricity from the town supply.

Tipton.—The Midland Electric Company are now laying their mains in the principal streets.

Beckenham.—An electric lighting cable is to be laid in Sidney-road, at an estimated cost of £90.

Rotherham.—Arc lights have been fixed in the market hall by the electric light department as an experiment.

Longton.—The Corporation's income from electric fans, established in three factories, averages 8½d. per month per fan.

Cleckheaton.—The District Council have received sanction to the borrowing of a further £6,000 on electricity account.

Carnarvon.—The Electric Lighting Committee are about to make further enquiries respecting a consulting engineer, etc.

Camborne.—The District Council have agreed to ask the electric lighting company on what terms they would light the town.

Finchley.—Building operations in connection with the Urban District Council's electric lighting station have been commenced.

Ainsdale.—The Parish Council are urging the National Telephone Company to establish telephonic communication with the district.

Mexborough.—An enquiry is to be held into the Council's application for sanction to borrow £2,500 for electric lighting purposes.

Lincoln.—The Town Council will reduce the charge for the current in all recognised places of religious worship from 6d. to 5d. per unit.

Brighton.—The Corporation have approved the plan and specification for the construction of the proposed telephone switchroom in Palace-place.

Lye and Wollescote.—The order for lighting granted in 1899 is now coming to an end. The Council are stirring up the Midland Electric Company.

Maidenhead.—The last report of the Electric Lighting Committee shows that satisfactory progress is being made with the coming electric lighting undertaking.

Spennymoor.—The electricity supply company has been invited to supply the columns for the electric light on the tunnel footpath at the same cost as "The Blocks."

Wandsworth.—The Wandsworth and Clapham Guardians have decided upon the electric lighting of the new receiving wards at their infirmary. The estimate is £300.

Teignmouth.—The Council are negotiating with an electric lighting company, by which works will be erected very shortly, and have asked for an extension of their order.

Devonport.—The Admiralty have informed the Town Council that a comprehensive scheme is being prepared for supplying electric light and power from a station in the dockyard.

Direct United States Cable Co.—The directors have resolved to pay an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum, for the quarter ended Sept. 30 last.

Change of Address.—Messrs. F. W. Smith and Co., Limited, have recently removed their Manchester offices from Victoria-buildings to larger premises at 181 and 183, Chapel-street, Salford.

France and Denmark Telephone.—A Reuter's wire from Copenhagen says that telephonic communication will be established between Paris and Copenhagen in the course of next month.

Aston Manor.—The following scale of charges has been approved for the supply of electricity for all purposes in the district: 1½d. per unit for 22 hours a day, and 6d. a unit for the remaining two hours.

Monmouth.—During the past month the number of units generated have increased from 6,492 to 7,156. The income earned was £69. 2s. 10d., against £49. 17s. in the corresponding period last year.

Kettering.—The Urban District Council have received sanction to loans for the purpose of constructing a refuse destructor, electric light plant, and the provision of public baths on the Rockingham-road site

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Tunstall.—It appears that the Urban District Council are willing to reopen negotiations with the Potteries Electric Traction Company with regard to transfer of powers under the Tunstall electric lighting order.

Airdrie.—A committee has been appointed to confer with the Glasgow Corporation as to the extension of their telephone system to Airdrie. Coatbridge, Uddingston, and Hamilton have taken similar action.

Greenwich.—The Blackheath and Greenwich District Electric Light Company, Limited, have agreed to supply electric current to the Council's premises at 3½d. per Board of Trade unit for a period of three years.

Hartlepool.—The Town Council have approved a draft agreement with the Northern Counties' Electricity Supply Company for the supply of electricity for public, private, and power purposes within the borough.

Lecture.—At a recent meeting of the Broomwood Ward of the Battersea Municipal Alliance, held in the Honeywell-road Board School, Councillor S. Ramsey delivered an address upon "Electricity—its Rise and Progress."

Aberystwyth.—Mr. E. E. Putland having resigned, Mr. W. L. Knight has succeeded him as resident engineer to the undertaking of the Aberystwyth and Chiswick Electricity Supply Corporation, Limited, at Aberystwyth.

Bedford.—The Electric Light Committee being prepared to take the steam generated by a dust destructor at a certain price, a small committee has been appointed to enquire into the advisability of erecting such an apparatus.

Gloucester.—The ash and refuse destructor which has been erected by the Corporation at a cost of £8,700, was formally opened on Wednesday by the Mayor (Mr. S. Bland), who was accompanied by the members of the Corporation.

Long Eaton.—An arrangement has been come to with the Bridge Mills Company and with Messrs. Sutton for their factory in Clifford-street. Numerous applications are being received, and various extensions of mains have been decided upon.

Electrical Trades Union.—We are informed that the Electrical Trades Union have had installed a post office telephone, No. 623 Central, which will probably prove of great assistance to employers requiring efficient workmen at short notice.

Stirling.—The County Council have decided to introduce the electric light into the sheriff court-house and police premises, Falkirk, in place of gas. The cost is estimated at £90 for the court-house, £50 for the police offices, and £20 for an electric fan.

London County Council.—On Tuesday it was decided to lend the Battersea Borough Council £5,000 for electric lighting purposes and £650 for electric lighting works of public libraries, and the Fulham Borough Council £25,000 for electric light installation.

Criccieth.—At the last Council meeting the Clerk said that the Electric Lighting Bill had been passed with the stipulation that substantial progress should be reported in two years. Fifteen months had elapsed, and no progress appeared to have been made.

Frome.—The Council have adopted a draft agreement with a firm of contractors for installing electric lighting works and carrying them on for a period of 25 years unless the Council take them over in the meantime. Positions for arc lamps in the streets have been agreed to.

Stock Exchange Settlement.—The Stock Exchange Committee has ordered Blackheath and Greenwich District Electric Light Company, Limited (£100,000 4½ per cent. first debenture stock in lieu of the provisional certificates now quoted), to be quoted in the official list.

Louth.—The Corporation of Louth have retained Messrs. Handcock and Dykes, of Westminster-chambers, 1, Victoria-street, S.W., to advise them with regard to their electric lighting order, and have instructed them to prepare forthwith a full report as to the capital outlay and system to be adopted.

Bury.—The parishioners have resolved to recommend the rector and wardens to consult an electrical engineer as to a simple scheme of electrical lighting for the parish church with a view to applying for a faculty. The estimated cost is about £300, and a small committee has been formed to raise the money.

New Pacific Cable.—The "Colonia" buoyed up the end of the Pacific cable one mile off Fanning Island on Monday. The total length of the cable is 3,455 miles, being 85 miles less than was anticipated. This feat marks the completion of the first and longest stretch of the new all-British Pacific cable.

Liverpool Royal Infirmary.—The additions to be inaugurated to-day include the electric light fittings, which have been installed by Messrs. Boothroyd and Co., of Bootle, and embody the latest designs in that means of illumination for similar purposes, and are arranged to minimise the chance of failure at critical times.

Manchester.—At a recent special meeting of the Telephone Committee the Corporation proposed that steps should be taken to approach the National Telephone Company with a view to the acquisition by the Corporation of the telephone undertaking in the Manchester area. The proposal was, after considerable discussion, negatived.

Cleethorpes.—The District Council have decided, in pursuance of the recent Improvement Act and an agreement with the Grimsby Tramway Company, to purchase from the company all land acquired by the company for a generating station and the generating station and plant erected thereon, and to give the company legal notice.

Glasgow.—The general manager of the Corporation telephones, in his last report, shows that the booked orders now number 8,006, showing an increase of 133 since last report, or an average of 8·6 orders per working day. The instruments speaking number 6,565. A quarter of a million calls passed through the exchange during the week ending Sept. 18.

Heywood.—Mr. W. S. Johnston, the electrical engineer, has resigned his position under the committee, he having been appointed engineer to Messrs. Verity and Co., Birmingham. It has been decided to give Mr. Johnston a testimonial under the seal of the Corporation. Mr. James Stott, late chief assistant, has been appointed to the vacant post.

Blackpool.—The borough electrical and tramway engineer's report and estimate, amounting to £1,200, upon coal-hauling plant, including narrow-gauge tramway, wagons, weighing machines, and coal storage bunker and elevator, states that out of seven tenders received for cooling plant the three tenders as under were the most favourable: Messrs. Doherty and Donat, Arthur Cappoll, and the Klein Engineering Company.

Wallasey.—The Electricity Committee have decided to supply electric motors upon the hire or hire-purchase system, as consumers of power prefer. Commencing with the present quarter, the charge for electricity for power purposes will be 2½d. per unit for the first 500 units per quarter, 2d. per unit for each additional unit from 500 to 1,500 units per quarter, and 1½d. per unit for each additional unit beyond 1,500 per quarter.

Tunbridge Wells.—An enquiry is to be held to-day into the application for a loan of an additional £10,000 for electricity works extensions, which have been occasioned by the phenomenal growth of the undertaking. The number of consumers on the register is 700, with 56,000 lamps. The engineer's last report states that since the last meeting of the committee applications representing 2,285 8-c.p. lamps had been received.

Worthing.—The cost of the proposed lighting of Tennyson-road between Richmond-road and Heene-road with 5.158 c.p. Nernst lamps is stated at (capital cost) £51, and (annual) £48. 15s. for all-night use, and £33 for half-night use. It is stated that the total number of applications to date was 171, and the total number of consumers connected 156, the equivalent number of 8-c.p. lamps applied for and connected being 10,270 and 9,127 respectively.

Hammersmith.—Since the last Council meeting 22 additional consumers have been connected, representing a maximum of 476 8-c.p. lamps, that five consumers have been disconnected, and that the present number of consumers now taking current from the mains is 1,098. The Post Office are making a start with the taking up of portions of the footways and carriageways of the various thoroughfares in the district for the purpose of laying telephone wire pipes.

Somerset Power Scheme.—Mr. E. E. Smith, of 41, Broad-street, has been appointed secretary *pro tem.* to the promoters of this scheme. It is proposed to make an application to Parliament next November for an Act empowering them to supply current in bulk. The main generating station would be erected upon the Somerset coalfields somewhere in the neighbourhood of Radstock, and with coal cheap the promoters are confident that they will be able to give the consumer of electricity great advantages.

Accidents.—A fatal accident occurred at the Sheffield tramway power station, Kelham Island, owing to the breaking of a flywheel while a 35-h.p. engine which drives the dynamos for lighting the station was being tested. A foreman fitter received several injuries, from which he died shortly afterwards. At a colliery near Sunderland, where electricity is used in the pit, a putter slipped and came in contact with a "live" wire, the result being instant death. At Edinburgh, on Monday, an explosion occurred in a manhole connected with the public electric light system. Fortunately no person happened to be in close proximity at the time. The western half of High-street was in darkness for about an hour. On Saturday night the electric light in the High-street and district at Perth suddenly went out, but the light was switched on again in about half an hour.

Belfast.—The Council have decided, in reference to the stand-by supply, that any person requiring from the Corporation a supply of electrical energy to any circuit, cable, or current-consuming device, while the same are or is supplied from private sources, shall be charged for electrical energy at the prices from time to time charged by the Corporation to other consumers, and shall agree to pay to the Corporation a minimum amount per annum of £6. 10s. per kilowatt of their possible maximum demand. Messrs. Harland and Wolff Limited, have withdrawn their application for current, as there would appear to be no immediate prospect of obtaining the same from the Corporation, and have informed the Council that they are now obliged to make other arrangements, and must therefore withdraw their application and the corresponding guarantee of May 27 last. The Council in their reply point out that so far as they are concerned no delay has taken place, as they are only waiting the Local Government Board's decision before commencing to lay the pipes.

St. Annes.—After considerable debate of gas *v.* electricity, it has been decided to lay cables in the streets under discussion. The electrical engineer's last report states that the works ran satisfactorily during the past month. The load was steadily increasing, and the previous Saturday the maximum yet recorded of 114 kw. was reached, which is equivalent to about 3,250 8-c.p. lamps being alight at one time. They had sold 37,313 Board of Trade units up to the end of August, the quantity for the month being 9,824, the corresponding figures last year being 25,507 and 5,507, the increase to date being 46·2 per cent. The cost of production was 2·640 per unit, as against 3·13 in corresponding period of 1901. Six applications were received for 266 8-c.p lamps. The lamp connections now stand at 8,487, as against 3,578 in 1901. Several of the shopkeepers had lately installed Nernst lamps, which gave very good results, the efficiency being very high, only 1·5 watts per candle. These small Nernst lamps have only been commercially obtainable during the last few weeks; they are rated at 40 c.p., taking the same amount of energy as the ordinary 16-c.p. incandescent lamp.

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Scarborough Telephones.—The Corporate Property Committee have agreed that Mr. A. R. Bennett should prepare a detailed estimate of the cost of installing a municipal telephone system at Scarborough. Mr. Bennett's fee is to be merged in commission if the Corporation decide to go on with the scheme and appoint Mr. Bennett as their engineer.

Kingswear.—The Urban Electric Supply Company, who are putting the finishing touches to the preparations for lighting the borough of Dartmouth, have made a proposal to light the parish by electricity, and the Parish Council are considering the question of adopting the Lighting and Watch Act of 1833 in conjunction with this proposition.

Derby.—A sum of £7,823 is to be applied out of the profits of the water undertaking for the year ended March 31, 1902, to the district fund, to cover the deficiency on the electric lighting account for the two years ended March 31, 1901, and March 31, 1902, and also the additional quarter's interest charged to the electric lighting account during the year ended March 31, 1902.

Worksop.—The Urban District Council may well be congratulated upon closing their first year with a deficit of £20 only. The Council commenced the scheme with £16,000, but have since borrowed a further £8,000 for extensions of cables. The light is giving every satisfaction, and is supplied at 4d. per unit. An increased number of customers will soon result in a substantial profit.

Darlington.—Mr. J. R. P. Lunn in his last report shows an increase of 14 per cent. in the number of units generated during the month, and an increase also in the number of consumers connected. There were applications from 29 intending consumers, who will require 1,939 8-c.p. lamps. During August 1,097 yards of feeder and pilot cable and 1,390 yards of distributor cable were laid.

Redruth.—At the last Urban District Council meeting a long discussion ensued with reference to the placing of an electric box outside certain premises in Fore-street. Objections were raised to the effect that the box might interfere with persons who (under illuminating circumstances not traceable to electric currents) might stumble or ramble against it. The objection was, however, over-ruled.

Westinghouse Wattmeter.—We are pleased to note that the Board of Trade has approved of the Westinghouse integrating wattmeter, also of the means for fixing this type of meter, and for connecting it with the electric service mains. This meter is of the alternate-current type, and is applied to either single or polyphase circuits. The honour of the Board of Trade's approval is especially to be appreciated, in view of the fact that it is so rarely obtained.

Caerphilly.—The District Council will next week consider a report by Mr. R. H. Fletcher, Cardiff, on the Council's proposed electric lighting scheme. Mr. Fletcher says that the cost of supplying the district from the Council's own stations would at the present time be absolutely prohibitive, though in the event of the population increasing this might not always be the case. At the same time he recommended that, when applying for a provisional order, powers should be sought for generating as well as distributing electricity.

City Lighting.—The Court of Common Council last week adopted a report from the Streets Committee relative to a letter from the London County Council, asking the views of the City Corporation as to the reintroduction into Parliament next session of the London County Council (Electric Supply) Bill. The committee recommended that the London County Council be informed that the Corporation had no objection to the reintroduction of the Bill, subject to the insertion of a clause protecting the rights of the city.

National Electrical Contractors' Association.—A meeting of the Northern Section was held at the Royal Station Hotel, York, on Oct. 4, when representatives of about 60 electrical contractors in the North of England were present. A scheme for the registration of workmen was adopted and will shortly be in use. Questions relating to the training of apprentices, municipal trading, and standardisation of wiring, rules, and specifications, were also discussed, and it was decided to hold the next meeting in Newcastle early in January.

Southwark.—The General Post Office have obtained a general permission to lay distributing pipes for telephones under the footpaths and streets with only 48 hours' notice. The West Newington branch of the Social Democratic League recently passed a resolution expressing disappointment at the failure of the Council to provide an efficient system of electric lighting in the borough, and calling upon the Council to make an early, public, and full explanation, stating what steps they intend taking to improve the present unsatisfactory state of affairs.

Eccles.—Several applications for permission to take electric current from the Salford Corporation were refused at the last meeting of the Eccles Town Council. The Chairman said the Council were still conferring with the Salford Corporation and the Salford Electric Power Supply Company, the latter of whom had stated that they would be prepared to supply current to the district by the lighting season of 1903. The Salford terms so far were prohibitive, the only possible advantage in treating with the Corporation being a quicker supply.

Bethnal Green.—The Electric Light Committee are considering a letter from the Board of Trade stating that, so far as they were aware, no efforts had been made to put into force the provisional order for the lighting of the district with electricity which was obtained some years ago. Under the circumstances it was for them to determine whether the order should or should not be revoked. Before doing so, however, they were prepared to receive representation on the matter. It appears that the main difficulty lies in the want of a suitable site.

Exeter.—The Electric Lighting Committee's report for the year ended Dec. 31 shows a profit of £879. The total accumulated profits, which are practically a reserve fund and in respect of depreciation, amount to £3,617. The town clerk said at the last Council meeting that up to the present the electric light undertaking had not cost the city a farthing. The Council decided to appoint a clerk of the works to supervise the erection of the new electricity station at the Basin, and to invite Mr. Domville, who had been chairman of the committee from its formation, to lay the foundation stone.

Ross.—Mr. John Parker, in his last report, makes on behalf of the electric lighting company the following special offers in respect to the street-lighting: to erect bracket lamp free of cost; the net cost of lighting for 1,500 hours to be £15; for trimming, carbons, etc., £4. 10s.; extra for 100 hours' increase over 1,500 hours, £1. 2s. 6d.—total, £19. 10s. If the Council decide to extend the electric light the cost of erecting three further lamps would be £22, and the annual cost of the current, trimming, carbons, etc., for 1,500 hours would be £13 each lamp, and for every 100 hours extra 17s.

Northern Gas Managers.—At the half-yearly meeting of the North of England Gas Managers' Association at Wallsend on Saturday, Mr. A. B. Walker, in his presidential address, said the indifference noticed a few years ago in the matter of electric supply had somewhat diminished, and "electricity *v.* gas" was now very much to the fore. However the gas world might look upon the competition, it was now clear that the policy of the past was to be regretted. His experience led him to believe that it would have been better had the consolidation of the two industries been recognised in the earlier days.

Russia.—Hitherto electricity has scarcely been used in Russia for the transmission of energy for great distances. Projects, however, are under way to utilise the waterfalls of Marva and Imatra. The Russia Government has granted a concession to a company to supply power to St. Petersburg from the Volhov Rapids. The estimated cost of the enterprise is about £2,800,000. It is said that the power to be transmitted will equal 150,000 kw., and the maximum transmission distance is 188 miles. The company has undertaken to provide the public lighting of St. Petersburg gratuitously. It is also intended to use the colossal force of the Dnieper cataracts for the transmission of energy.—*The Miller.*

Dudley.—The contract with Lord Dudley for the supply of slack to the generating station has been renewed. The hours 6 to 8 p.m. have been fixed as when the price of 6d. per unit for current shall be charged during the winter months. From the balance-sheet giving details as to the financial state of the electrical undertaking at March 31 last it appears that £41,500 has been borrowed, and that £44,825 has been expended on buildings and equipment. On the year's working there has been a gross profit of £2,439, against which there is £2,829 for amortisation and interest. Claims to an amount exceeding £300 have been made against contractors for supplying unsatisfactory material.

Hull.—At the last meeting of the Chamber of Commerce it was stated that a letter had been received from the Postmaster-General with respect to the connection of Hull with the new underground telegraph cable to the North. The Postmaster-General regrets that he cannot commit himself to any further extension of the present scheme in contemplation, which provides for the extension northward of the underground system already provided between Hull and Birmingham. This will eventually be continued to Scotland in the one direction, and by way of Leeds to the north-east coast to the other. The Council of the Chamber decided to reply that it was absolutely necessary that the underground cable should be extended to Hull.

Cardiff.—The cost of generating current during the past month was 1·03d. per unit, and the total cost 2·6d. per unit, as against 1 3d. per unit for generating, and a total cost of 3·4d. per unit during the previous month. This decrease in cost is attributed to the fact that with practically the same staff and plant the electricity produced during the month of September was 116,639 units, as against 90,794 units in August. On Saturday a conference will take place between Sir William Thomas Lewis, representing the Cardiff Railway Company, and a deputation from the Cardiff Electrical Committee relative to an application by the Municipality to obtain access over the company's premises at Bute Docks, so as to enable the Corporation to lay mains for the supply of light and motive power to tenants of the company.

Sheffield Telephones.—We quote from the *Sheffield Daily Telegraph* as follows: "The following letter has been sent to us for publication by Mr. Geo. Marshall, 170, Howard-road, by whom it was received: 'General Post Office, London, Oct. 2, 1902. Sir,—In reply to your letter of the 25th ultimo, on the subject of the proposed grant of a telephone license to the Corporation of Sheffield, I am directed by the Postmaster-General to say that he has informed the Corporation that he is willing to grant them a telephone license, and that he has given them full particulars of the terms and conditions of the grant. If the Corporation decide to apply for a license on those terms such application would, of course, be made on their responsibility as a Corporation, and the Postmaster-General does not feel that he is in a position to question their authority for their proceedings.—I am, Sir, your obedient servant, G. W. MURRAY.'"

Cheltenham.—The Town Council have resolved, in consequence of the failure of the Rural District Council to signify their consent, as requested, to the extension of the electric lighting area so as to include the parish of Prestbury, to abandon the intention to apply to the Board of Trade for a provisional order to include certain parishes and hamlets in the Cheltenham electric lighting. The electrical engineer in his last report stated that all work, both of extensions and ordinary running, had progressed satisfactorily during the past month; that 622 customers, with the equivalent of 38,300 8-c.p. lamps, were connected to the private supply mains; that a synchroniser and a boiler testing pump were required at the works, and that he recommended the purchased of these at costs not exceeding £15 and £20 respectively; and that he recommended the purchase of two transformers at a cost not exceeding £80. Application is to be made to sanction a loan of £160 to provide for the above expenditure.

Ashton-under-Lyne.—Owing to the increase in the voltage, the whole of the lamps in the borough used by private consumers have

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been replaced by new ones, and those for lighting the streets materially altered. No inconvenience has been occasioned to consumers in carrying out this alteration. By this change the capacity of the generators has been increased by 3,000 or 4,000 lamps at the very nominal cost of the new ones on the consumers' premises. Consequently, the increase of 240 at the lamps, or 480 on the three-wire system, which is used in Ashton, enables the output to be increased proportionately. The work has been carried out under the supervision of Mr. Applebee, the electrical engineer. There is now an equivalent of 16,000 8-c.p. lamps connected. The accounts for the year ending last March show a surplus of £277, instead of a deficit of £907 the year before, and matters generally are in a very satisfactory state. Recent connections or orders include the District Infirmary, the town hall, free library, and the technical school.

Wednesbury.—In their last report the General Purposes Committee recommend that the Corporation supply electricity for private purposes in the borough only on the basis of receiving electricity in bulk from the Midland Electric Power Company. The capital outlay on the scheme is estimated at £11,000, and electricity will be supplied on the continuous or direct-current system. They recommend that application be made to the Local Government Board for their sanction to a loan of £11,000, and also that instructions be given for the necessary plans and specifications, and for tenders for the necessary transforming plant, mains, etc. They further recommend that the Corporation seal an agreement with the Midland Electric Power Company for the supply of electric energy in bulk through a meter in the company's sub-station in the borough for both power and lighting purposes on the maximum-demand meter system on the basis of 3d. per Board of Trade unit for the maximum demand for one hour per day for each day, and ·825d. per Board of Trade unit for the remaining hours, the company undertaking not to lay any distributing mains in the borough.

Durban Telephones.—Acting upon the report of the borough electrical engineer, says the *British and South African Export Gazette*, the committee of the Durban Corporation appointed to consider his recommendations lately brought up a report that they be approved so far as forwarding indents for cables, poles, and overhead wires, and the equipment of the exchange, and sanctioned the proposal that the Telegraph Manufacturing (Colonial) Company, Limited, the Western Electric Company, Limited, and the Ericsson Company be invited to forward particulars and prices. When the report came before the Corporation it was referred back to the whole Council in committee for further consideration, the Mayor remarking that the total cost would amount to £80,000. In the meantime, the Government and the Corporation have come to loggerheads, as it would seem that the former, who originally desired to obtain control of the telephone system of the colony, have in hand a project for establishing an exchange of their own at the Point to connect all Government departments and military and transport offices, and later on Maritzburg and all other Government departments in the colony. The two schemes are quite unnecessary, and if the Government persevere with theirs it will have the effect of seriously interfering with the Corporation system.

Aberdeen.—The report by Mr. J. A. Bell, city electrical engineer, as to the electric lighting of all the streets of Aberdeen on which electric cars are run will be laid before the next meeting of the Watching and Lighting Committee. It is proposed that the part of the report dealing with Union-street be at once proceeded with, as also that referring to the sections from the east end of Union-street to the junction of Constitution-street and Park-street, and from the west end of Union-street to Queen's Cross, and to the junction of Great Western-road with Holburn-street. The portions of the report dealing with the other thoroughfares on which electric cars are run will probably be deferred for further consideration, since George-street is already lighted by electricity, while there is not so much urgency with regard to the outlying parts of the tramway routes, where the general traffic is not nearly so heavy as in the central streets. It is generally admitted that the lighting of Union-street, in which two or three different systems are employed, is at present very unsatisfactory; and as the Town Council have declined to adopt the Kitson system of lighting, it is felt that there should be no delay in proceeding with the present system for the improved illumination of the fine thoroughfare of which all Aberdonians are justly proud. The adoption of the scheme detailed in Mr. Bell's report would enable the committee to substitute electric standards for the whole of the existing gas lamp posts, thus saving space for pedestrians on the pavements.

Nottingham.—The annual report of the electrical engineer (Mr. H. Talbot) states that the plant at the Talbot-street station has been increased during the year by the addition of two steam dynamos of 700 i.h.p. each. This last addition completes the equipment of this station. The power of the plant installed is 8,925 h.p., and consists of the following—viz.: eight Lancashire boilers, 14 dry-back marine type boilers, nine steam-dynamos of 700 i.h.p. each, four steam-dynamos of 360 i.h.p. each, seven steam-dynamos of 135 i.h.p. each, three steam-dynamos of 80 i.h.p. each, and seven pumps. Three of the 700 i.h.p. steam-dynamos are at present being used for traction purposes, but the whole of the traction load will shortly be transferred to the new power station at St. Ann's Well-road, when the three steam-dynamos will be available for meeting the increased demand for lighting and power. The distributing mains have been extended in 43 directions during the year, the total extension being 3·04 miles. The total length of distributing mains laid is 36 miles. The number of applications received for a supply of electricity on March 31 was 1,867, as compared with 1,529 on March 31, 1901. The number of 8-c.p. lamps or their equivalent connected up on March 31 was 170,826, as compared with 136,137 on March 31, 1901. The number of units sold in the year was 4,094,897, as compared with 2,312,557 during the previous year. The costs of production show a decrease in every item over the previous year, the total engineering costs having being reduced from 1·45d. to 1·02d., and the total costs—including sinking fund and interest—from 2·43d. to 2·06d.

Swansea.—The chief engineer (Mr. Prusmann), in his last report, states that the number of consumers was 250, and the number of equivalent 8-c.p. lamps on the books was 29,306. A scheme is before the Corporation providing for the hiring-out of motors to consumers, the proposed scale of charges ranging from ½ b.h.p. at £1. 15s. to £8 for 10 b h.p. per annum, the hirer to use current for power purposes for not less than 12 months. Mr. J. C. Pottinger held an enquiry on Tuesday into the application of the Town Council for sanction to borrow £20,300 for the purposes of the establishment of a municipal telephone system in the borough, as well as in the following districts: the urban district of Oystermouth, the rural district of Llangyfelach, and portions of the rural district of Pontardawe, Gower, Neath, and Llanelly. Mr. Wheatley (assistant Corporation solicitor) explained the scheme, and mentioned that 337 inhabitants had already applied for the service at £5 per annum, and 57 at the reduced charge of 1d. per call. The Corporation had also secured 33 per cent. of the subscribers of the National Telephone Company, who had promised to come over to the municipal scheme. The rateable value represented by these was £89,631. Evidence was also given by Mr. H. G. Solomon (chairman of the telephones company), Major-General Webb, Captain Colquhoun, and Mr. A. R Bennett. The latter stated that for the outlying districts junction lines would be laid. There would be switch-rooms at Pontardawe, Clydach, Morriston, Skewen, Pontardulais, Gorseinon, Gowerton, and Loughor. Tenders for carrying out the scheme had been received from the best firms in the country, and the total of the tender accepted for carrying out the various portions was £13,335. 5s. 11d., and the total expense would be about £18,000.

Manchester.—At the meeting of the Manchester City Council last week some very severe criticism was indulged in—chiefly by the chairman of the Gas Committee—with regard to the capital expenditure of the Electricity Committee. This expenditure was declared to be ahead of all reasonable requirements, and a definite statement was made to the effect that, with a capital equal in amount, the electricity department's revenue was barely a fifth that of the Gas Committee. We learn from an official source that these statements and criticisms were misleading. The Electricity Committee was misled, during the inception of the city's tramway scheme, by a miscalculation as to the number of cars likely to be run on the different routes. Up to now not half the number promised have been put on. Other routes will be opened in December next, and in March, 1903, so that in six months there ought to be 638 cars running, and by the end of next year (allowing for other routes contemplated and for cross routes) 119 more—in all 757 cars. The Electricity Committee have provided plant sufficient for 700, but it is considered doubtful if the number actually brought into use will exceed 500. As a result, the Electricity Committee will find itself in possession of plant capable of providing power for some 250 cars over and above the number in use. In the face of these facts the Electricity Committee cannot fairly be accused of overstocking its works. The committee, it should be stated, wished to avoid a repetition of the disaster of 1901, when they had to refuse 60,000 8-c.p. lamp connections on account of their plant not being available for giving the requisite supply. They therefore looked ahead somewhat, and ordered machines necessary to deal with supplies till the end of 1904. The last of the machines so ordered is not expected to be running until March, 1904. With regard to the capital expenditure of the electricity department, it is pointed out that the accounts to March, 1902—the last published—show capital barely half that of the gas department, and the fact should also be taken into account that in the accounts of the gas undertaking for a long period depreciation of plant has been allowed for to a considerable amount. Another injustice the Electricity Committee feels arises from the competition in gas. As far back as 1897 the City Council authorised the committee to make arrangements for street-lighting, and specified the streets to be lighted. It was also understood that all tramway routes would be lighted by means of arc lamps or other form of electrical illumination, and the Electricity Committee was led to instal sufficient plant in the new Stuart-street works to meet all these requirements. They have also laid the necessary cables along the tram routes and other authorised streets. It was expected that about 3,000 arc lamps would be required upon the routes referred to, but the Council has now decided that no further step shall be taken for the street-lighting of Manchester with arc lamps, and the Gas Committee will have the benefit of the revenue to be derived from this source. This means that the horse-power provided to meet the demand originally made for street-lighting by electricity will have to be diverted to some other purpose. A scheme is, therefore, being matured for the hiring-out of motors, arc lamps, and any apparatus connected with the use of electricity to private consumers; and it is also suggested that a reduction in the price charged for these purposes should be made. This would increase the demand for current, and bring all the plant into use. During the year ending March 31 last the Electricity Committee sold over 10½ million units. The borrowing powers of the department amount to £2,171,121, and it supplies, in addition to the Manchester area, seven outlying districts whose provisional orders the Corporation has taken over. The total revenue from the lighting and tramways together was £134,103, and the maximum demand for electricity during the period referred to was 9,140 kw. There were only three small tramway routes then opened; others have since been completed and opened, and the committee estimate that when the whole tramway scheme is completed the requirement for this purpose alone will amount to 20 million units per annum. Of the 9,140 kw. above mentioned as the demand for the year ending March last, 7,930 were for lighting and 1,210 for traction. The tramways department is being charged at cost price for current, so that the profit it hands over in relief of rates should be equally credited to the electricity undertaking.

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PROVISIONAL PATENTS, 1902.

SEPT. 29.

21185. An improved method of and apparatus for automatically operating telephone exchanges. Lancelot Eldin de Mole, 4, South-street. Finsbury, London.

21201. Process and apparatus for the manufacture of accumulator plates Matthew Atkinson Adam, 18, Southampton-buildings, Chancery-lane, London. (Ludwig Engelmann, Germany.)

21202. Improvements in or connected with dynamo-electric machines. John Herbert St. Hill Mawdsley, Norfolk House, Norfolk-street, Strand, London.

SEPT. 30.

21213. Improved method of and means for lighting miners' and other lamps by electricity. William Patterson and Charles Darráh, jun., 55, Market-street, Manchester.

21217. Improvements in the construction of regulating switches for use in connection with electrical installations. Alfred Normanton and Francis Joseph McElroy, 417, Stretford-road, Manchester.

21222. Improvement in electrical switches. Arthur Ford-Lloyd 35, St. James-street, Brighton.

21229. Improvements relating to automatic electrical switches. Charles Herbert Offord and Thomas Herbert Marsh, 18, Southampton-buildings, Chancery-lane, London.

21236. Improvements in and relating to steering gear for motor road vehicles, electric or steam launches, and the like. Thomas Mathewson and Arthur James Fielding, 11, Southampton-buildings, Chancery-lane, London.

21267. Secret electrical interrupter. Emile Zay, 60, Queen Victoria-street, London.

21279. Improvements in the manufacture of incandescing electric lamps. Tom Wiseman Lowden, Clun House, Surrey-street, Strand, London.

21301. Improvements in or relating to telegraphic apparatus for engines on shipboard. John Charles Kay and John Goodrich Kay, 6, Lord-street, Liverpool.

21302. Improvements in electric lampholders. Thomas Chalmers, 18, Cawdor-road, Fallowfield, Manchester.

OCT. 1.

21328. An improved machine for insulating wires. James Healey, Helsby, near Warrington.

21346. Improvements in or relating to electric arc lamps. The Jandus Arc Lamp and Electric Company, Limited, and Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

21370. Improvements in devices for suspending electric lamps and other lighting apparatus. William Henry Pick, trading as Collins and Co., 322, High Holborn, London.

21375. Improvements in methods of laying insulated cables under conditions of cold, and in apparatus therefor. Georg Zapf, 6, Lord-street, Liverpool.

21388. Improvements in electricity meters. Guy Carey Fricker and William Morris Mordey, 46, Lincoln's-inn-fields, London.

OCT. 2.

21431. Improvements in conduits and appurtenances for electric traction. Thomas Walter Barber, 5, Palmer-street, Westminster, London.

21453. Improvements in capstans operated by electricity. Frederick William Hollick, 65, Chancery-lane, London. (Complete specification.)

21462. Improvements in or relating to the detection of electrical oscillations. Louis Heathcote Walter and James Alfred Ewing, 111, Hatton-garden, London.

21470. Improvements in electrically actuated and controlled clocks and other time-recording apparatus. Joseph Alexander Carruthers, 27, Chancery-lane, London. (Complete specification.)

21471. Electrically actuated and controlled clocks. Joseph Alexander Carruthers, 27, Chancery-lane, London. (Complete specification.)

21473. Improvements in machinery or apparatus for perforating telegraphic tape suitable for use in the automatic transmission of telegraphic messages. Frederick George Creed, 46, Lincoln's-inn-fields, London.

OCT. 3.

21488. An improvement applicable to trolley heads for electric tramcars to guide the line wire into the groove of pulley when changing the direction of car. William Hall Cook, Thomas Cook, and William Edwin Partington, Rose Cottage, Stanley-grove, Longsight, Manchester.

21490. Improvements in wireless telegraphy. Frank Biddle and Joseph Crowley, 60, Newall-street, Birmingham.

21502. To create a new system of signalling (for steam locomotion and electric traction) and to abolish the use of fog signals entirely. James William Lesson, 24, Queen-street, Horwich, Lancs.

21563. Improvements in insulated rail joints. Michael Joseph Greeney, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21515. A watertight device for the protection of insulated electrical conductors where entering junction-boxes. A. Sillar Richmond, Corporation Electricity Works, Stanwell-street, Colchester.

21526. Electric fire-alarm. Arthur Pizzala and Alfred George Griffin, 175, St. John-street-road, Clerkenwell, London.

21536. Improvements in electric lampholders. Philip Johnstone Spenser Tiddeman, 99, Cannon-street, London.

OCT. 4.

21604. An electric cordgrip lampholder and shade carrier. A. M. C. Joannidi and C. Hesford, 3, Wellington-street, E. Hr. Broughton. Manchester

21616. An improvement in the construction of commutators for series-wound brush dynamos. William Hodgson, 61, Tarset-street, Battlefield, Newcastle-on-Tyne.

21628. An electro-magnetic friction clutch. Kenneth St. George Kirke and Frank Churchill, Ivydene, Linden-road, Romford.

21648. Improvements in the control of the electromotors on electric railway cars. Siemens Bros. and Co., Limited, Francis Lydall, and Audley Mervyn Duke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane. London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 23.

1901.

13142. Construction of commutator trimming apparatus. Phillips.

21878. Electric time switches. Morgan.

21974. Collector for use on electrically propelled or lighted vehicles. Griffiths and Bedell.

22012. Fittings for conduit systems of electric wiring. Lander and Simplex Steel Conduit Company, Limited.

22220. Perforators for electric telegraphs. Murray.

22899. Wattmeters. Duddell and Mather.

23038. Electric arc lamps. Branson.

23115. Windings for electrical machines. Lamme. (Date applied for under International Convention, April 17, 1901.)

23536. Apparatus for treating patients with electrical lighting and heating rays. Dowsing.

24276. Electric arc lamps. Jandus Arc Lamp and Electric Company, Limited, and Jones.

24470. Electricity meters. Abel. (Compagnie Anonyme Continentale pour la fabrication des Compteurs de Gaz et autres appareils).

1902.

1546. Lighting of electric cars operated by the overhead conductor system. McGillivray.

2552. Electric couplings or terminals. Hardman.

5981. Rail bonds or connections for electric railways. Blanchard.

11076. Electric arc lamps. British Thomson-Houston Company, Limited. (Rice.)

12474. Wireless telegraphic and telephonic systems. Shoemaker.

13593. Electric commutators for telegraphic, telephonic, and other like purposes. Prött.

14676. Electric railways on the surface-contact system. Brown.

14953. Automatic trolley catchers. Shanahan. (Date applied for under International Convention, Aug. 7, 1901.)

15954. Electric switches. Haskins. (Date applied for under International Convention, July 27, 1901.)

17691. Armature windings for induction motors. Lake. (General Electric Company.)

17712. Hot-wire electric meters. Stewart.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	8-8½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6½
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	103-106
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15½-16½
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2½-3
—— 5 per cent. Debentures	100 ..	101-105 pd
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	77-82 xd
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102 xd
W. T. Henley's Telegraph Works, Ordinary	5	16-17
—— 4½ per cent. Preference	5	5¼-5⅜
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20¼-21¼
—— 4 per cent. Debentures	100	99-102 xd
Parker, Thos., Limited, Ordinary	10	14¼-15¼
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4¼-4½ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12¼-13⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12¼-13
—— 5 per cent. Perpetual Debenture Stock	100	124-127 xd
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅛-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜-5¼ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5¼ xd
—— 5 per cent. Deb. Stock, Red.	100	104-107
—— Prov. Cert., all paid	100	98 101
Cape Electric Tramways, Nos. 1-400,000	1	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4¾-5¼
—— 4 per cent. 1st Mortgage Debentures	100	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11¼-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10	14¼-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98 xd
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14¼-15¼
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4⅜
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 / 5	11½-12 / 8⅜-9½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	107-109
—— " " Prov. Crts.	50	81-83
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10⅜
—— 5 per cent. Cum. Pref.	10	11¼-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8¼-9⅜
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	16/3	3 16
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c.	87 p.c

Electric Railways.—

Central London, Ordinary	100	104-107
—— 4 per cent. Pref.	100	107-110
—— " " deferred	100	104-107
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	71-73
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	90 93

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	104-107
Bournemouth and Poole, Ordinary	10	12-13
—— 4½ per cent. Cum. Pref.	10	9¼-10¼
—— Debenture Stock, Red.	100	102-105
Brompton and Kensington, Ordinary	5	10¼-10⅜
—— 7 per cent. Preference	5	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7¼-8¼
—— Nos. 20,001-30,000	5	7¼-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " £10 Ord.	6	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	105-108
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5¼-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5¼-6
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	9¼-10¼
—— 6 per cent. Cumulative Pref.	10	12¼-13¼
—— 5 per cent. Debenture Stock	100	125-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London and Brush Provincial, Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	111-114
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¾-6¼ xd
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	3	1⅞-2⅛
—— 6 per cent. Pref.	5	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15¼-16¼
——4½ per cent. First Mortgage Debenture Stock	100	110-113
——3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9½
—— Preference	4	6¼-6½
Notting Hill Electric Lighting	10	13¼-14¼
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104 xd
Oriental, 1879	1	—
—— £5 Shares	5	—
—— £4½ Shares, New	4½	—
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2⅛
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5	15-16
—— 7 per cent. Pref.	5	8¼-9¼
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3¼-4¼ xd
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3¼-4¼ xd
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	6-6½

Telephones.—

National Telephone, Preferred	100	93-95
—— Deferred Stock	100	55-57
—— 6 per cent. Cum. First Pref.	10	12¼-13¼
—— 6 per cent. Cum. Second Pref.	10	11¼-12¼
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-5¼
—— 5½ per cent. Deb. Stock, Red.	100	96-99
—— 4 per cent. Deb. Stock, Red.	100	102-106
Oriental Telephone and Electric Company	1	¼-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 4	997	739	+ 257	+ 4,942	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	" 4	5,110	5,104	+ 6	+12,983	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	Sept. 26	831	781	+ 50	+ 3 802	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	" 25	1,616	1,543	+ 73	− 194	16½	—	Mar. 31	41,818	5,809,190	753,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	Oct. 4	667	664	+ 3	− 443	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	Sept. 28	1,707	1,568	+ 138	+ 2,725	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	Oct. 5	3,292	1,154	+2,138	+76,406	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57
Bristol Tramways Company	" 3	4,612	4,289	+ 323	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	Sept. 20	195	180	+ 15	+ 450	—	—	" 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	Oct. 4	6,902	6,151	+ 751	+ 7,694*h*	12	12	" 31	335,086	41,188,389	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	" 5	3,033	2,031	+1,002	+13,037	12½	9½	" 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	" 2	777	465	+ 311	+ 4,625	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	" 4	209	244	− 35	+ 79	4½	—	" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 5	102	105	− 3	— *h*	6¾	6¾	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	" 3	3,743	3,722	+ 21		46	46	" 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	" 3	845	834	+ 11											
Dundee City Tramways	" 1	844	712	+ 132	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	" 4	13,486	13,184	+ 302	—	104	95	" 31	582,146*e*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	Sept. 24	1,253	1,209	+ 44	+ 1,866	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	" 27	1,382	1,199	+ 183	—	—	—	" 31	49,011	7,624,865	1,001,033	1·54	11·7	—	13·90
Hull Corporation, E. S.	Oct. 4	1,758	1,670	+ 88	+ 2,013	19	9½	" 31	72,331	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	Sept. 27	10,473	9,954	+ 519	+30,193	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	Oct. 5	1,506	1,440	+ 66	− 1,250	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Sept. 20	1,831	1,003	+ 828	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Oct. 5	4,133	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82
Southampton Corporation	" 2	1,083	992	+ 90	—	11	—	" 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	" 5	1,050	1,068	− 18	—	19	17	" 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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NOTES.

Electric Lighting in the Netherlands.—Most of the electric incandescent lamps used in the Netherlands are imported, the principal supply coming from Germany, although England, Belgium, and Switzerland also participate in this trade. It is estimated that about half a million of these lamps are used in the Netherlands annually, but at present only three firms are engaged in their manufacture in that country, with the result that the orders for incandescent lamps have to be placed abroad. The import duty is 5 per cent. of the value, and there are no regulations restricting the importation of lamps. The competition is very keen, and purchases are largely governed by price considerations. Naturally, the best quality at the lowest figure is in demand, and the trade is one which our English lamp firms would do well to cultivate.

Durability of Submarine Cables.—A section of the submarine cable between Cienfuegos and Santiago, in the Carribean Sea, has recently been raised, with some very interesting results. The cable was manufactured in 1873, and laid off Cienfuegos, Cuba, in 1881. Some few months ago a question arose as to the durability of cables covered with indiarubber, as in this case, and it was decided to raise the Cienfuegos cable and subject it to tests. The line was picked up in 1,350 fathoms of water in April last, and received at the works of Messrs. Hoopers, at Millwall, in June. The tests of this core showed that after 20 years' submersion it was still in perfect electrical condition. An examination of a foot specimen proved that the insulation was in good mechanical condition, and that the copper conductor had not suffered from the attacks of any sulphur in the rubber.

Manchester Local Section.—Although somewhat late in the year, the second annual report of the committee on the work of the above section of the Institution of Electrical Engineers shows that last session was quite as successful as its predecessor. The chairman of the section for next session is Mr. Hardman A. Earle, who succeeds Mr. C. H. Wordingham in that capacity. Mr. Edward W. Cowan has vacated the post of hon. secretary, which is now filled by Mr. P. A. Ramage, of the Salford Ironworks, Manchester. The total roll of the section comprises 415 members of all grades, as compared with a total last year of 354—an increase of 61. As regards the question of acquiring central premises in Manchester for the meetings of the section and the library, a committee has been appointed to formulate a definite scheme. It is hoped that some practical result will follow.

The Proposed Electric Post—News comes from Rome that Count Taeggi, the inventor of a system of electric telpherage for carrying mails, has left there for England at the invitation of the British Postmaster-General. It is said that the commission appointed by the Italian Government to investigate Count Taeggi's proposal for an electric post between Rome and Naples has reported on it most favourably. But in the event of any undue delay occurring in the Italian scheme, Count Taeggi has announced his intention of offering to make his first experiment between London and Liverpool. As a general rule, all inventors are ambitious, but we venture to suggest that the Count should first satisfy himself that his system will work satisfactorily over short distances before trying it between London and Liverpool, involving, as it does, the construction of overhead wires all the way.

Tramcar Letter-Boxes.—A definite arrangement has now been come to between the Postmaster-General and the Corporation of Sheffield with reference to the collection of mails by the electric tramcars, and one day last week saw the new "service" inaugurated. The innovation is intended to offer better facilities to residents in the suburbs of the city to post their letters at a later hour than has hitherto been possible. The cars leaving the suburban termini are equipped with little red boxes, in which the mails are placed. These boxes in appearance are so like the receptacles generally used by the Post Office for collecting letters that there is no mistaking their object. The duty of clearing the boxes is, of course, undertaken by the postal department. From the record taken of the extent to which the new system was used on the inauguration day, it is likely to prove a great success. It is not the first innovation of the kind, but we believe that it is the first to be permanently adopted in this country.

Institution of Civil Engineers.—The council of the above institution have, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1901-1902: a Telford gold medal to J. Macfarlane Gray (London); a George Stephenson gold medal to R. Price-Williams (London); a Watt gold medal to W. Bell Dawson, M.A., D.Sc. (Ottawa); Telford premiums to W. R. Cooper, M.A., B.Sc. (London), E. M. de Burgh (Sydney, N.S.W.), George Wilson, D.Sc. (Manchester), Frank Oswell, B.A. (Buenos Ayres), A. W. Brightmore, D.Sc. (London); a Crampton prize to C. D. H. Braine (Mowbray, Cape Colony); the Manby premium to B. W. Ritso (Cape Town). For students' papers the awards are: a Miller scholarship (tenable for three years) and the "James Forrest" medal to H. F. Lloyd (Birmingham); Miller prizes to J. C. Collett and W. H. C. Clay (London), H. C. M. Austen (London), A. M. Arter (London), Robert Bruce (Manchester), L. F. Wells, B.Sc. (Manchester), W. H. McLean (Glasgow).

Royal Photographic Society.—The winter session of the Royal Photographic Society was opened on Tuesday evening at the society's house in Russell-square with an address by the president, Mr. T. R. Dallmeyer. In the course of his remarks he showed that the most noticeable achievement in photography was that of Mr. E. Senior, who had taken micro-photographs of sections of the Lippmann colour photographs of the spectrum, and demonstrated experimentally the truth of the theory that the various colours were due to the stationary waves of different periods of vibration, which was in itself a further confirmation of what was known as the "theory of light." He criticised the facilities offered in this country for the education of photographic students, and alluded to the unsuccessful attempts that had been made to provide a systematic instruction in photography. Mr Dallmeyer remarked, in conclusion, that there was not an art, a science, and, perhaps, hardly an industry in which photography had not played a most important part, often, indeed, being the pioneer process of investigation, and it was, therefore, a branch of technology of the first importance.

The Glasgow Accident.—The report to the Board of Trade by Major E. Druitt as the result of his enquiry into the causes of the electric car collision in Renfield-street, Glasgow, on Sept. 6, goes to show that if the electric brake on the car which originated the mischief had been applied at the first, the accident would have been entirely diverted. The report is abstracted elsewhere in this issue, from which it will be seen that the practice in Glasgow is to use the electric brake only in the case of an emergency. Major Druitt thinks the probability is that the driver of the first car never applied the electric brake at all

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during the run back down the hill. It is quite conceivable that this neglect was due to the fact that the driver was not conversant with its use, and we suggest that some arrangement might be come to by which the driver of every car would be required to apply the electric brake in conjunction with the hand-brake at least once each trip, say, on a gradient. If this were done, it would ensure that the electric brake was in working order, and would familiarise the drivers with its application, so that they would know exactly what to do in an emergency such as occurred in the case in question.

Steel Cable Towers.—Particulars are to hand of the erection of a couple of steel towers on the Ohio River for the purpose of carrying a number of long-distance telephone wires across the river aerially. The span is a little over 2,000ft., and has a dip in the centre of about 30ft. The towers are of exceptionally heavy construction, this being necessitated by the number of circuits they will ultimately carry and the length of the span. Each tower is 125ft. high, and measures 16ft. across at the base and 4ft. at the top. A feature in connection with the construction is the manner in which the wire is suspended and fastened. To the steelwork are bolted oak cross-arms, 12ft. long, and capable of carrying four circuits each. Eye bolts suspending a steel pin, upon which a porcelain roller revolves, are fastened to the cross-arm. The wire is passed over these rollers and fastened to the first pole from the tower, thus taking all the lateral strain off the towers, and also making it an easy matter to cut the wires or take up slack. The completion of this big river crossing is a great help to the independent telephone companies throughout Ohio and West Virginia, as it gives the subscribers an opening to the manufacturing and commercial centres of the surrounding States.

The Dunedin Water-Power Scheme.—Not much headway would appear to have been made with this scheme since we last wrote concerning it. The Corporation of Dunedin have had the matter under consideration for many months now, and as yet it has only got as far as the report stage. The advice of Mr. J. T. Noble Anderson, the engineer to the Dunedin Drainage Board, has been taken on the scheme, and his report, we understand, is now in the hands of the Town Council, but is not yet published. There are only three schemes of water power possible in Dunedin, but we understand that the one favoured is that known as the Lee Stream scheme. It will be remembered that Messrs. Noyes Bros., the agents of the Westinghouse Company in Australasia, were first consulted by the Dunedin Corporation, notwithstanding that they themselves were prospective tenderers for carrying out the work. Since then the Corporation have had one or two other reports before them on the subject, but apparently they are not yet decided as to which is the best scheme to adopt. Their policy in this matter is not one which commends itself much to business men, but in the interests of progress we hope that the scheme will ultimately be carried to a successful conclusion.

Road Disturbances.—The conversion of the tramways by the London County Council for electrical working is causing a vast amount of inconvenience which can hardly be avoided. When such radical changes have to be made in the permanent way, and conduits constructed involving alterations to pipes under the track, it is the quickest way in the long run to close the road while the work is being carried out. We are pleased to see, however, that the Highways Committee of the London County Council rightly appreciate the value of the rights of the ordinary traffic. In the new contract which they were called upon this week to sanction for the New Cross and Greenwich sections of the tramways, penalties are to be enforced at the rate of £1,000 per week if the period agreed upon for the conversion is exceeded. We are still more pleased to find that, as is only right, the contractors are to receive a bonus of £1,000 per week if they succeed in completing the work under the contract time. That the contractors may gain a good many weeks' bonuses at the above rate will be the wish of all who have to do business along the roads in question. The principle of strictly enforcing penalties, and also giving bonuses for prompt execution, is one which cannot be too highly commended for this class of work.

Tesla's New Laboratory.—In a recent issue of the *Electrical World* illustrations are given of the new Tesla laboratory at Wardenclyff, and of the large tower erected near by for experiments in wireless telegraphy and the transmission of power. The reasons which have induced Mr. Tesla to erect his new laboratory 65 miles away from New York are given in a short article. Amongst these is the isolation of this expert from the reporters of the daily papers. If this can only be accomplished we think that the move will be a most valuable one, but we are afraid that Mr. Tesla will not be free from the effects of the encouragement which he has given to these gentlemen in the past. With respect to the tower, we regret that no dimensions are given. It consists of a vertical cone of iron girder work, on the top of which there appears from the illustration to be a large disc. It is said that the tower stands on a hollow base excavated in the ground and of practically equal dimensions There is only one small building near the tower, and from the character of this we infer that the height of the tower is considerably over 150ft. It will be interesting to see whether the announcements concerning the object and use of this tower will be communicated first to a scientific society, or to the reporter of one of the New York newspapers.

Street-Lighting at Bermondsey.—On the instructions of the General Purposes Committee, the borough engineer of Bermondsey, Mr. R. J. Angel, A.M.I.C.E., has carefully gone into the relative cost of gas and electricity for street-lighting in the borough, and has prepared a report which is to be submitted to a meeting of the full Council. In the table of figures given the cost is not considered as of the whole parish, but as per candle-power per annum. Thus the following are the figures obtained of the comparative cost and maintenance of various kinds of gas-burners and of electric light lamps—*i.e.*, 5ft. Borrodaile's flat-flame burners, 4s. 0¾d. per candle-power per annum; 7ft. Siemens's flat-flame burners, 3s. 5¾d.; incandescent "C" burners, 10¼d.; No. 2 Kern burners, 1s. 0¼d.; No. 3 Kern burners, 8d.; No. 4 Kern burners, 7½d.; Sugg's high-pressure gas-burners, 5d.; arc electric lamps, 3⅛d.; and incandescent electric lamps, 1s. 4¾d. It will be seen from these figures that the arc lights are by far the cheapest, the cost being 1⅞d. per candle-power per annum less than the most economical gas-burner considered. We are greatly surprised, therefore, to find that with this report before them the committee have decided to recommend the extension of gas lighting in Bermondsey to the exclusion of the electric light.

The Osmium Lamp.—The lamp which Dr. Auer von Welsbach is attempting to work out for incandescent electric lighting, in which he displaces the carbon filament by one of the rare metal osmium, is again to the fore, a paper dealing with the matter having recently been read before the Electro-Technical Society of Vienna. The company who owns the patents claim now to have produced thoroughly practical lamps, but only at very low voltages. Their standard lamp works with a pressure at its terminals of 25 volts, and has then a life of 1,400 hours, with a con-

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sumption of about 1·5 watts per candle, as against the consumption by the present lamps of from 3·5 to 4 watts per candle. The company state that they have made lamps to work with 200 volts, but they are hardly in a practical form yet. It is possible to use the lamps by running them four in series on a 100-volt circuit, but that is hardly a convenient arrangement, as it means that all lamps have to be lighted and turned out together. On the other hand, where a certain number of lamps can be conveniently arranged in this manner, it saves breaking the insulation of the cables for each lamp. The lamp is now stated to have been placed on the market, having undergone several improvements in manufacture. We are afraid, however, that, notwithstanding the high efficiency claimed for it, the osmium lamp will not be in great demand at present, owing to its heavy first cost—*i.e.*, 5s. per lamp.

Production of Natural Gas.—Interesting data on the production of natural gas are given in a report issued by the United States Geological Survey, which show that the consumption has continued to increase, although the pressure has continued to decline. This decline necessitates the expense of compression in order to market an increased production from the declining field, which expense must continue to increase as the pressure declines, and the distance to the source of supply increases. As a source of power, natural gas stands at the head of the list for economy among the fuels, both as to expense of installation and expense of operation. It has been supplying the power for a very large number of factories and operations in the gas belt, and lately it has been extensively applied in creating the power by which the natural gas itself is compressed from a low to a high pressure when the original pressure has failed and the pipes are insufficient to deliver the necessary quantity of gas at the well pressure. A number of these compressors work up very close to 1,000 h.p, with an economy that enables eight to ten cubic feet of natural gas to develop a horse-power for an hour, a saving of from 40 to 50 per cent. over high-duty steam-engines. It is estimated that over 4,000,000 people in the States are furnished with natural gas as a lighting agent, while companies and other concerns to the number of 1,545 report its use in manufacturing establishments of various kinds.

Transmission of Telegrams in London.—In our last week's issue we described briefly a system of interconnecting at the central telegraph office the telegraph circuits of London, in order to avoid the retransmission of messages at the central office. It occurred to us at the time that the system was an exceedingly obvious one to improve the present telegraphic communication within the metropolitan area. We now find that it is by no means novel, having been used as long ago as 1864 in Germany, and 1873 in England. The German installation was carried out under General von Chauvin in the Berlin central telegraph office. One attempt was made to introduce it into our telegraph service by Major—now Major-General—Webber, who in 1872 had charge as divisional engineer of the eastern division of the postal telegraphs. The system was installed at Colchester, and allowed of six or eight outlying post offices being connected up direct to the terminal lines from London, so that the retransmission of messages in the Colchester post office was halved. It remained at work for about two years, and was discarded because it was not shown to promote much saving. It is curious that the system should not have survived, and it would be interesting to know the actual reasons, as the saving of time in the direct transmission of messages must be considerable. Although the switching arrangements now in use and the signalling by means of incandescent lamps are considerably better than those available in 1873, there was at that date quite sufficient technical experience to enable the system of cross-switching and ringing-off signals to be carried out successfully.

Variation of the Spectrum of Sparks.—When the spark terminals contain different metals, variation of the self-induction of the circuit greatly affects the composition of the light given by the spark. Using terminals of aluminium wire coated at their ends with a small quantity of metallic sodium, Mr. B. Eginitis has found that the spectrum of ordinary sparks passing between the terminals contains aluminium and sodium lines, but that when the self-induction of the circuit is increased, while keeping the resistance constant, the aluminium rays diminish very rapidly in intensity, while the yellow sodium rays become more and more intense. The aluminium rays are confined more and more to the neighbourhood of the terminals, and finally, when the self-induction is sufficiently increased, disappear altogether. The sparks are then of a brilliant orange colour, due to sodium vapour, and if the self-induction is still further increased, there comes a point at which the sodium line is reversed, aluminium being still absent from the spectrum. The same results are obtained with platinum, iron, tin, and some other metals, in place of aluminium. In some cases—*e.g.*, iron-sodium—the large values of self-induction make the iron rays reapper. Some metals—*e.g.*, Hg, K, or Na—can never be wholly eliminated from the spectrum. The peculiar behaviour of mercury leads the author to the general conclusion that the metals whose spectra are eliminated or diminished in intensity are metals which give small quantities of vapour, while those whose spectra persist or increase in intensity are among the very volatile metals.

Wireless Telegraphy in War.—Wireless telegraphy played an important part in the United States war manœuvres last month, and once again its utility in the field and in coast defence was clearly demonstrated. The system employed was the De Forest-Smythe, of which the Signal Corps had two sets—one installed at Fort Mans field and the other on board a scout-boat, the "Unique." These two sets were mainly used for keeping touch between the home fleet and the troops on shore, and some very successful work was accomplished during the manœuvres in this service. The longest distance covered at any time was between 50 and 60 miles, and it is said that the message was received at the rate of 40 words per minute. Inasmuch as the scout-boat's masts were but 40ft. in height, the performance was considered a remarkable one, both for distance and speed. The sending apparatus included a small kerosene engine belted to an alternating-current generator, transformer, condenser, and key. The antennæ on board the boat consisted of three parallel stranded wires 65ft. in length. That at Fort Mansfield was similar, and was hung from an 80ft. mast. The average speed of transmission during the manœuvres is stated to have been at 20 words per minute. Although the services rendered by wireless telegraphy were accounted quite satisfactory in this work, we understand from our Chicago contemporary, the *Western Electrician*, that the United States Navy Department have not yet decided upon the adoption of any one system for use in the navy. Tests in space telegraphy have been going on for some time between the Washington navy yard and the naval academy at Annapolis, and as a result the official decision is that "no reliable system of wireless telegraphy has yet been developed." The actual results obtained from the tests with the different systems have not been made public, but it seems evident that no system proved to be

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sufficiently reliable to warrant its adoption by the Navy Department.

Durability Tests of Storage Batteries.—Details of tests recently carried out by order of the French Minister of Marine with storage batteries of French manufacture, presumably for use in submarines, have now been published. The cells submitted for test were connected up in series to form one battery, and were charged and discharged 250 times. A current of 330 amperes was used for the first charging operation for a period of four hours, and subsequent chargings were carried out with the same current for a period equivalent in ampere-hours to a 50 per cent. increase on the previous discharge from the battery. The discharge was carried out at 660 amperes, and was continued until the E.M.F. of any cell had fallen to 1·65 volts. Two chargings and dischargings were completed daily, and Sundays were observed as rest days. The level of liquid in each cell was preserved constant by additions of water or acid during the period of the test. The cells which fell below 1·65 volts in less than half an hour from the commencement of any period of discharge were withdrawn from the series, and the plates submitted to a final examination in presence of a representative of the makers. The number of cells entered for the test was 21, these being submitted by 13 manufacturers. The experiment continued from Oct. 10 to March 17, and on the latter date only five cells were left as survivors of the durability test. The following are the trade names and final E.M.F.'s of these five cells: Heinz, 1·860 volts; Union, 1·790 volts; Metaux, 1·772 volts; Max, 1·714 volts; Fulmen-d'Arsonval, 1 650 volts. Of the above five makes of batteries, the first four are manufactured exclusively with pasted plates. The maximum weight of accumulators for the French navy is fixed by the Ministry at 225 kg. The Heinz cell had a total weight of 181 kg., of which 106 kg. represented the weight of the plates.

Electrolytic Reduction.—Mr. C. J. Reed communicated a very interesting paper to the Niagara meeting of the American Electro-Chemical Society, in which he described some phenomena of electrolytic reduction. From an abstract of the paper in the *Electrical World* we gather that it was in effect an attack on the dissociation theory, and dealt principally with the details of an experiment, the results of which were held to contradict that theory. The essential part of the experimental arrangement was somewhat as follows: A receptacle was divided by two porous diaphragms into three compartments. One of the outer chambers contained a copper electrode in copper sulphate, and the others sulphuric acid. Mr. Reed held that, according to the dissociation theory, during electrolysis both the volume and weight of the contents of the middle compartment should decrease, whereas the experiment showed an increase in both of these. Other divergences from the theory were noted as the result of the experiment, one being that the migration constant is not a constant, but dependent on the nature of the electrolyte and on the action at the electrodes. In the discussion which followed Mr. Woolsey McA. Johnson pointed out that the factors of voltage and rise in temperature should not have been neglected in the experiment. Mr Hering, who presented the paper in Mr. Reed's absence, said that a water bath had been used, but it was pointed out that difference of temperature might yet have existed in the electrolyte. Another speaker said that an attack on the dissociation theory could not be conclusive unless it also took into account the support which that theory received from non-electrical facts; for example, the changes in the boiling and freezing point caused by the presence of salts. Mr. Hering thought the experiment to be a mere determination of the migration velocities, and that Mr Reed's results merely differed from those of other experimenters; he also called attention to the fact that the nature of the diaphragm would make a difference. Moreover, the dissociation theory should not be condemned merely because the determination of the migration velocities did not coincide with those of other experimenters.

Marconi's Wireless Telegraphy.—The *Times* of Tuesday last published the official report of the experiments in wireless telegraphy which were carried out on board the Italian warship "Carlo Alberto" during the months of July, August, and September of this year. The greater part of the report is in the nature of a diary of the messages received by the "Carlo Alberto" from the Poldhu station in Cornwall while she was making the passage between England and Northern Italy and of the subsequent experiments at Spezia. These have already been recorded in this journal, but at the end of the report Lieutenant Luigi Solari, who drew up the document, presents a number of considerations which were suggested by the experiments. In view of their importance, we give them below in full: First, that there is no distance limit to the propulsion of electric waves over the surface of the globe, both sea and land, provided that the energy of the transmission is proportioned to the distance to be covered. Second, that land interposed between the transmitting and the receiving stations does not interrupt their communications. Third, that the light of the sun has the effect of diminishing the field of radiation of electric waves, and therefore renders necessary the employment of greater energy during the day than during the night. The influence, also, of atmospheric electric disturbances makes it necessary to diminish the sensibility of the apparatuses so as to make them independent of it, and at the same time calls for an increase in the energy of transmission so as to obtain the same results upon the less sensitive apparatuses. And fourth, that the efficiency of the magnetic detector has been shown by positive experience to be superior to that of any kind of coherer, and that not only by its not requiring any regulation, but also by the absolute accuracy of its working and the great handiness and sensitiveness of the system. Mr. Marconi is still actively engaged in his attempt to span the Atlantic Ocean by wireless telegraphy. A Rome message states that arrangements have been made to establish a service between Italy and Argentina. The cost is estimated at £50,000, and Mr. Marconi hopes to be able to offer a tariff of 9½d. per word in place of the present rate by cablegram of 4s. 9d. per word. The conference on wireless telegraphy, it is further stated, will probably collapse, as France, England, Russia, and Italy have not yet made any answer to the proposal of the German Government.

Dock Telephones and Lighting.—Liverpool is nothing if not a progressive city, and its Dock Board is admittedly one of the most go-ahead dock and harbour bodies in the world. But it cannot as yet be said to have excelled in its provision of telephone facilities at the Liverpool Docks. The present arrangements do not compare at all favourably with those at other ports in the country and at some Continental ports, but there is good promise that this backwardness will be remedied within the next month or so. We learn that negotiations are now going on between the Dock Board and the National Telephone Company with a view to the adoption of the system of temporarily fixing telephones on ships while

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they lay in dock, discharging or loading. There is little doubt but that such facilities would increase the efficiency of the port, and generally tend towards the quicker dispatch of business. Of course, the question involved from the point of view of the Telephone Company is whether the proposed extension of their system would pay, but from the experience of other parts, little fear should be entertained on this score. Another improvement which the Liverpool Dock Board has in contemplation is the lighting of all the quays by electricity, and the introduction of an arrangement by which the ships could tap this supply during the period of discharging and loading. At the present time the arrangement is in vogue at a few of the warehouse docks at Liverpool, notably the Waterloo grain dock, where the electric light is used in the holds of the ships. This involves no extra charge on the shipowners when cargoes are discharged by the Board. The expense of adopting the system at all the docks would necessarily be heavy, but this consideration will doubtless be outbalanced by the benefits to be derived from the electric light in this particular class of work. The Liverpool stevedores are particularly anxious that the Dock Board should decide in favour of the innovation, as they show in a letter to the Liverpool *Journal of Commerce*. They state in this communication that the electric light is the only light which gives satisfaction to people engaged in their business at night, and its general adoption would remove the principal objection they have to working cargoes at night. We understand that the chief question the Dock Board is debating is whether it shall lay down a central generating plant of its own or take current from the municipal supply. A decision one way or the other is expected to be come to soon, when we trust it will be on the right side.

Sydney Electric Tramways.—The first electric tramway in Sydney, New South Wales, commenced operation in 1893, but it was not till some five years later that the line was built that was the forerunner of the great system which is now admitted as one of the best and cheapest electric tramway systems in the world. The conversion of the remaining steam lines is at the present time rapidly approaching completion. This has been rendered practicable by a large extension of the main power plant at Ultimo, which, we gather from the *New South Wales Railway Budget*, was brought into operation at the beginning of last month. The boiler-room extension alone measures 85ft. by 170ft., and contains boilers designed for a working pressure of 160lb. They are equipped with Babcock and Wilcox patent chain grate automatic stokers, and provision has been made for bringing the total number up to 60 boilers of this type and capacity. These will furnish steam sufficient to bring the total capacity of the station up to nearly 24,000 h.p. The engine-room extension consists of an addition of 170ft., making the building 98ft. by 270ft. The extension provides for six main generating sets of 1,500 kw. each, three of which are now in operation. They are of the Allis-Reynolds vertical cross-compound condensing type, with 32in. and 64in. cylinders and 60in. stroke, running at a speed of 75 revolutions per minute. These engines are, in fact, practically identical with the Allis engines in use at the tramway power-house at Glasgow, over which so much controversy has raged in this country. Each main engine operates a 1,500-kw. General Electric three-phase 25-cycle alternator, capable of supplying 131 amperes per phase at 6,600 volts continuously, and designed for an overload capacity of 25 per cent. for two hours. All parts of the engine-room can be reached by means of a triple-movement travelling crane. The switchboard is designed for controlling the output of the completed station. The whole of the high-tension switches are of the enclosed oil type From the power-house the high-tension current is distributed to five sub-stations by means of three-core, paper-insulated, lead sheathed cables. These cables are laid in duplicate to each sub-station as a precaution in case of accident. The plant as completed is by far the largest of its kind south of the equator, and was laid down by the General Electric Company of America. With the extension of electric traction in Sydney so the rolling-stock increases, until at the present time some 338 cars are in operation on the electric lines. The complete tramway system of Sydney comprises no less than 104 miles of single track, the revenue last year amounting to £631,750. The financial position of the undertaking was dealt with in our last issue.

Water-Power Rights in South Africa.—The report by Mr. W. Wilcox, C.M.G., on irrigation in South Africa, contains a vast amount of information which is worth perusal. The point to which we wish to draw attention at the present time is that concerning the right to the waters of the country. Mr. Wilcox advocates that all rivers and torrents should at once be proclaimed as public property in order that irrigation may have a fair chance in South Africa. In this course the Government would be following the precedent of Italy. Thus, to quote from the report: "When Victor Emmanuel consolidated Italy into one country, he decreed at the outset of his reign that the whole of the rivers and torrents of Italy were part of the public domain, and; as such, the property of the Government representing the people. Old irrigation rights of thousands of years' standing stood in the way of such legislation, but the Government of Count Cavour possessed a strong hand. Having decreed the rivers and torrents as public property, the Government in the same bold and decisive manner defined with great accuracy all the indefinite and vague claims of centuries, and then set itself to legislate for future concessions. Modern Italy owes much of its prosperity to this wise and strong legislation." If this be done in South Africa, there will also be water power available which can be used for a variety of purposes, as the fall from the reservoirs on to the land where irrigation is required will, as a rule, be considerable. The utilisation of this water power is not within the scope of the present report, but having once declared the water rights to belong to the Government, there need be no obstruction in the development of water power. In connection with the Irish water-power schemes, referred to in our issue a few weeks ago, we showed how development is hindered by the obstructive policy of the fishery right owners. Unfortunately, Ireland is a country in which a proclamation making all the rivers Government property would not be feasible, otherwise the course has much to recommend it. Reverting to Mr. W. Wilcox's report to Lord Milner as High Commissioner for South Africa, the conclusion is that the rainfall in South Africa is sufficient in quantity in even the very worst years to allow of the storage of water on a very large scale. On a rough calculation, Mr. Wilcox estimates that with the aid of its rainfall and the Orange River the Cape Colony should be able to ensure the perennial irrigation of 1,000,000 acres, the Orange River Colony of 750,000 acres, and the Transvaal of 500,000 acres in the high-lying regions and 1,000,000 in the low tracts. An addition of 200 millions sterling to the permanent wealth of South Africa would, in the opinion of Mr. Wilcox, result from the irrigation works in question being successfully carried out. He concludes that without such agricultural wealth to lean upon, the exhaustion of its mines would plunge the whole country into conditions of poverty which cannot be contemplated without dismay.

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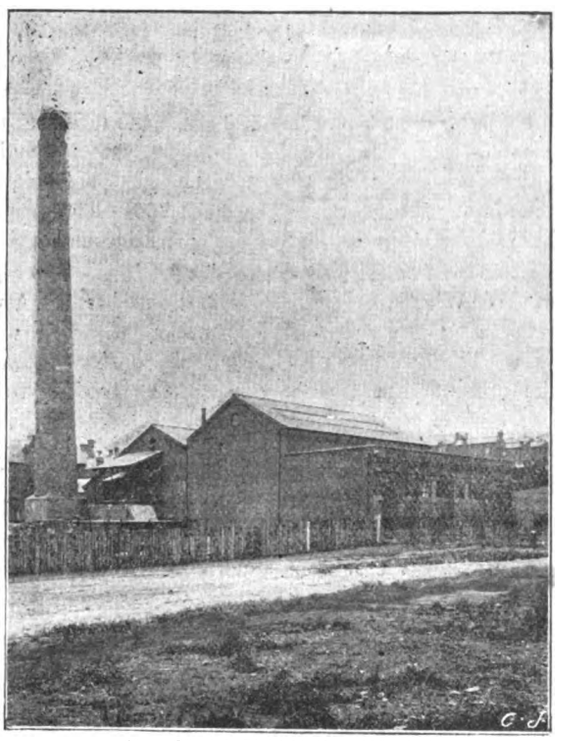
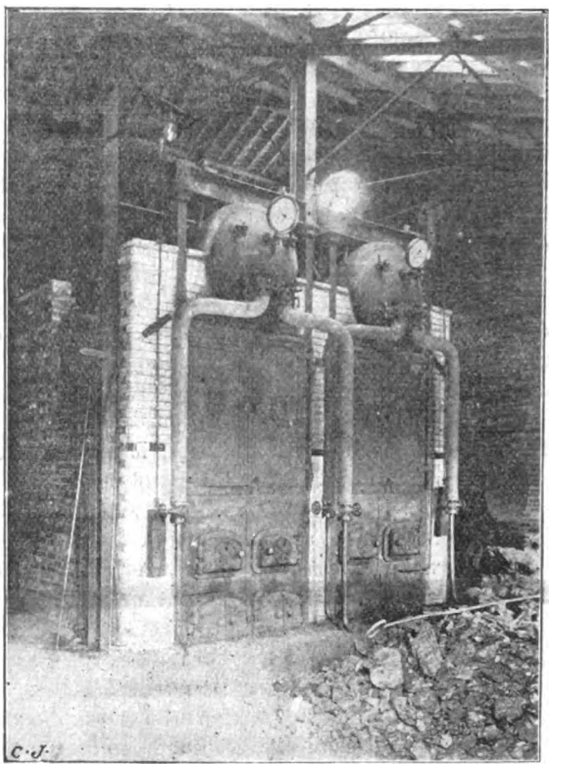
MUNICIPAL ENGINEERS AT ALDERSHOT.

At a district meeting of the Municipal Engineers at Aldershot, Mr. Nelson Dennis, A.M.I.C.E. engineer and surveyor to the Council, read a paper on "Some Municipal Works at Aldershot," describing, among other things, the town central-station installation, which was briefly described and illustrated in our issue of May 23. A brief reference therefore to this portion of the paper, with the information given in the accompanying photographs, will bring the history of this installations up to date.

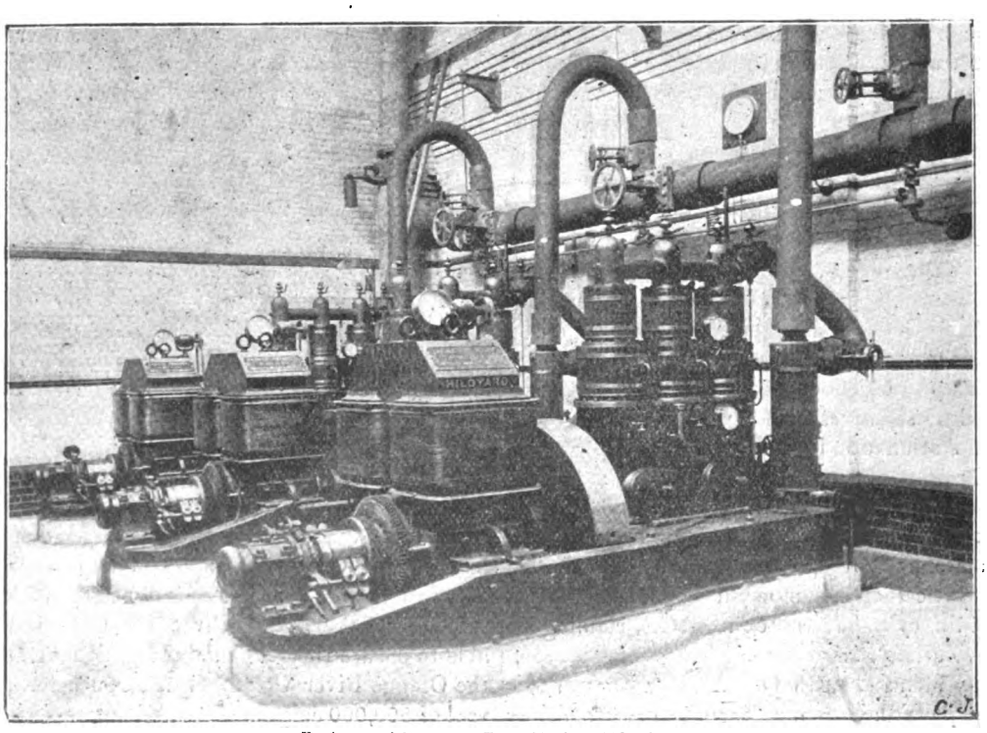


Town Electric Light Station, Aldershot.



Boiler Room, Town Station, Aldershot.

Mr. Dennis designed the station, which, as we said previously, is exceedingly well arranged for the requirements. Mr. Dennis in his paper says: "In designing the buildings, all extravagance in adorning the elevations was avoided. The engine-house has a brown glazed brick plinth and a white glazed brick dado 4ft. 6in. high, finished off with a chocolate-brown reeded brick. The walls are built of white pressed bricks, which gives a light and cheerful appearance. Piers are built 9ft. 8in. centre to centre, which terminate under the corbelling that supports the oak running beam, upon which the crane rails are fixed. The engine-house is 50ft. by 30ft., which affords room for doubling the present engine power. The boiler-house is 41ft. by 45ft. The offices, engine-house, and boiler-house adjoin, and are parallel to each other, the engine-house occupying the middle position. The accumulator-room is placed under the offices, which latter, together with the entrances, extend for the whole frontage to the road."



Engines and Dynamos, Town Station, Aldershot.

Two Babcock-Wilcox boilers are installed, but some trouble has been found with the firebars burning away "owing to the intense heat of the Welsh smokeless large coal, which coal quickly freezes on to the bars and runs in

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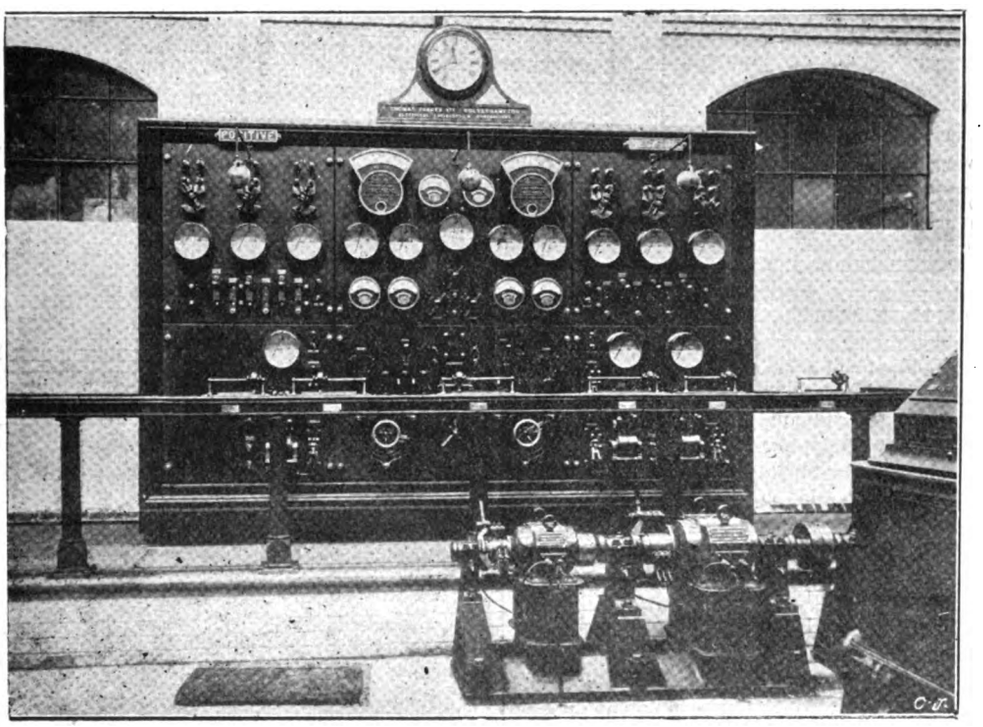
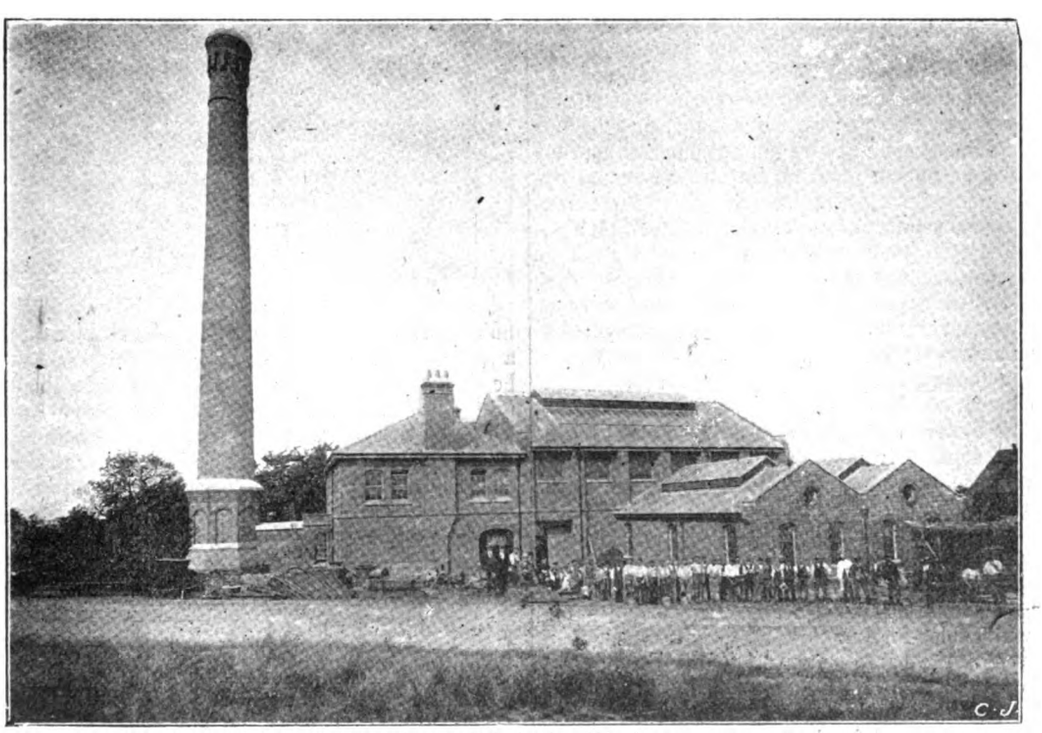
between, thereby partially stopping the draught, when the bars at once commence burning at the tops." Arrangements are being carried out to prevent this trouble.

There are two Worthington feed pumps, each capable of feeding two boilers when working at full capacity. A Baker's oil extractor is inserted in the main exhaust pipe before it reaches the condenser. The engine-house contains three Willans-Parker sets, each of 90-kw. capacity, which deliver current to the outers of the three-wire system at 420 to 460 volts. The balancer and boosters are four Parker machines, all coupled on the same shaft. This is placed close up in front of the switchboard platform. The two boosters are for charging the two halves of the battery, and are driven by either or both of the balancer armatures—the output of each is 40 amperes at from 10 to 100 volts, the normal charging current being 30 amperes. The output of each balancer armature is 40 amperes at 210 volts, which is capable of dealing with an out-of-balance current of 75 amperes on either side of the system.



Switchboard, Town Station, Aldershot.

In addition to the information given in May, the following will be useful. The average price obtained from private consumers, from May up to the present time, is practically 5d. per unit. Arc lamps for public lighting are charged at £16 per lamp per annum, lighted until one o'clock at night; and incandescent electric street-lighting is charged at £2. 15s. per lamp per annum, lighted until 2.30 a.m. At present only eight arc lamps are erected, in two series of four across 210 volts, with the "live" switch leads of each circuit brought back to the station, and the "town" ends of each circuit tapped on the neutral distributor. Eight more lamps are to be erected, and this can be done by converting each of the present circuits into a circuit of eight lamps, and tapping the "town" ends on to the opposite live distributors, and disconnecting the neutral connections. All these lamps



Camp Electric Light Station, Aldershot.

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are to be erected along the line of route of the present two circuits, so that it will be unnecessary to lay any extra cables for them. The house services are laid by the Council without charge to the consumers, and meter rents are not levied unless the annual bill for current used is less than £3, when rents will be charged at 8s. per annum.

The total cost of the installation per 8-c.p. lamp which the plant is capable of supplying at the same time, works out at £2. 10s. A loan of £20,000 was obtained for electric lighting purposes, to be repaid in 25 years. The contract amounted to:

Boilers, condenser, economiser, pumps, and pipework ...	£3,992	0	0
Engines and dynamos	3,390	0	0
Balancer-booster, switchboard, and connections	1,495	0	0
Battery	806	0	0
Crane and spare parts	424	0	0
Mains, and eight arc lamps	3,950	15	0
Buildings and shaft	3,615	0	0
	17,672	15	0

The remainder of the £20,000 goes for contingencies, excavation for cables (which was a separate contract from the mains themselves), service connections, meters, indicators, etc.

The camp electric light station is not quite finished. The following information relating to it was given in the paper:

Aldershot Camp Electric Lighting.

In the problem of supplying electricity for the requirements of a military camp such as Aldershot, exceptionally exact data were available, and the shape of the load curve could be made out as a working basis. The system of distribution adopted was by direct current on a three-wire network, the pressure at lamp terminals being 200 volts. The camp was divided into 28 sub-divisions. The total number of points to be wired for, irrespective of the number of lamps per point—many being three and five—is about 14,000. No particular system of wiring is adopted, but in soldiers' quarters and buildings generally, where internal brickwork is merely whitewashed, the conduit system is used; on plastered walls, where work is on the surface, the conductors are laid in casings; in many cases of long runs in roofs the wires are supported by porcelain cleats. Although it is proposed to earth the middle wire of the network, no difference is permitted in its insulation or protection in the wiring circuits; each side of the three-wire system is treated as an individual installation at 200 volts. All switches and single-pole fuses (if any) are placed on the outer conductor, which result is obtained by the use of red and black wires, the red being the outer in every case. Power circuits taken into buildings are kept distinct from lighting circuits, and are connected up to the outers, all motors being wound for 400 volts. There are at present installed motors aggregating 100 b.h.p., but this is likely to be considerably increased. The distribution network consists of two complete ring distributors, one for Stanhope and one for Marlborough lines, each supplied by several feeders. These rings are each provided with a number of distributing points, at which are placed pillar boxes, a certain number of these being also feeder points; the branch distributors are connected with the pillar boxes, and are arranged so that each barracks may be separately metered and controlled. The mains are three-core or concentric cables insulated with paper, lead-covered, and laid solid in stoneware troughs. Where road crossings occur at places subjected to heavy traffic, the troughing is of cast iron with cast-iron covers. The street-lighting circuits are kept entirely separate from the remainder, and are provided for by single cables for the arc and twin cables for the incandescent lamps. The main road through the camp—viz., the Queen's-avenue—will be lighted by 32 arc lamps, the columns being each fitted with two incandescent lamps as an alternative; the remainder of the roads will be lighted with incandescent lamps, two on each post. Service boxes on buildings are in the majority of cases on the outside walls; this is brought about largely by the general absence of cellars, by the requirements of the War Department as to switch control, which is conveniently arranged for by an external switch, and generally as a protection from fire.

The steam generating plant consists of six water-tube boilers set in pairs in brickwork; their evaporative capacity is each 5,000lb. of water per hour, with feed water at 112deg. F., to a pressure of 160lb. per square inch. The feed pumps are in duplicate, each set consisting of a three-throw pump actuated by a multipolar motor, series wound, water being taken either from an overhead tank of 5,000 gallons capacity (into which the condensed water is returned) or from the cooling pond. The arrangement of the feed piping provides for a duplicate service either through the economiser or direct into the boilers. The economiser consists of two double sections, each of 192 vertical tubes, and is arranged with a junction pipe so that both sections may be used singly or in parallel, or the sections may be placed in series with each other. There is no by-pass in the economiser chamber, but there is an entirely separate underground flue for use during repairs. The boilers are arranged for firing with coal by hand under natural draught. It is estimated that five boilers will deal with the load, and that one may therefore always be down for cleansing; consequently five bunkers are provided, each having a capacity of about 10 tons without stacking. In addition to the bunkers it is intended to

Laying Mains from Camp Station, Aldershot.

build a coal store of 500 tons capacity as a stand-by; and a narrow-gauge railway laid in front of the boilers will be used for conveying purposes. Inside the boiler-house, near the entrance, the trucks pass over a weighbridge. The quantity of water pumped into the boilers is measured by passing through duplicate water-meters under pressure; and the quantity of condensed water, equivalent to that used in the engines, by passing through a meter after leaving the hot-well.

The electrical generating plant consists of three sets of 250 kw. and one set of 100 kw. capacity; the dynamos are bipolar, and the armatures direct driven by turbines. The 250-kw. sets generate at 400 to 450 volts, and are coupled direct to the outers of the network; the 100-kw. is a tandem set, with two dynamos, each generating at 200 to 225 volts, the terminals being connected with the three-wire for acting as a steam balancer The main steam-pipes are in duplicate, and provide two distinct means of supplying the separator columns connected with the turbines. These separator columns are fitted with automatic traps of the thermoscopic type, arranged for returning condensed water to the feed tank, and also with water gauges for hand working. Similar traps are fitted to the main steam-pipes on the boiler-house side,

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The exhaust steam is led through stop valves to a common exhaust pipe, running in a subway underneath the engine-room floor, and thence to the condensers, which are in duplicate, or through an automatic valve to atmosphere. Circulating water for condensing purposes is brought by gravity from an adjacent cooling pond, and pumped back again by two centrifugal pumps. These form part of the duplicate motor-driven combined pumps, which deal with the air and hot-water delivery and also the return from the hot-well to the feed tank referred to. The capacity of each combined pump with its condenser is the exhaust steam of one 250-kw. set at full load. The balancer booster consists of four bipolar machines coupled together, compensates for 100 amperes out of balance, and the booster will raise 375 amperes on each side of the three-wire system from 0-100 volts. The switchboard provides for three panels and one spare for the 250-kw. sets, one panel for the 100-kw. set, one for the balancer, and two (one positive and one negative) for the battery, 12 feeder panels and two spare, two panels for combined pumps, two for feed pumps and economiser motors, and one for station lighting. The whole of the control of the electrical plant, except the feed pump and economiser motors, is from the switchboard.

In the generating station the boiler-house is parallel with the engine-room, both being of similar dimensions—viz., length, 65ft.; breadth, 46ft. 10in.; and height, 26ft. to the wall plate. Each is lighted from a skylight in the roof, glazed with Mellowes and Co.'s patent "Eclipse" glazing, and ¼in. rough plate glass; ventilating louvres run along the whole length, which, in the case of the engine-room, may be open or closed. In addition to the top lights, there are windows in the outer walls above the crane rail. The pump-room, 16ft. by 12ft., and stokers' room adjoining, with tank over, and the economiser chamber, 35ft. by 21ft. 7in., are on the south end of the boiler-house, while the offices, workshops, stores, and test-room are on the same end of the engine-room. At the north end of the engine-room is the condenser pit; this runs the full width of the engine-room, is 14ft. wide and 11ft. 6in. deep; it is approached by means of an iron staircase leading under the north end of the switchboard gallery, from which access is also obtained from a landing to the cable chamber, which runs under the remainder of the switchboard gallery. Behind the switchboard gallery, which runs lengthways in the engine-room, lies the accumulator house, forming an eastern wing, the dimensions of which are 43ft. 6in. by 43ft. The roof of the accumulator house is in two spans, each provided with a glazed skylight with fixed open louvres. Light and ventilation are also provided by windows round the walls, which are treated with Blundell's petrifying liquid. The floor is paved with Candy's 32-panel buff vitrified paving bricks; a lead-lined sink of special design is provided for plate washing, whereby all sediment is retained for examination, etc., in a stoneware receiver. The engine-room is paved with red Ruabon tiles, laid herring-bone pattern, the walls being glazed brick to a height of 13ft., above which the bricks are light buff. The glazed brickwork is in two colours—Candy's French green for a height of 6ft., the remainder being white; the edging of the machinery foundations is a glazed green bull-nosing to match. The front of the switchboard gallery is panelled with white centres upon which are mounted the station wattmeters. A six-ton travelling crane on rails, supported by wrought-iron stanchions, traverses the engine-house and condenser pit. Opening on to the gallery are the offices of the engineer on watch, the passage leading to the remainder of the offices, and the test-room—from each of which, through plate-glass windows, the engine-room may be viewed. In the boiler-house, a cross gallery runs the whole length of the boilers, and gives access to the stop valves; the top of the economiser and the feed tank are also approached by the same means. Separate rooms, each fitted with a lavatory and water-closet, are provided for engine-room and boiler-house staff, leading from their respective houses. The boiler-house is paved with blue Staffordshire bricks, the walls for a height of 6ft. being of the same material, the remainder of the walls, as well as the interior of the economiser chamber, pump-room, and mess-rooms, being treated with petrifying liquid. The floors of the pump-room and stokers' room are also in blue Staffordshire bricks. The bunkers, which are on the outside of the boiler-house, are protected by a lean-to galvanised iron roof, and have raked bottoms and sides to facilitate handling the coal through the bunker doorways, which are shut by sliding iron doors, and communicate with the firing space in front of the boilers. Four separate sumps are provided for the boiler blow-off pipes, and are arranged so that it is impossible for steam during blowing-down operations to find its way into a boiler laid off for cleaning. Access to these sumps is made through manholes with locked covers, and each is provided with a 4in vent pipe to carry off any pressure caused when blowing down. The economiser blow-off is dealt with in a similar and separate sump. The arrangement of duplicate flues enables repairs to the economiser, which is placed in the main flue, or to the flues themselves, to take place at any time. Access is obtained at both ends by double seal iron doors, while at the chimney end is provided a double damper with vanes at right angles to each other, mounted on and actuated from outside by a vertical spindle, which can be locked in one or other position, so that when one flue is open the other is shut. The sectional area of the main flue is 7ft. by 4ft. 6in.; that of the reserve 6ft. 3in. by 4ft. 6in.

The chimney shaft is 150ft. in height above ground level and 7ft. 4in. internal diameter at the top. It is lined to a height of 75ft. with firebricks, having an annular ventilated space between them and the chimney brickwork. This space is covered over at the top with projecting York stones built into the outer brickwork, which slightly overhangs it to prevent dirt, etc., falling into the cavity. This projection is a few inches above the firebrick lining, to allow for expansion. The foundations are octagonal in shape, 31ft. across the flats and 7ft. thick, with an area of 800 square feet, upon which the brickwork commences. This octagonal shape is carried up to a height of 34ft. above the concrete and 25ft from the ground line, the last 3ft. consisting of eight granite blocks dowelled together and forming, with 3ft. of brick over sailing courses, a cornice from which starts the circular portion of the shaft. The shaft is built in red wire-cut bricks of ordinary pattern, and, with the exception of the base, without a scaffold. It is surmounted by an ornamental cap, the whole terminating in a massive cast-iron weathering ring in six sections, bolted together and rag bolted into the solid brickwork. The latter is 1 in 40, with a smooth taper outside; eyes for scaling ladders are fixed on the north side. The lightning conductor consists of a ring of copper carrying eight spikes, secured to the cast-iron weathering ring, and connected to an encircling ring at ground level by two copper tapes of 1½in. by $\frac{3}{16}$in. section. Gunmetal holdfasts built into the brickwork give the necessary fixing for the tape, which is kinked in places to provide for expansion. The ring at the base is provided with two earth-plates, either of which may be disconnected for testing purposes. The object of the double tape is to secure a means of testing continuity. The shaft is calculated to withstand a wind pressure of 56lb. per square foot, without reckoning the binding properties of the mortar. The total load on the foundations is 1,200 tons. The mortar used consisted of blue lias lime, 1 to 2. The cooling pond lies a distance of 100 yards from the central station, on the opposite side of the road; the supply of water is obtained from the roofs of buildings, supplemented by the water-mains. The dimensions are 200ft. by 100ft., with an average depth of 6ft. The water is drawn from the corner nearest the station through 15in. cast-iron spigot socket pipes, and returned at the opposite corner through pipes of the same dimensions. Valves placed in chambers constructed in the pond enable the supply to be cut off. The retaining walls are constructed of brickwork, surmounted by a blue brick coping, and backed up with earth; the bottom is of concrete 6in. thick, laid in two layers, with a lining of Callender's bitumen sheeting between to render it watertight; this sheeting is also carried up the sides in the brickwork. The whole is rendered on the waterside with ¾in. Portland cement. The pond is surrounded by an unclimbable iron fence. The whole of

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the work has been carried out by civil contractors, under the direction of the Commanding Royal Engineer, South Aldershot.

Mr. Arthur J. Mayne, A.M.I.E.E., is the chief electrical engineer on the civil staff for the scheme

MANCHESTER MUNICIPAL SCHOOL OF TECHNOLOGY.

The Prime Minister (Mr. A. J. Balfour) opened the new school of technology at Manchester on Wednesday. The construction and equipment of the building, at a cost of something like £300,000, have occupied seven years, and of that cost the ratepayers of Manchester have willingly borne a large share. Much, however, is due to local benefactions. The representatives (or legatees) of the late Sir Joseph Whitworth, who had the disposal of large funds for carrying out the benevolent intentions of the deceased baronet, helped the municipal scheme largely by facilitating the transfer of property vested in them to the Corporation. In this way the Corporation were able to build, upon the foundation of what was then known as the Whitworth Institute (which had previously absorbed the old technical school and mechanics' institute), the present noble building, which bears the title of the Muncipal School of Technology. It is one of the largest and handsomest buildings in Manchester, and there is probably no institution in Europe—certainly none in this country—better equipped for its purpose in every department. The curriculum includes courses in mechanical engineering, electrical engineering, and technical physics, municipal, and sanitary engineering, general technical chemistry, dyeing, metallurgy, etc

The electrical department is splendidly equipped. It is located on four floors, the heavy machinery being installed in the basement, and a dark sub-basement is reserved for photometry, etc. There are four spacious laboratories for physics and electrotechnics, also research, high-tension, and standardising laboratories; two lecture theatres, well lighted and of large dimensions; and separate laboratories for photometry and optical work, with experimental accumulator and cable-testing rooms. The present plant consists of four 100-kw. steam dynamos of various types, and one of Parsons 50-kw. steam turbo-dynamos. The motors installed are over 70 in number; they vary in size from ½ h.p. to 200 h.p., and have all been produced by the best-known makers. A set of four machines by Kolben, of Prague, has been installed in the principal electrical engineering laboratory. These machines are controlled by a four-panel marble switchboard supplied by Messrs. Witting Bros., and they illustrate a central station with an alternating supply. The alternators are of the Inductor type, and the armatures are wound so as to give either one or two phase currents. The alternators are driven by two 220-volt motors. Each gives 10 kw. as a single-phase and 15 kw. as a two-phase machine. There is also an Oerlikon three-phase alternator for 200 volts and 50 periods to give 20 kw., provided with an armature rotating in a four-pole field. It is directly coupled to a 400-volt motor provided with a Sturtevant starter, and driven from the city mains. The several machines are controlled by switchboards of Messrs. Dorman and Smith's manufacture. The truck of an electric tramcar occupies a pit in the centre of this room. It was made by the English Electric Manufacturing Company, Preston, and is furnished with two continuous-current motors of 25 h.p. The truck is mounted on friction wheels, and is coupled to a segmented flywheel, whose mass can be altered as may be desired. The framework of the car carries four galvanised iron tanks capable of holding 10 tons of water, and the load can be varied in amount and position by means of inlet and outlet valves. There are also facilities for raising and lowering the car, and for studying problems relating to efficiency and acceleration. On the left side of the room is a triple set of machines by the British Schuckert Company. The central one is coupled on either side to a machine with an output of 40 kw. That on the right hand, giving 600 amperes at 70 volts, is for electro-chemical and other purposes; and that on the left is a 500-volt generator for driving the tram motors, and, being provided with slip-rings, is capable of being run as a single or three phase alternator. The three machines are controlled by a switchboard on the same side of the room. Near it is one by Dorman and Smith, connected with a battery of accumulators of the Chloride type, for experimental purposes. The current is capable of being regulated in steps of 10 volts up to 220 volts. Laboratory No. 2 has several machines of smaller size than those above described. There is a set of two 5-kw. rotary converters for transforming from three-phase to direct current, controlled by an Alioth Company's switchboard, and the plant is arranged to represent a distributive sub-station. Experiments in synchronising and parallel running can be made. There are also in this room four single-phase motors by the Langdon-Davies Co., the Oerlikon Company, Witting Bros., and Fuller-Wenstrom Company, arranged for brake and efficiency tests. Other motors by various firms, including Brown, Boveri, and Co. (Baden) and the Electrical Company, are installed, together with transformers representing Scott's system of conversion from three to two phase by the British Schuckert Company.

Without going into further detail, mention may be made of a set of three machines supplied by Messrs. Bruce Peebles and Co., of Edinburgh, arranged for experimental work—these are connected by magnetic couplings—also machines for direct-current working by Messrs. Crompton and Co, of Chelmsford, and by Bergmanns, of Berlin, and a motor provided with reduction gearing by the Electrical Company. The machines are controlled by efficient switchboards. It is not necessary to give full particulars of the remaining rooms, but everything is on the same complete scale. The cable-testing and photometry rooms are provided with the newest and most perfect apparatus. There is a special laboratory devoted to research work, fitted with Prof. Schwartz's arrangement of galvanometer test tables. Portable testing stands are used throughout the department. In the electrotechnical laboratory is a collection of meters of the best English and Continental types. The head of the department is Prof. Alfred Schwartz, A.K.C., A.M.I.C.E, and M.I.E.E., formerly of the electrical engineering department of the South-Western Polytechnic, Chelsea, who was appointed to his present post in July, 1901. Prof. W. W Haldane Gee, B.Sc. (Lond.), A M.I.E.E., is second in command.

The opening of the school by Mr. Balfour was a brilliant function. The Premier was accompanied by the Lord Mayor (the Earl of Derby) and a large body of the City Council and other citizens interested in the work of the school In his speech Mr. Balfour said no one could go over the building, observe its equipment, and study even in the most cursory manner the care which had been devoted to it without feeling that the Corporation of Manchester had set a great example worthy of the place they held in Lancashire and in the country. He drew attention to the change in the industrial conditions of the world, and also to the change indicated by the necessity for institutions of this character, from what he called the pre-scientific to the scientific stage of industry. There was always, of course, the closest connection between mechanical ingenuity and invention and the great growth of our industries, but the intimate correlation between the discoveries of the laboratory and the processes of the workshop were not always in existence. So it happened that in some branches of work we were behind our Continental neighbours, who had been in this respect more apt to learn than ourselves. He contrasted the practice of English and German firms. Anyone who set himself to study the equipment of a great industrial concern—electrical, chemical, or other—in Germany would find a proportion of scientifically-trained assistants, not merely in excess, but enormously in excess, of anything that was commonly thought necessary in this country. There was not the least use, he concluded, in turning out competent students unless employment was found for them by British manufacturers.

The proceedings terminated with a vote of thanks to Mr. Balfour. In the evening there was a brilliant assembly at a conversazione in the new building, the physical, electrical, engineering, and other laboratories being thrown open.

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ELECTRIC LIGHTING RETURNS—COMPANY v. MUNICIPAL.

The returns which have recently been issued by order of the House of Commons of the electric supply undertakings in the United Kingdom leave much to be desired. In the first place, they are only for the year 1900, and hence practically 12 months late in arriving. Again, the more important objection is that they are far from complete. It is exceedingly difficult to understand how it is that the Board of Trade cannot obtain for completing a statement of this kind the figures from annual reports which their own auditors have certified. This would seem to be the case from the number of blanks which appear in the returns for both municipal and companies' stations. The effect of these blanks is made worse, as the columns have in many instances been added up in spite of the omissions. The totals thus arrived at do not do credit to the department from which they are issued.

At the present time, while the ill-effects on industries of municipal trading are being exaggerated in a series of articles in the *Times*, it is not out of place to investigate, as far as electrical undertakings are concerned, the actual performances of the local authorities as compared with companies in electric supply. Individual instances of mismanagement, both in equipping stations and in working them, are to be found amongst both company and municipal undertakers. Either side, therefore, can make out a case against the other by dwelling on these individual instances of mismanagement, and by exaggerating them as certain of our contemporaries habitually do whenever a municipality is in fault. The only fair means of comparison is obtained by adding up all the complete returns available for any one year, and analysing the average figures arrived at in this way. It is useless in making up these averages to include stations which have not yet been at work for a full year. These figures we have obtained by totalling the returns as certified by the Board of Trade auditors from over 160 electric supply stations, of which the larger proportion are owned by local authorities. It did not seem to us to be right to include the London companies in the average of all those within the United Kingdom, because these companies established their works before the electric lighting and distributing systems had been fully investigated. They had, therefore, to do a great amount of pioneering work, and have since had to discard plant which has become out-of-date and uneconomical. In keeping the returns from these London companies by themselves, we have also divided out those from the local authorities within the London area. These figures are given side by side in Table I. A perusal of the average figures in the

TABLE I.—Aggregate Returns of the Metropolitan Electric Undertakings from Last Year's Returns.

—	Companies.	Local authorities.
Total capital outlay	£9,299,000	£1,448,000
Total revenue	1,234,000	205,600
Total cost, excluding capital charges	678,900	136,800
Units sold per annum	62,985,000	13,755,000
Total capacity of plant (kilowatts)	80,700	15,000
Average capital expenditure per kilowatt installed	£115	£96·5
Average price per unit sold	4·72d.	3·58
Average cost per unit sold	2·59d.	2·38
Gross profit as percentage of outlay	5·98	4·75
Units sold per kilowatt of plant installed	780	917

Companies spent 19·2 per cent. more on plant, charged 32 per cent. more per unit, and costs were 8·8 per cent. more.

table will show that in London the companies have spent 19·2 per cent. more per kilowatt installed for plant and mains than the local authorities. The cause for this is largely that the companies commenced operations earlier. The other figures indicate that these companies now charge 32 per cent. more on the average for the units sold, and that these units actually cost them almost 9 per cent. more than they do the local authorities. The last row of figures in the table gives the average number of units sold per annum for every kilowatt of plant installed in the stations. Here again the local authorities score, as they are able to sell 917 units as against the companies' 780 units. This shows that these local authorities' stations have the better load factor. One of our contemporaries devoted to the gas interests would explain this by saying the improved load factor was due to the street-lighting, and to a certain extent it is true that more electric street-lighting is done from the works of the corporations than from those owned by companies. It is equally true to say that this is quite explicable on the ground of cost. The other and more important reason for the better output per kilowatt installed is that the municipal station engineers have done more than the companies' engineers to encourage motor loads. The lower capital expenditure of these municipal stations enables a lower price to be charged, which would mean a loss to the undertakings in companies' hands. In Table II. will be

TABLE II.—Aggregate Returns of Provincial Electric Lighting Undertakings from Last Yearly Returns available.

—	Companies.	Local authorities.
Total capital outlay	£2,963,000	£13,404,570
Total revenue	292,000	1,561,000
Total cost, excluding capital charges	154,200	866,600
Units sold per annum	15,760,000	119,224,000
Total capacity of plant (kilowatts)	30,100	171,600
Average capital expenditure per kilowatt installed	£98·5	£78·5
Average price per unit sold	4·45d.	3·15d.
Average cost per unit sold	2·34d.	1·75d.
Gross profit as percentage of outlay	4·65	5·18
Units sold per kilowatt of plant installed	524	695

Companies spent 25·5 per cent. more on plant, charged 41·4 per cent. more per unit, and costs were 33·6 per cent. more.

found similar figures for those provincial electric lighting stations of which complete returns have reached us. Exactly the same arrangement is followed in the arrangement of this table as was adopted in Table I. In this case, however, the largest total figures are for those stations owned by local authorities. The figures as analysed showed that as far as electric supply is concerned, private enterprise has not been able to compete with municipal trading. For instance, the companies in the provinces have had to pay from some cause or other 25½ per cent. more per kilowatt of plant than the municipal undertakers. How much of this 25 per cent. is watered capital it would be difficult to ascertain, but the figures clearly indicate that our electrical contractors will carry out work for a corporation at lower rates than they will for privately owned companies, or for companies working under the Limited Liability Acts. Although there has not been much company promoting in electric lighting undertakings in recent years, contractors have frequently had to do work for which they have been partly paid in cash and partly in shares, and this fact accounts for the increased rates charged. When it comes to the average price obtained per unit sold, it will be seen that the companies get no less than 41·4 per cent. more than the local authorities. This is exceedingly good, from the municipal consumers' point of view. What is more important, from economical considerations, is that it actually costs the company 33·6 per cent. more to produce each unit they sell than it does the local authorities. The figures as to the output each year per unit of plant installed show that here again the local authorities have a better load factor, but the figures are not so good as those for the London area. The difference between the company and municipal returns are without doubt partly accounted for by the fact that the corporations supply a considerable number of tramways with electrical energy. This is obviously not the only cause, because the motor users have also been encouraged, and even then the number of units sold per kilowatt of plant per annum is less than that for the London undertakers, who have no tramways. The only conclusion, however distasteful to the opponent of municipal trading, is that the municipal electrical engineers and the electric lighting committees throughout the provinces manage their undertakings better than the electric lighting companies do. The returns clearly show that, in spite of the disadvantages of a committee of councillors who are not chosen in consequence of

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any expert knowledge of electrical engineering, such committees, aided by the best expert advice, are able to equip stations more cheaply and to run them more economically than the experts usually found on companies' directorates.

There is one other point of difference between corporations and companies as far as their financial arrangements are concerned, to which endless references are made in the daily Press. This is the different way in which they are capitalised. A company presumably gets its capital from the public, and returns to the public dividends when it is able. The municipality obtains its money on loan under Government regulations which enforce a regular annual interest and repayment of capital, for which the rates are a security. This repayment of loan is a compulsory depreciation fund, which will wipe off the capital spent at the end of the period of the loans, which varies from 30 to 40 years. As a rule, the annual sum for interest and repayment varies between 5½ and 6 per cent. It will be seen from Table II. that the average gross profits of the provincial electric light undertakings in the hands of local authorities is 5·18 per cent. It follows, therefore, that the balance between this and the annual repayment has to be made up out of the rates. The average percentage would have been considerably higher were it not for the fact that the large electric lighting undertakings do not attempt to make profits in aid of the rates. Instead of this, they reduce their charges to keep their profits practically equal to their capital charges, after allowing for a small reserve. It is urged by the writer of the *Times* articles and others that the annual repayment of loan is insufficient as a depreciation fund, and hence that with time these undertakings will become insolvent. If this is so (we deny it), then the companies must be in a very bad way financially. Their average gross profit in the provinces is now only 4·65 per cent. of their capital outlay. Out of this they are distributing dividends in spite of the fact that their period of life is limited, and that at the end of the expiration of their orders their undertakings can be purchased at considerably less than the capital cost. It would serve no useful purpose to elaborate this point, as the one which we wish to bring out is that so often lost sight of in such discussions—*i.e.*, that the balance-sheet alone is not the true indication of the work done by any undertaker. If the policy of the local authorities owning electric supply undertakings is to earn large profits, they could easily do so by slightly increasing their charges. They prefer instead to supply electrical energy at cheap rates with enormous monetary savings to their consumers. For instance, if the local authorities had charged the average rates the companies did in the provinces last year, they would have received an additional income of about £650,000 for the same output. Obviously this large increase would not be possible, as to raise the price would reduce the consumption, but the figure shows what large sums are involved in the difference between company and municipal management with electric lighting undertakings.

THE SMOKELESS COMBUSTION OF BITUMINOUS FUELS.*

BY W. H. BOOTH, M.AM.SOC.C.E.

Engineers are taught at college that combustion can only take place in the presence of a sufficient supply of oxygen at a sufficiently high temperature. An ordinary classroom experiment is to surround a candle flame with a coil of wire which abstracts heat so rapidly from the flame as to cause combustion to cease, and the flame is extinguished. This experiment contains the whole secret of combustion. When engineers go out into the world, they find that the burning of coal and generation of steam are carried out upon lines which are quite opposed to the principles they were taught at college, and more upon the lines of the refrigerated candle flame experiment. They become aware that the daily practice of steam raising, while opposed to theory, is very far from good, and they are told that it is not possible to burn bituminous fuel except with evolution of smoke. Most engineers acquiesce in this very lamentable state of affairs, and are more inclined to do so because, where teachers of engineering have been responsible for boiler arrangements, they are unable to find that these present any differences from the common herd. The modern steam-boiler is, in fact, quite as primitive as a common pan set directly upon a fire to boil. An African savage, with a gourd as his pot, places this to boil just as scientifically as do our professors of engineering place boilers. The modern boilermaker merely sells boilers. The consulting engineer, who ought to order their setting, accepts the methods of the savage, the impossibility of which, in respect of good results, he has taught, or has been taught at college, but has not comprehended.

There are certain fuels which burn *in situ*. No flame is produced. They waste away when exposed to air, and the wasting surface becomes brilliantly incandescent. Such fuels are wood, charcoal, coke, or anthracite coal. Because of this peculiar manner of combustion such fuels may be burned directly below heat-absorbing surfaces, and combustion will be very perfect; but even with fuels of this description a certain mingling into one stream of all the products of a fire may be of advantage, because such a fire may be of uneven thickness, and in places may admit too much air that will serve to burn the carbonic oxide that has been formed where the fire is too thick. In other forms of fuel, known as the bituminous and semi-bituminous coals, which contain hydrocarbons, the problem of industrial combustion is more difficult. In the first place, a bituminous coal passes through two distinct processes when burning—first, the hydrocarbons, which are volatile, are distilled off by the heat of the bed of partially consumed fuel into which the fresh coal is thrown. The hydrocarbon gases will burn with a flame of greater or less strength if raised to a sufficient temperature with a suitable amount of oxygen. While they are being distilled they absorb so much heat that the solid carbon, from out of which they are driven by the heat, does not itself ignite. Its temperature is kept too low for combustion. When the hydrocarbons have been evaporated the solid carbon begins to acquire heat from its position on the hot fire below, and soon it acquires the temperature of combustion and begins to combine with the oxygen passing by, and to glow with its own incandescence. Its future behaviour is simply that on the solid carbons first named.

Engineers are more concerned with the behaviour of the hydrocarbons. These, as explained, burn with a flame of greater or less length according to character and temperature. Thus certain Welsh coals of a so-called smokeless variety burn with a short flame. This flame is short because the hydrocarbons, whose combustion causes the flame, are burned in a short space. Hence it is that, even when the boiler is placed near to the fire surface, these coals will often burn without smoke. The long flaming bituminous coals give off hydrocarbons, either of such large volume or peculiar constitution that they require much greater space in which to complete their combustion. It is essential that this space should be of such a nature as to its surroundings, that the temperature of the burning gases shall be kept sufficient to ensure continuous and perfect combustion. If this be not done, the hydrogen may, perhaps, burn, but the carbonaceous particles will not burn, but will be separated out in the flocculent form as soot. It seems probable that the worse the condition, the longer will be flame up to a certain point; that is to say, if the cooling effect is moderate, so as not to extinguish the flame altogether, this may continue many feet, but if the cooling is rapid, as when the gases are sent directly from the furnace between cold-water tubes, the flame will be at once extinguished. Where the furnace is entirely of a non-heat-absorbing nature, the combustion will be rapid and the flame will be reduced in length. If the process of combustion of bituminous fuel be analysed, some idea may be formed of what really occurs. When carbon is burned to its first oxide it develops 4,415 British thermal units per pound. When to its second oxide it develops a total of 14,647 units, or 10,232 units more. The difference is 10,232 − 4,415 = 5,817 units, and it is usual to look upon this as the latent heat of evaporation of carbon. This is not known to be true, the opinion of Berthelot being that the latent

* Paper read at the Belfast meeting of the British Association.

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heat is some further amount, which he terms *c*. The commonly accepted figure of 5,817 is at least less than the truth, and may be used in the present paper.

In a piece of bituminous fuel the whole of its constituents are solid. There is solid hydrogen as well as solid carbon in the hydrocarbon gases which are distilled from the coal. Before these solid substances can become gaseous they must be supplied with the latent heat necessary to vaporise them. The chief heat absorber will be the carbon. Of each pound of coal in a furnace, let a sample be assumed containing 50 per cent. of fixed carbon and 33⅓ per cent. of volatile carbon, the remainder being hydrogen, oxygen, and nitrogen. Neglecting everything but the carbon, it is obvious that the heat generated from the fixed carbon will be 7,324, or $\frac{50}{100}$ of 14,647 thermal units. To vaporise, the volatile carbon will require 1,939 thermal units, or 33⅓ per cent. of 5,817 as a minimum. The net quantity available at the grate is thus only 5,385 British thermal units, and this amount is all there is to produce the temperature of the furnace products. This will give barely a third of the temperature given by solid carbon, and even this is subject to some reduction on account of the vaporisation of the hydrogen and other gases from the solid. Generally with bituminous fuel about half the fuel burns at the grate and half is volatilised, and the heat available per pound of products is one-half available to give temperature and one-half absorbed in volatilisation. If, therefore, the volatilised portions could be removed without combustion the net heat would be very small. But where the volatile portions are finally burned the total heat of the fuel is finally secured, but considerable space is necessary. It seems probable that per pound of fuel about one-fourth only of the total heat capacity is secured at the grate and the remaining three-fourths along the total path of combustion, and this path must not be cooled below the temperature proper to combustion, or there will be smoke and loss.

If the various boiler settings adopted in practice be examined, it will be found that very scant attention has been paid to the question of the continued combustion of the bituminous fuels beyond the grate. Internally-fired boilers are well arranged as regards the form of furnace and the direction of flow of the gases over the length of the fire. Mixture of the gases is well provided for, and space is provided for their continued combustion beyond the bridge, but the arch of the furnace is water cooled, and the internally-fired boiler is thereby brought down from an easy smokelessness to a critical position of being smokeless or the reverse, according as the condition of the draught and the fire may decide. As though to render the critical position one of certain smokiness, boilermakers have long persisted in placing water-pipes across the flue tubes. These baffle and extinguish the flames, and have never yet been shown to have a good effect even on evaporation. As a fact, they are worse than useless in this respect, and an incentive to smoke production, their evil effect being well seen by comparing the condition of the flues in Lancashire boilers with and without these useless encumbrances

There is considerable difficulty in lining the furnace of a Lancashire or other internally-fired boiler with firebrick so that the water-cooling effect may be prevented, because the lining would so much reduce the furnace diameter. This, however, should prove successful. In the ordinary setting of the water-tube boiler is seen the absolute apathy of engineers and their neglect of sound principles. The simple form of water-tube boiler, consisting of a number of inclined tubes, is set directly over the firegrate. From every square inch of the grate surface the gases of combustion rise vertically upwards, proceed at once between the tubes, and combustion is promptly extinguished. Here, even if given draught and a sufficient total air supply, smoke is inevitable. First, there is no general sweeping action of the gases over the whole grate area, and there can be no mixing of volumes containing too much air with volumes containing too little. This is the fault of all boiler furnaces where the gases rise vertically from the grate. In the short distance from grate to water-tubes even a short flaming Welsh coal will not always sufficiently complete its combustion as not to smoke, for so soon as the gases enter between the tubes they are practically extinguished, and soot is formed. Belleville tried to agitate the products of combustion by forcing in jets of air to mix everything up in the small space of the furnace, but this expedient was very partially successful, as might be expected, and though best Welsh may be burned at moderate rates of combustion with little smoke, an ordinary bituminous coal cannot. Yet the ordinary water-tube boiler lends itself exceedingly well to a smokeless setting. In the first place, the grate requires to be arched over with a firebrick arch occupying the place of the lower row of tubes. The boiler itself requires to be raised about 4ft. higher than the usual position, and the gaseous products of the furnace having been compelled to sweep over the length of the fire, are turned back under a second arch which springs forward from the back wall of the furnace and a large combustion chamber is thus formed, entirely surrounded by firebrick lining, whence the now perfectly burned gases escape to the water-tubes. Admission of air above the fire appears to be essential, as was pointed out by Wye Williams years ago. Thus the water-tube boiler, hopelessly smoky in its usually accepted form, can more easily be made certainly smokeless than can the usual forms of internally-fired boilers.

The usual form of water-tube boiler and its setting, so blindly adopted by electrical engineers, had its origin in the anthracite-burning localities of the United States. Pennsylvania anthracite is so entirely carbon that it will produce no smoke under any conditions. In another form of American water-tube boiler, which is an outcome of more westerly or soft coal areas, the setting is different, and involves more or less fully the conditions above described as necessary. This shows the influence of environment, while the failure here of the anthracite mode of boiler setting again points to the absurdity of attempting to employ American methods outside America without proper consideration of the facts involved. The smoke nuisance from water-tube boilers has been so great that the fault has been laid on the principle of water-tubes, whereas it is simply a fault of improper brick settings. The small-tube boiler may be similarly considered. Here again is ordinarily found a large firegrate, from which the gases rise directly amongst the tubes. The furnace is approximately triangular in cross-section, the grate forming the base and the two sides being formed by the sloping walls of cold-water tubes. Such a boiler must inevitably produce smoke, for there is no mixture of gases and no attempt to conserve temperature to the period of total combustion. In the boiler of Mr. Jas. Weir, without any increase in the breadth of the boiler at the ordinarily widest part—the grate level—the tubes have been differently spread so as to form the usual triangular furnace by means of a single row of tubes only, and between this wall of tubes and the main body of tubes space is formed to give a fairly commodious combustion chamber. Both the walls of single tubes and the first rows of the main body of tubes are enveloped in fireclay blocks, in order that the boundaries of both furnace and combustion chamber shall be of non-heat-absorbing material. The gases which rise from the furnace have to pass over the top edge of the furnace wall in order to enter the combustion chamber in which their flow is downward, so that they may escape among the tubes by passing below the edge of the second fire block wall. The products of combustion are then doubled back on themselves in entering the combustion chamber, and a mixing action is secured similar to that in the long furnace of the internally-fired boiler, and the correctness of this principle is demonstrated by the smokelessness of the Weir boiler, and it is very interesting to watch through the sight holes provided for the purpose the clearing effect of the above fire air admission.

Smoke represents loss of fuel, but in the ordinary boiler furnace its prevention can only be secured by the employment of so great an excess of air that loss ensues, and usually the best results are obtained from a boiler when smoke is allowed. As just stated, one reason is the more moderate supply of air. With a refractory lined furnace a high temperature is secured, and the flame of bituminous coal is shortened, so that even the long flaming coals

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appear to complete their combustion within a few feet of the fire. Such coal as the best Welsh "smokeless" have naturally so short a flame that they burn off within a very short distance of the fire, thereby securing that high temperature which is essential to keep a flame short. Thus, the shorter the flame from a coal, and the easier it is to keep the flame short. Where a bituminous coal is seen to produce flames extending 60ft. or 80ft. round the flues of a Lancashire boiler, this must not be taken to indicate the impossibility of smokelessly burning such coals in a proper furnace and combustion chamber of comparatively short length. The very long flame simply indicates that the cooling effect of the boiler plates has served to prolong the flames, but has not been sufficient to cool them to the point of extinction. The prolonged combustion implies slow combustion. Higher temperature would shorten the period of combustion.

The general correctness of the principles enunciated are exemplified in the locomotive. Though surrounded with cold plates, the sharp draught of the locomotive boiler causes the production of a high firebox temperature, but the gases from the grate pass so directly into the cold tubes that the locomotive form of furnace is a very smoky one. But an arch of firebrick is thrown across the box from side to side, springing from the tube plate below the lowest tubes, and compelling all the products from the grate to travel round the higher edge of the arch, meeting a stream of fresh air entering at the door and completing combustion in the upper half of the firebox. The path to the cold tubes has been greatly lengthened by the arch, and the gases have been made to travel together and mix with air, and the result is more perfect combustion, and a well-managed locomotive does not smoke when running under draught. Though for years all this evidence has been before engineers, it has apparently had no effect with the boiler arrangements of almost all modern power stations. First, the badly set boiler is laid down, then follows the period of smoke and fines, and the aid of mechanical stokers, of steam blowers, and other palliatives is sought in mitigation of the evil. Some of these things introduce other evils, notably loss of economy, as noted above. Others, as mechanical stokers, which might be very successful under properly set boilers, fail under badly set boilers, and gain a bad reputation undeservedly.

The whole trouble is, of course, in faulty initial design. The one object of modern practice seems to be the crowding of heating surface closely upon the fire, to the entire neglect of the production of the heat it is sought to utilise. If the many unsuccessful attempts to prevent smoke when burning bituminous coal be examined, it will be found that they fail on the point of temperature. Air admission and the mixture of the furnace gases has been frequently tried, but has failed wholly or partially because of lack of temperature. Forced draught has more or less remedied many cases, because it has helped to create more heat per unit of furnace volume. Masses of incandescent brick have effected partial remedy, because they have assisted to transfer heat from periods of ample temperature to periods of insufficient temperature. Mixture of the gases to be burned with air, a sufficient temperature, and an unimpeded space for combustion to complete itself, appear to be the essentials. The first is neglected where the gases rise vertically from the grate, though the error can be subsequently rectified. The second can only be secured by keeping the burning gas from contact with heat-absorbing surface for a sufficient time to enable combustion to become sufficiently complete. The third is what is neglected in all cases where heat-absorbing surface is brought too near the grate, and is exemplified in the cross tubes of the Lancashire boiler, the fire-tubes of the locomotive when the brick arch is absent and the water-tubes of all the improperly set water-tube boilers. The efficiency of heat-absorbing surface is very great. A bank of water-tubes having an area 27 times that of the firegrate will absorb the heat from a brilliant fire of smokeless Welsh coal burn at the rate of 40lb. per square foot of grate per hour and send the waste gases away at 600deg. F.; if the circulation of water in the tubes is good and rapid, the temperature of the fire being 2,500deg. F., there is no necessity to be in a hurry to crowd heat-absorbing surface upon the fire.

It is better to attend to heat production and perfect combustion. This secured, the heat-absorbing surface will remain clean and do its duty. Unless such conditions are fulfilled, the smokeless combustion of bituminous coal cannot be economically and certainly carried out. With these conditions fulfilled, smokelessness is certain Bituminous fuel has a higher calorific capacity than anthracite where the proportion of ash is alike, and it will give a calorific effect just in proportion to its composition, but on account of the heat absorption of its volatile half the grate or actual solid fire temperature may be less than half that given by anthracite, while the locus of heat production will be extended to the length of the flame. In fine, there is nothing in smoke prevention that justifies the frequent assertion of its impossibility, and it is lamentable that at this late hour engineers and teachers of engineers should stultify their teaching by practising the opposite from what they teach or are taught, in disregard of the obvious scientific principles that underlie the processes of combustion.

It is distinctly a misfortune that through business aptitude and the capacity to effect sales, the most successful water-tube boilers have been of American origin. It originated in the hard coal district of the United States. This hard coal is a pure anthracite that will not, cannot, smoke under any conditions. The water-tube boiler introduced from America was an outcome of this hard smokeless coal, and has been set to work in this country to burn bituminous fuels with no variation in the setting or surrounding brickwork, and with a callous indifference to the fuliginous effects of such futile arrangements, that might be perhaps excused in a mere dollar-hunting American possessed of no consideration for this country beyond the dollars he could make out of it. But the list of engineers who have swallowed the American system whole includes, or has included, presidents and past-presidents of supposed learned societies and professors of engineering, who must surely have known better than they worked The water-tube boiler is not necessarily a smoky boiler, even if its present form did originate in the anthracite zone. It can be set smokelessly even with less trouble than most other forms of boilers, and the reason why it has been so arranged as to foul the atmosphere is indefensible carelessness and a neglect of the plainest teachings of chemistry and physics. Smoke production, in short, is the outcome of methods of combustion from which nothing except smoke can be expected. Steam-boilers are, in fact, arranged very much on the lines of the lampblack factory. Perfect combustion can as easily be secured by following lines that are correct.

LEAVES FROM A TESTING ENGINEER'S NOTEBOOK.

BY FRED. W. DAVIES.

(Continued from page 518.)

Armature Windings.—Perhaps the most prolific source of trouble in a continuous-current machine is the armature winding. Probably there is no fault in such a machine which at first sight appears so obscure, and yet is so easily discovered to one conversant with armature action and reaction, as a fault in the armature winding. The complications which may occur are numerous, and it were futile to attempt to deal with all the possible cases. However, a record of a few of the faults which have come within the cognisance of the writer may be of interest.

A shunt-wound bipolar dynamo of low voltage, having a wire-wound armature of the drum type, afforded an interesting example of what may occur through carelessness in the winding shop. On testing the machine preparatory to its being sent out of the works it was found that it would not work at all as a dynamo; and when run as a motor the brushes sparked badly, and the machine required an abnormally large current to run it light—so much so that it was considered unwise to run it for many minutes. On examination it was found that the mica was badly burned between two of the bars of the commutator. This, as will hereinafter be dealt with, seemed to indicate that there was either a broken coil or a break in one of the connections from the coils to the commutator bars. An alter-

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native hypothesis was that one of the coils, instead of having its ends connected to two adjacent bars of the commutator as they should have been, was "short-circuited" in itself (and the circuit through the armature broken in consequence) by having its ends connected to the same commutator bar, the rest of the coils on the armature being connected up in regular rotation as usual. In order to find out with certainty which hypothesis was correct, the brush leads were reversed and the machine run as a motor in the opposite direction for a few minutes. Now, had the trouble been due to a break in the winding, it is obvious that reversing the direction of rotation would not alter the location of the break, and the same piece of mica would have been burned—only more deeply—as before. If, on the other hand, one of the coils on the armature was "short-circuited" in itself, as appeared likely, then the interruption in the current would occur as the commutator bar to which that coil was connected left the brush; and as it would come under the brush from the opposite side when running in the opposite direction, the mica plate on the other side of the bar would be burned. It should be pointed out here that the machine was not run for a sufficiently long period for a "short-circuited" coil to show itself by heating. The machine was accordingly run again for a short time. On stopping it and again examining the commutator, it was found that a plate of mica adjacent to the one previously damaged was burned, thus proving that a coil was "short-circuited" by having both its ends connected to the commutator bar between these two mica plates. The armature was disconnected from the commutator and tested, and it was soon placed beyond all doubt that this was the cause of the trouble.

An interesting case was that of a small motor-generator fed with 200 volts on the primary, and giving 100 amperes at 75 volts on the secondary, when running at a speed of 750 revolutions per minute. The armatures of both the machines were of the plain drum type, running in bipolar fields of the inverted horseshoe type. This machine first aroused suspicion when on the test-bed, by the abnormally large current required to run it light and by the undue heating of the primary armature. The first thing that was done was to run the primary armature with the field magnet separately excited and the brushes raised from the commutator. It still heated, and it was noticed that a bunch of keys held near to it whilst running throbbed perceptibly. This sufficed to prove that something was radically wrong with it—possibly a few "short-circuited" coils. In order to ascertain definitely whether this was so, and also in order to locate such "short-circuits," the commutator was taken off and tested for insulation between the bars, and each coil of the armature was tested for insulation from the core and from each of the other coils. Strangely enough, both the commutator and the armature came out all right in the test. In order to test whether the trouble was traceable to the core (a very unlikely event, by the way), the armature was replaced in the machine without the commutator, and with the ends of its coils disconnected from one another, and run with its field magnet separately excited, as before. That the core was not at fault was evidenced by the fact that it now ran quite coolly, and without affecting a bunch of keys held near to it. A not improbable hypothesis, suggested by the previous tests, was that the trouble was due to currents circulating in the whole of the armature winding, due to the winding being out of balance electrically. In order to test this hypothesis, the commutator was again placed in position and the armature connected up, with the exception of the two wires from one of the commutator bars, which were left loose Two separate bands of tinned steel wire were then put on the commutator, but insulated therefrom with slips of mica. To each of these bands one of the above-mentioned wires was connected. The armature was now run with its field magnet separately excited, and two brushes, which were connected to a voltmeter, were held on the two bands on the commutator, when it was noticed that the voltage between the two bands was about 10 volts. When these two brushes were connected together all the old symptoms (heating of the armature, vibration of the field, etc.), again manifested themselves, whilst when the brushes were taken off the bands they ceased altogether. This proved most clearly that the trouble was due to the armature being out of balance electrically. This want of balance was due to an unsymmetrical winding of the armature—that is, unsymmetrical as far as the end-windings were concerned—in conjunction with an excessive stray field at the ends of the armature, due to the armature being rather too short for the field magnet. The method of winding the armature, it should be mentioned, was that every alternate coil was wound in rotation, this being done until all the coils were wound. This is a simple and common method of winding, but one that is not to be recommended. Preferably, an armature should be former-wound. Failing this, it may be wound either with a "symmetrical" hand-winding, or else coils which are to be connected to opposite bars of the commutator should be wound at the same time, so as to ensure their projecting to an equal distance at the ends, and consequently being in electrical balance.

On one occasion a two-pole dynamo with a toothed drum armature gave trouble by sparking at the brushes. It ran well when on the test-bed, and appeared to be satisfactory in all respects. However, after it had been at work for some little time, every alternate bar on the commutator began to show signs of burning, and flats began to develop on them. This phenomenon was due to the way in which the armature was wound. Half of the coils on the armature consisted of one turn each, and the other half had two turns each. Thus, taking the coils in rotation round the armature, the coils were composed of alternately one and two turns each. This was probably done in order that a stock pattern of armature stampings might be used, for the armature being a toothed one, it was necessary that the number of coils on it should be some multiple of the number of teeth. Such a departure from recognised practice is sometimes resorted to in order to facilitate the manufacture; but it is to be deprecated. In the case under consideration, the fault was only remedied by remaking the armature and winding it in such a way that all the coils had the same number of turns—namely, one turn per coil. It may be mentioned, incidentally, that in designing a machine it is always well to avoid having an unequal number of turns in the armature coils. It is, however, permissible for a number of symmetrically-placed coils to be wound with fewer turns per coil than the rest, providing they do not vary from the other coils by more than 10 per cent.

Annoyance is sometimes caused by the bands on armatures giving way. This can be avoided by the simple expedient of putting, in place of each band, two narrow bands, each of half the usual width. The mica slips which insulate the bands from the armature should, of course, be sufficiently wide to receive the two narrow bands In the event of one of these narrow bands giving way, the mica slips are kept in place by the remaining band; and the armature may with safety be kept running until a convenient time arrives for replacing the broken band. It is never wise to test an armature whilst "green"—that is, before it has been baked; for, if it is run before it is thoroughly dry, it is liable to break down. An instance of this was a hand-wound drum armature; which, being wanted urgently, and in consequence tested before it was thoroughly dry, broke down through two coils which were connected to opposite commutator bars sparking to one another. It always pays to suffer the inconvenience of a little delay, rather than hurry over such an important matter as the drying of an armature.

A four-pole drum dynamo, giving 1,000 amperes at a pressure of 25 volts, once gave trouble by sparking viciously at the brushes. It was impossible by changing the position of the brushes, or by resetting them on the commutator, to remedy the sparking. "Short-circuited" armature coils usually manifest themselves by becoming abnormally hot, but in this case, although the whole armature appeared to be warmer than it should be, yet no appreciable local heating of the armature could be discovered. However, it became clear by the throbbing of a bunch of keys held near to the armature, that there was a local current circulating in one or more of the coils On making an examination of the commutator, it was found

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that two of the bars had been burred over, and thus connected together, when it was turned up. When the small piece of copper which bridged over the two bars was removed the machine ran coolly and sparklessly. The reason why the "short-circuited" coil did not show itself by heating was that the particle of copper which bridged the two commutator bars was of such a relatively high resistance, compared with the resistance of the armature coil, that it acted only as a partial "short." The low resistance of the armature coils should always be borne in mind when dealing with low-voltage generators, for it affords the key to many an otherwise difficult problem.

In the higher voltage machines a "short-circuited" armature section is readily discovered; indeed, unless great care is exercised, it may burn itself out before the machine can be shut down. A case in point was that of a 400-volt, four-pole, enclosed motor, having a former-wound toothed drum armature, which was wound with a four-pole series wave winding. On testing for the first time on the test bed four coils became excessively hot, and the insulation on them began to smoke. As in the last instance, it was clearly a case of "short-circuiting." It turned out that there were two "shorts" on the commutator. Owing to the winding of the armature being a series one, each "short" on the commutator affected *two* armature coils. In this way the two "shorts" on the commutator accounted for the "short-circuiting" of four armature coils.

(To be continued.)

MUNICIPAL TRAMWAYS.

The Birmingham Corporation is just now greatly concerned with the tramway question, as a decision as to who shall be the ultimate controlling tramway authority in the district has to be come to. The tramways companies in the town and surrounding areas are practically controlled by the British Electric Traction Company. This company strongly urges the advantages of a single control over the large system of tramways. On the contrary, many members of the Corporation favour municipal control of the system. With a view to arriving at a just conclusion the town clerk of Birmingham has obtained information from several towns where the tramways are worked by the corporations. The queries circulated were the following, and below will be found the interesting replies received:

1. Total mileage (single track) of tramways worked by Corporation.
2. Form of traction employed.
3. When working commenced by Corporation.
4. Total capital expenditure to end of last financial year.
5. Last year's working: (*a*) total receipts; (*b*) working expenses, exclusive of depreciation; (*c*) interest and sinking fund; (*d*) depreciation and reserve fund; (*e*) contribution to rates; (*f*) amount carried forward.
6. State generally any other advantages which have been derived from Corporation working—*e.g.*, improved service; reduction of fares or increased stages; improvement in hours or wages of employés; workmen's cars, etc.

Blackpool.

Length of track: About 14 miles. Traction: Electricity (overhead trolley system). Corporation working commenced: Sept. 9, 1892. Capital expenditure: £216,058 to March 31, 1902.

Last year's working: Total receipts, £41,818; working expenses, exclusive of depreciation, £28,260; interest and sinking fund, £6,649; depreciation and reserve fund, nil; contribution to rates, £3,479; amount carried forward, nil.

Note.—There are two sums, amounting to £3,430, "written off" out of revenue to defray certain expenditure of a capital nature without Local Government Board sanction.

Advantages: The advantages have been (1) a very much improved service and a very considerable extension of the ramway system; (2) a reduction of fares in the winter season; (3) the hours of employés have been shortened, the wages increased, and a general improvement in the terms of service; and (4) an improved municipal control of the traffic and the roads.

Bradford.

Length of track: 65 miles. Traction: Electricity. Corporation working commenced: Various dates from September, 1898. Capital expenditure: £419,892.

Last year's working: Total receipts, £70,214; working expenses, exclusive of depreciation, £44,559; interest and sinking fund, £17,053 (proportion of profits paid to companies as surrender value of unexpired leases, £3,877); depreciation and reserve fund, £10,015; contribution of rates, nil; amount carried forward, net deficit, £5,290.

Advantages: Generally improved service and comfort of passengers; reduction of fares; new districts opened up and increased stages; hours of employés shortened; wages of employés increased; workmen's special fares.

Glasgow.

Length of track: 103½ miles as at May 31, 1902. Traction: Overhead electric. Corporation working commenced: July 1, 1894. Capital expenditure: £2,041,035. 19s.

Last year's working: Total receipts, £614.413. 4s. 11d.; working expenses, exclusive of depreciation, £293,146. 17s. 7d.; interest and sinking fund, £96,314. 17s. 5d.; depreciation and reserve fund £111,956. 3s. (depreciation and permanent way renewal); contribution to rates, £12,500 (no rates are levied for the common good—it is the corporate estate of the city); amount carried forward, £100,495. 6s. 11d. (general reserve fund).

Advantages: Sixty miles, measured as single track, were operated by the company prior to July 1, 1894; the Corporation will shortly be operating 140 miles. In the last year of their lease the company carried 53,729,472 passengers. In 1901-2 the Corporation carried 163,678,190. The following is a comparison of the fares charged by the company with those now charged by the Corporation.

	Company.	Corporation.
½d.	—	0·58 miles.
1d.	1·12 miles	2·33 miles.
1½d.	1·80 miles	3·46 miles.
2d.	2·20 miles	4·64 miles.
2½d.	—	5·80 miles.
3d.	3·23 miles	6·96 miles.

The hours of employés have been reduced at least 25 per cent., and, in addition, the wages have been increased practically to the same extent, a net improvement of about 50 per cent. in the conditions of employment.

An ample service of early morning cars for workmen is given on all routes.

The policy of the Corporation is to give the best possible service at the lowest possible fares. In addition to paying interest and sinking fund on capital, they have always charged against revenue ample sums for depreciation as provision for renewals, and have also set aside each year a considerable sum to reserve fund. The accumulated funds from seven years' operation of horse traction have enabled the Corporation to wipe out the cost of that system and start electric traction with a capital account unburdened with any expenditure not exclusively relating to it.

Kingston-upon-Hull.

Length of track, 19 miles. Traction: Electric. Corporation working commenced: July, 1889, to December, 1900. Capital expenditure: £310,552.

Last year's working: Total receipts, £88,294; working expenses, exclusive of depreciation, £47,438; interest and sinking fund, £16.018; depreciation and reserve fund, £11,838; contribution to rates, £13,000; amount carried forward, nil.

Advantages: Very considerable advantage has undoubtedly resulted from Corporation management. Prior to that time the tramways were in the hands of a company, and each route was a single line worked by horse traction. The service was most unsatisfactory and inefficient, and it was found impossible to compel the company to properly maintain their portion of the road, as the undertaking was a losing concern, and eventually the company went into liquidation. The Corporation then purchased and reconstructed the tramways as double lines and converted them to electric traction, and the result has been a very much improved and successful service. A three-minute service is run in lieu of a ten-minute service as formerly, and the cars run longer hours (from five in the morning till midnight). The fares are the same as those charged by the company during the latter part of its existence—namely, 1d. for the whole or any part of each route, but some of the routes have been extended a little, and the longest is now a little over 2½ miles.

With regard to improvement in wages and hours, the wages of drivers under the company were 21s. per week on appointment, rising to 26s., and conductors 18s., rising to 22s. 6d. The wages of drivers now are 28s. on appointment, rising 1s. per week per year to a maximum of 35s.; and conductors, 21s., rising in the same way to a maximum of 27s. The hours of labour are now 60 per week, whereas they were 76 hours under the company.

The receipts of the company were between £200 and £300 per week, and they now amount to over £1,700 per week.

Leeds.

Length of track; 71¾ miles. Traction: formerly electric, horse, and steam; now all electric. Corporation working commenced: Feb. 2, 1894. Capital expenditure: £898,454. 5s. 9d.

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Last year's working: Total expenditure, £224,294. 1s. 9d.; working expenses, exclusive of depreciation, £130,451. 18s. 3d.; interest and sinking fund, £32,902. 14s. 10d.; depreciation and reserve fund, £12,475. 12s. 9d.; contribution to rates, £41,000; amount carried forward, £7,241. 5s. 11d. Total profits transferred to relief of rates to March 25, 1902, £45,580. 17s. 9d., plus amount transferred to current rate, £41,000—£86,580. 17s. 9d.

Advantages: The maximum number of cars in use in Leeds at February, 1894, when the system was taken over by the Corporation, was 68; now there are 245 in use, and belonging to the Corporation. The fares have been reduced about 40 per cent. by giving increased distances. The wages of drivers and conductors have been increased by 52 per cent. and 58 per cent. respectively, whilst the hours worked have been decreased by 17 per cent. In addition, there are now granted uniforms, week's holiday with pay, and to drivers in addition a bonus of £2 per year for keeping clear of blame for accidents. There is also an increase of 100 in the number of workmen's cars, the fares on which have been reduced in the same proportion as the ordinary fare.

LIVERPOOL.

Length of track: 100 miles electric, 1 mile horse. Corporation working commenced: Sept. 1, 1897. Capital expenditure: £1,749,428.

Last year's working: total receipts, £474,508; working expenses, exclusive of depreciation, £327,451 (including £19,157 for maintenance of lines and overhead equipment); interest and sinking fund, £95,799; depreciation and reserve fund, £35,215; contribution to rates, £17,607.

Advantages: Since the Corporation took over the undertaking of the Liverpool United Tramways and Omnibus Company in 1897 the length of track has been increased from 68 to 101 miles, and constructed or reconstructed for electric traction. At that time there were 267 horse cars and omnibuses in service. Now there are 400 electric cars constantly running on 21 routes to all parts of the city. The fares have been reduced nearly 100 per cent., and passengers are now carried an average distance of 2½ miles for 1d. in or out, the fare charged in the old company's days being 2d. for the same distance outside and 3d. inside. The service of cars averages three minutes on all the routes. Under the old company the hours worked by their employés averaged nearly 14 per day. The wages of drivers averaged 3½d. to 4¾d. per hour, and of conductors 3¼d. to 3½d. per hour.

Under Corporation management the hours are in no case more than 10 per day, and the rate of pay is 5d. to 6d. for conductors and 6d. to 6½d. for drivers, in addition to 1s. per week merit pay after 10 years' service. Summer and winter uniform is also provided free. Mess and entertaining rooms are provided at the depôts for the use of the men. There is also a benefit society, to which the Corporation contributes 33⅓ per cent. of the subscriptions, having a membership of nearly 1,600. The society provides for the relief of members in case of sickness or accidents, medical attendance and medicine, death payments, grants, and such other payments as the committee of management may determine. In 1897, the last year of the company's management, the number of passengers carried was 36,409,084, the mileage 6,013,182, and the receipts £290,743, and for the year ended Dec. 31, 1901, the number of passengers carried was 101,108,780, the mileage 10,970,063, and the receipts £468,383, showing a percentage increase of 1901 over 1897 as follows:

	Per cent.
Passengers	163·2
Mileage	82·4
Receipts	61·1

An early morning service is provided on all routes, by which workmen travel as ordinary passengers, paying at the rate of less than ½d. per mile, which is lower than the statutory fares fixed for workmen's cars.

MANCHESTER.

Length of track: 25 miles (will eventually be about 150 miles). Traction: Overhead electric (a short section worked by horse traction). Corporation working commenced June, 1901. Capital expenditure: £603,332 (including works in course of construction).

Last year's working (10 months only): Total receipts, £91,830; working expenses, exclusive of depreciation, £64,207; interest and sinking fund, £16,145; depreciation and reserve fund, £10,600; contribution to rates, £20,000; amount carried forward, nil.

Advantages: The service generally has been improved and fares reduced. On certain routes ½d. fares have been introduced. The hours and wages of employés have been rearranged to the benefit of the men.

CITY AND COUNTY OF NEWCASTLE-UPON-TYNE.

Length of track: 35·4 miles of single track. Traction: Electric overhead trolley. Corporation working commenced: Dec. 16, 1901. Capital expenditure: £673,338 to end of financial year, on March 25, 1902.

Last year's working: The tramways have only been working nine months, and therefore a complete year's details cannot be given, but there will be a substantial balance in hand at the end of the year.

Advantages: A very much improved service is now given as compared with the facilities the company used to give in the town. The frequency of service has in some cases trebled, and in some cases increased 10 times. The speed is greater. The fares have been decreased 50 per cent. The hours of the employés have been decreased, and a heavy service of workmen's cars provided, carrying workmen a distance of five miles for 1d. or a mile for ½d.

SHEFFIELD.

Length of track: Electric, 43 miles; horse, four miles. Traction: Overhead trolley and horse. Corporation working commenced: Electric, Sept. 4, 1899; horse, June 11, 1896. Capital expenditure: £803,221.

Last year's working:—Total receipts: Electric, £175,575; horse, £16,262; working expenses, exclusive of depreciation, electric £105,481, horse £15,590; interest and sinking fund, electric and horse, £35,648; depreciation and reserve fund (depreciation only), electric £818, horse £1,689; contribution to rates, £5,000, making total contribution to rates to date £27,000; amount carried forward, £71,886 accumulated surplu (after paying all liabilities, including interest, sinking fund, maintenance, up-keep, repairs, and renewals out of revenue) to provide for contingencies.

Advantages: When the Corporation took over the working of the system there was only 18 miles of single track worked by horse traction. The lines have since been converted to the overhead trolley system with the exception of one route; numerous extensions have been made, and other extensions are authorised and will be made in the near future. The cars were under the company run at intervals of 10 to 15 minutes. They are now run on a majority of the sections at intervals of from 2½ to 5 minutes. The fares have been reduced by fully one-half their former amount. The cars are run as long a distance as three miles for 1d., and there are short stages at ½d. fares. The hours of the employés have been shortened. They are now allowed time for meals, which was not formerly the case. Their wages have also been considerably increased. A system of workmen's cars has also been instituted.

SOUTHAMPTON.

Length of track: Twelve miles (about). Traction: Electric overhead trolley. Corporation working commenced: July 1, 1898 (date of transfer from company to Corporation). Capital expenditure: £150,608. 2s. 6d.

Last year's working: Total receipts, £45,168 19s. 2d.; working expenses, exclusive of depreciation, £28.735. 16s. 9d.; interest and sinking fund, £6,073. 1s. 11d.: depreciation and reserve fund, £2,516. 18s. 4d.; contribution to rates, £5,000; and carried forward, £5,864. 13s. 4d.

Advantages: As regards the financial aspect, the enclosed abstract is, I think, the best evidence of the successful working of the undertaking by the Corporation. (It must be borne in mind that since 1898 the whole of the permanent way has had to be reconstructed throughout to allow of the substitution of electric for horse traction). Amongst other advantages which have followed the transfer of the undertaking to the Corporation are: an incomparably quicker and more reliable service generally, the greater comfort and care of passengers, the introduction of 1d. sections, a greatly improved system of workmen's cars, extensions of the tramways in all directions, and shorter hours and better pay for the employés.

FORTHCOMING EVENTS.

FRIDAY, OCT. 17.

Institution of Mechanical Engineers.—At 8 p.m., first monthly general meeting. Paper: "Oil Motorcars of 1902," by Captain C. C. Longridge.

SATURDAY, OCT. 18.

Municipal and County Engineers.—District meeting at King's Lynn.

TUESDAY, OCT. 21.

Institution of Junior Engineers.—At 2 p.m., visit to the London Bridge widening works.

APPOINTMENTS VACANT.

Chief Electrical Engineer, Glasgow Corporation Tramways, £500 per annum, Oct. 22.

Testing Assistant, Public Health Department, Corporation of London, £200 per annum. See advertisement.

Various Workmen, Meter-Testing Department, Corporation London, from 4d. to 8½d. per hour See advertisement.

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THE

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CONTENTS.

Notes	541	Aberdeen Electricity Undertaking	563
Municipal Engineers at Aldershot	546	Trade Notices and Novelties	564
Manchester Municipal School of Technology	550	New Companies Registered	564
Electric Lighting Returns—Company v. Municipal	551	Greenock Electricity Accounts	565
The Smokeless Combustion of Bituminous Fuels	552	East Ham Electricity Accounts	565
Leaves from a Testing Engineer's Notebook	554	Legal Intelligence	565
Municipal Tramways	556	Contracts for Electrical Supplies	565
Forthcoming Events	557	Traction Notes	567
Appointments Vacant	557	Lighting Notes	571
The Truth *re* Municipal Undertakings	558	Provisional Patents, 1902	574
Correspondence	559	Companies' Stock and Share List	575
Questions and Answers	560	Traffic Returns	576
		Supplement: Distribution of Energy for Tramway, Lighting, and Power Purposes	1-8

TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed*

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THE TRUTH RE MUNICIPAL UNDERTAKINGS.

Although protestations are made to that effect, it is not quite credible that controversialists always desire to arrive at the truth. We have often preached caution in forming conclusions from figures given without supplemental information. It is an old wheeze to say there is nothing so misleading as figures except facts, but the saying has the merit of being true. Perhaps some people wonder what is meant when they are told that facts often lead to wrong conclusions. The explanation is simple, and it is that *all* the facts pertaining to the subject are not stated, and therefore, not taken into consideration. This is just where municipalists and anti-municipalists fail to get nearer to a common agreement. In controversy the latter put forward figures to prove their case; the figures are perfectly accurate and the statements are perfectly truthful, yet the conclusions arrived at are incorrect. We shall concern ourselves here with the question of costs. These as a rule can hardly ever be comparable, because the conditions existing in any two or more cases are not the same. If we examine the central stations of companies as erected throughout the kingdom, we shall find that some built and equipped a few years ago are working under more unfavourable conditions than those erected this year. Similarly as regards those of municipalities, therefore, neither in the cost of installation nor in the cost of generating the electrical energy can these dissimilar stations be compared. Yet comparisons are made every day, and no doubt fairly made, by those experts who are capable of making proper allowances and estimating their true value, but these comparisons are most misleading to the general public. Probably there is no method of comparison that will lead to absolutely true results, but we think the nearest approximation to the truth between municipal and company working is found by averaging the results of a large number of undertakings. This has been done and the result given in another column, showing favourably to municipal working. This result could have been foretold, and is, in fact, in accordance with theory. It is almost inconceivable that a municipality should embark upon experimental work. The citizens would never endure the large expenditure of money in order to obtain a problematical success. Thus it is only after private individuals have experimented and proved something to be successful that a municipal body can accept it. Their work, if undertaken, must therefore be more perfect than the earlier work undertaken by private adventurers, who had to gain experience from failures and from successes. In electric light work this is the history—private individuals experimented, tested, and proved the value, the economical value, of such lighting. Even then the municipalities were hard to convince, and when convinced utilised the knowledge and experience gained at the expense of the private individuals. From the very first moment of any industry, to the time of speaking or writing, there is progress towards perfection, hence the earlier works are less perfect than the later. It may be said in the particular case of electric lighting that the later company stations are in the same position as the municipal stations. That is so, and these stations should show to advantage in all ways as regards economy. There is another reason why comparisons without qualifications are—or should not be—convincing. The work will not be undertaken by municipalities where there is not much doubt of success, hence the companies will have to work only in such places where this doubt exists, or in smaller places where economy cannot equal that of the larger and more favourably situated places,

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The moral of the whole matter is that no general conclusions can be drawn from individual results, and that the averages obtained by considering a large number of stations should only be received as a guide towards results to be obtained, and around which individual results will fluctuate according to the favourable or unfavourable conditions prevailing. The great question of municipal action, therefore, should not be made to depend upon a comparison of figures, but upon some other principle not involving the drastic method of waiting upon other folks' experience.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BOLTON TRAMWAY DEPRECIATION.

SIR,—Mr. Alderman Smith, the chairman of our Tramways Committee, has called my attention to your copy of Mr. Morgan's report and to the letter signed "P. T." in this week's issue I had the most to do with the tramway depreciation in Bolton, after consultation with both Mr. Day, our electric engineer, and Mr. Morgan. At that time I was in conflict with the Inland Revenue Department for a serious increase of the allowance made in the taxable item of our profits which had to be put on one side for the relaying of our old horse track. "P. T." is labouring under a serious misapprehension. I quite accept the accuracy of his calculations, but we in Bolton include one-thirtieth of the tramway's debt (repayment of loan) in the 8 per cent. depreciation written off capital. Now, this is what "P. T." evidently did not understand.

I think possibly the enclosed correspondence between myself and the accountant of the Glasgow tramways will put the matter in a clear and simple form; they seemed to think we did not put aside enough for depreciation. At all events "P. T." will see that one-thirtieth of £6,046 must be added to his figure of £217, and Mr. Morgan's estimate of 8 per cent. is only slightly in excess of this, and it all may be needed. I said in my letter to Glasgow that 8 per cent. was a full depreciation, including sinking fund. I trust your readers will now appreciate that we in Bolton do *not* neglect "the important item" which, in "P. T.'s" opinion "completely changes the conclusion arrived at."—Yours, etc.,

GEO. SWAINSON, F.L.S., F.S.A.A., Borough Treasurer.

Town Hall, Bolton, Oct. 14, 1902.

COPY CORRESPONDENCE *re* TRAMWAYS DEPRECIATION.

Corporation Tramways, 88, Renfield-street, Glasgow.
8th October, 1902.

Geo. Swainson, Esq., Town Hall, Bolton.

Dear Sir,—Many thanks for your letter of the 7th inst., and for copies of reports just received. I shall try and get you a copy of the bound volume of Glasgow accounts. They will not be ready for some time yet. On p. 78 of your tramway accounts you have charged revenue with £16,298, being the amount written off your assets for depreciation. But out of this amount you have taken your annual sinking fund charge of £10,061. 15s. 8d., which, of course, you cannot reborrow. This leaves a balance of £6,236. 4s. 4d. I am sorry to trouble you in this matter, but I should like to know if you consider this sum of £6,236. 4s. 4d. as the annual amount necessary to replace the assets at the end of their life. From our report you will see that we keep our depreciation quite distinct from our sinking fund, and we lay aside the full depreciation which we consider necessary, and charge revenue with the year's sinking fund in addition. I should like to have your opinion on this point.—Yours truly,

(Signed) JAS. DALRYMPLE, Accountant.

Town Hall, Bolton, Oct. 9, 1902.

Dear Sir,—I beg to acknowledge the receipt of your letter of the 8th inst., and beg to say in reply that, in my opinion, you separate in the Glasgow tramway accounts *as distinct* two things that ought to be one and the same. Parliament originally used the technical term "sinking fund" in connection with municipalities and district councils with the same idea underlying it that exists in connection with the National Debt. It is only another illustration of the need there is in Parliament for more technical accountancy knowledge. The accountancy profession has never been represented in Parliament like the army, the navy, the law, or even medicine. What is there in common between the repayment of the debt of the markets, waterworks, or town hall, and the cost of the Transvaal War or any other item of the National Debt? The fact is that Parliament resolves that the municipality should be practically presented at the end of the loan period with a magnificent supply of water gratis without a penny of debt upon it, and the same with the town hall; but this latter is more excusable, as the town council ought to own its own official building. I have always asserted that in reference to waterworks this is unfair, and I made it an important part of my inaugural address when elected first president of the Treasurers' Institute at Nottingham in 1896, *that the bulk of a waterworks debt should be permanent*, for a waterworks will be more valuable at the end of 60 or 80 years than it is now. The reservoirs will be better consolidated, and if the line of pipes is renewed out of revenue when required, as is our practice, the water undertaking will be worth every penny that it cost; but now it will be handed over without a penny of debt upon it to the ratepayers of that period. With respect to the war debt, you have eaten your cake, or rather destroyed it, to begin with, and you will have nothing left of value at the end of the period except prestige to hand over to your successors, yet Parliament adopts the same methods. Well, all that we can do in our little way is to correct the mistaken idea. Therefore I propose to depreciate our tramways undertaking as fully as reasonable.

In reply to your query, "do we consider this balance of £6,236 as the annual amount necessary to replace the assets at the end of their life?" I reply, *certainly not*. If you will look at p. 494 of the *Electrical Engineer* for last week, you will find our borough engineer's report on our tramways depreciation, and from that I think you will gather that the £16,298 will be *more than* sufficient for depreciation, for I take it that when the debt is paid off and it is found necessary to again relay the track, Parliament or the Board of Trade will sanction the fresh borrowing powers needed for the cost of relaying the track if the increasing revenue will not suffice; but I am quite certain that the depreciation we take will be ample to cover the ordinary wear and tear of everything, including cars, electrical equipment, and the track, etc. I understand, however, that in Glasgow the amount you call depreciation is being criticised *as insufficient*, but if you add the amount of your sinking fund repayments to the depreciation you will get a figure that everyone will admit is quite ample for depreciation. The Board of Trade has allowed you 30 years for your sinking fund, and if you take the life of the concern as any way between 10 and 20 years, and provide sufficient depreciation, you will see at once that you are able to pay off the debt 10 years, it may be, before its time, and, therefore, you have a good case to go to Parliament or the Board of Trade for power for any further expenditure on capital.

I can give you a slight illustration of how this works in practice in connection with our waterworks. If you will turn to p. 42 of my abstract of accounts for the year ending March 31, 1901, you will see £5,283 written off the excess of assets, being the cost of the old Chorley-road main. This main was laid 40 years ago, and the loan for it having been entirely repaid, the Local Government Board gave us a fresh sanction, Feb. 1, 1899, for £7,466 for a new and enlarged main, repayable in the following 30 years, but I deduct the value of the old main from the capital. That is exactly what I would do in respect of the tramway track. Again, this year we propose to relay our Farnworth water-main, and the cost of this main having been fully repaid, the Local Government Board in January last gave us power to reborrow £8,600 as if it were an entirely new main to Farnworth. Of course, I shall take care when adding the £8,600 as new work to capital account

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to depreciate the capital by the exact cost of the original main laid—some £5,000. I have been driven, as you know, to consider this matter thus fully both in waterworks and tramways owing to the refusal of the Inland Revenue authorities *to allow any depreciation in respect of sinking fund repayments*, but when you claim and submit these repayments *as depreciation* they are compelled to allow the deduction. Of course, in waterworks they refused to admit that there was any depreciation in the undertaking except for renewal of mains, and as these two large mains were charged to capital, this is the only way I have of showing the depreciation and obtaining the allowance of tax accordingly. I have written you thus fully in answer to your queries to explain why it is that we in Bolton, adopting the Glasgow depreciation, do not adopt the Glasgow method of dealing with the tramways sinking fund.—Yours truly, GEO. SWAINSON.

James Dalrymple, Esq.,
Accountant, Corporation Tramways,
88, Renfield-street, Glasgow.

Corporation Tramways, 88, Renfield-street, Glasgow.
Oct. 10, 1902.

Geo. Swainson, Esq., Town Hall, Bolton.

Dear Sir,—Many thanks for your very interesting letter, which I shall look at very carefully. I have also to thank you for the copy of Mr. Morgan's report.—Yours truly,
(Signed) JAS. DALRYMPLE, Accountant.

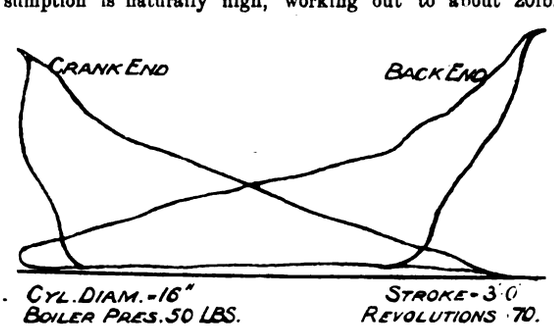
QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

525. The accompanying diagrams were taken from a horizontal non-condensing engine cylinder, 3ft. stroke and 16in. diameter. The boiler pressure is 50lb. per square inch, the indicator spring used $\frac{1}{8}$, and number of revolutions per minute 70. The coal consumption is naturally high, working out to about 20lb. per



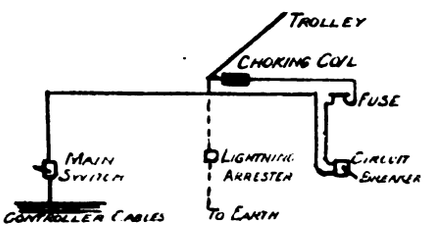
indicated horse-power per hour. The slide valve is a simple D type, and the governors, which are driven by bevel gearing from the crankshaft, actuate an ordinary double-beat valve inserted in the steam main. State defects and possible remedies for same.—BARON.

N.B.—The diagram has been reduced somewhat in reproduction. The extreme height of the diagram at the back end was $1\frac{11}{16}$in. above the atmospheric line in the original.—Ed. *E. E.*

526. A number of motor-type meters for tramway feeders are arranged in a horizontal row. It is found that the current in each meter has a slight effect on its neighbours, causing them to run a little faster. How can this effect be remedied without altering the position of the meters?—M. W. K.

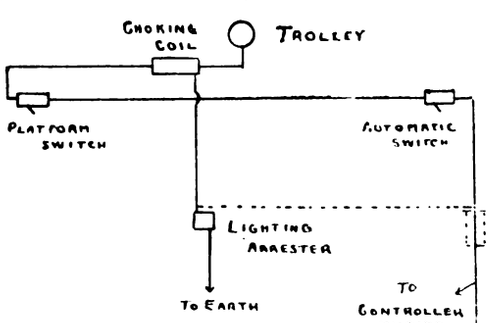
ANSWERS.

Question No. 519.—According to an illustration of the Preston car in your issue of Sept. 25, 1901, the current, after leaving the choking coil, evidently passes through the main fuse first, and thence through the circuit breaker and main switch as above. Is this correct, as when attending to the fuse it would be of no use opening the main switch (as is always done), the current being cut off at the controller; and, further, unless he took the trolley off, the



driver might stand a chance of receiving a shock, particularly in wet weather. According to other illustrations, the connection to the lightning arrester is taken off beyond the main fuse and circuit breaker, and apparently the lightning must pass through these before being diverted to the earth. This, I think, must be incorrect, as the lightning should blow the fuse or switch. Does the current usually pass through the fuse or circuit breaker first?

Answer to No. 519 (*awarded 7s. 6d.*).—We will first consider the question of the fuse. It would be very bad practice, indeed, to place the fuse in such a position that the current would have to pass through it before either the main or automatic switches, as it is more than likely that the person replacing a blown fuse would, as indicated by the question, receive a nasty shock, unless the trolley was "off." If the power circuit is fused at all, it should most decidedly be between the platform switches and the controller wiring, so that the switches may be opened, or at least one of them, before replacing fuse. It is not, however, now usual to have a fuse at all in the car power circuit, as a well-made adjustable automatic maximum-current circuit breaker answers the purpose even better than a fuse, and is decidedly less trouble. For example: supposing an excess of current is taken on a greasy up gradient, causing the automatic to open, it would be decidedly better and safer in every way to have only that to close than "messing about" with a fuse, besides being much handier to either motorman or conductor. Now, as to the true position of the lightning arrester. The connection shown in the diagram given by "F F. S." is, in my opinion, the correct one; because if taken off beyond



the main and automatic switches (as I have seen done in many cases of car wiring), the lightning discharge would have to pass through the magnet coils of the automatic switch, and there would offer a certain amount of impedance to the discharge, and much damage might result before finally passing to earth. The diagram is, in my opinion, the best method of wiring, and the dotted lines show a common method of connecting the lightning arrester, as mentioned above.—M. H. VOLK.

Answer to No. 519 (*awarded 7s. 6d.*).—Like "F. F. S.," I have often noticed in these diagrams that the instruments are sketched in without any apparent thought of their use, and which if wired in the order shown certainly does not tend to efficient working. Many engineers consider fuses a nuisance at the best, and think that if put in the circuit at all any place is good enough. Now, unlike a switch (which is used to break the circuit usually with the normal load), the fuse is required to perform the same function when an excessive current flows, and, therefore, this humble piece of apparatus deserves more consideration than it

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usually gets. In the diagram shown in the question the fuse was placed so that even with the circuit broken at the switch, circuit breaker, and controller, the attendant in renewing the fuse was still liable to get a shock. Similarly with the choking coil, this is placed wherever there is room for it in the sketch, but if the circuit breaker was required to convey a lightning discharge, I am afraid it would have

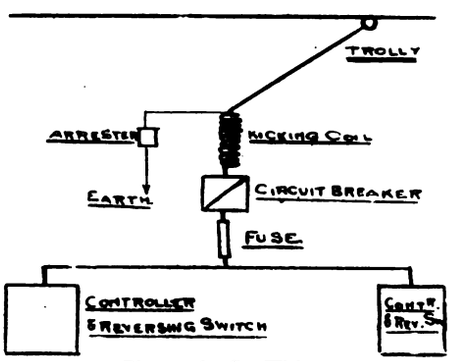

Diagram for Car Wiring.

a very hard time of it. The above diagram I think much simpler and more effective than most of them, and does away with the switch, which is not only a saving, but it also keeps the circuit breaker in better working order. By tripping the circuit breaker the fuse can be handled with safety, which would not be the case were it placed on the other side of circuit breaker.—SPARKLETT.

Answer to No. 519 (*awarded* 5*s.*).—In considering the question as to the correct position of the fuse in the wiring circuit, as given in the diagram, it will be advisable to note its real function. Given the position shown is the correct one, we have (1) that it will act as a safeguard on a short-circuit in the event of the circuit breaker failing to act; (2) that in case of the circuit breaker requiring attention, it can be given without taking the trolley off the wire and without risk by simply taking out the fuse. It is the rule in electric lighting work to place the fuse before the switch for this same reason, though, of course, the switch is turned off before a fuse is replaced. If the fuse were placed anywhere else in the circuit it would still act as in the first case given above, but not for the second purpose. There is no reason to say, then, that the position in the circuit in which it is shown is incorrect. The connection for the lightning arrester should be taken from the circuit before entering the choking coil. In one case it is taken from the positive terminal of the choking coil itself, thus saving joints on the cable. From the diagram it appears that this is what is intended, but, owing to a slight error in the drawing, the lightning arrester lead seems to be taken from the circuit beyond the circuit breaker. It might be mentioned that in replacing the circuit breaker or the fuse it is advisable to have the main switch off; thus in the event of the "short" still being "on," the circuit breaker will act more rapidly when the main switch is turned on.—E. T. W.

Answer to No. 519 (*awarded* 5*s.*).—In arranging the wiring of cars one does not usually have ideal conditions to deal with. Probably, also, one is not particularly careful to even aim at the fulfilment of the ideal circuit, because the working conditions are so entirely different from those obtaining in lighting work. In traction work generally fusible cut-outs are not of much real practical use, so that when employed they are used generally on those parts of the system where the current fluctuations are not very great, or they are used in conjunction with magnetic blow-outs as a duplicate safety device, which will act in the event of the magnetic blow-out failing from any cause if an injuriously high current be maintained through the circuit for an appreciable time. As one does not wish the fusible cut-out to work except in cases of emergency, it is usual in practice to put in a wire which will fuse at some current higher than that at which the magnetic blow-out will act. A little thought will show how inconvenient it would be, and how great the loss of time, if the motorman had to go through the process of replacing a fuse on his car when on service, as it is not an uncommon occurrence for the magnetic blow-out to act, especially on hilly tracks, where stoppages are frequent and the service also frequent. In such cases one or two minutes' delay would probably upset the whole service on that route to such an extent that it would take several hours to recover the lost ground. Under such circumstances, therefore, the position of the fusible cut-out in the circuit is not of great importance, as it will never act under normal conditions, and if it does act then it is an indication generally that something has gone wrong, and the sooner that particular car is taken out of service and overhauled the better. Thus it will be seen that the position in the circuit of the fusible cut-out is generally determined by its position on the car. Some people put the fuse under the canopy, if its design will permit; others put it under the platform or under one of the seats—in fact, in any place which will give the easiest method of wiring and entail the least amount of special work in the mouldings of the car. The same remarks apply generally to the position of the lightning arrester and its choking coil. In this country, at any rate, the occasions upon which lightning affects the cars are not very numerous nor very authentic, as, generally speaking, it has a path of less resistance to earth through the trolley wire and lightning arresters in the feeder pillars. One's experience is that traces of lightning discharges are more often found in feeder pillars than on cars, and this being so, convenience and cheapness are regarded as the ruling elements in defining the position of the choking coil in the circuit.—ALPHA.

Question No. 520.—What is the simplest method of finding out what kilowatts are likely to be generated by a small river, using turbines or Pelton wheels, supposing no waterfall available, but river course very steep and easy to dam?

Best Answer to No. 520 (*awarded* 10*s.*).—The first thing to do is to ascertain the volume of water, in cubic feet, that is passing along the river per second. This is done as follows: Construct a weir (as in Fig. 1), chamfering the

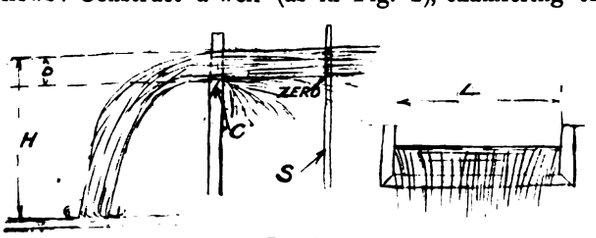

FIG. 1.

edges as shown at C; place this vertically in the river bed. Now take a staff and place it in the river above the weir, in a vertical position, where the water is as still as possible. This staff is shown at S in the sketch. Mark off this rod in feet and decimals of a foot, beginning with its zero level with the bottom of the weir, as shown above. Now, the quantity of water passing is found by the following equation:

$$Q = \frac{2\,C}{3}\,(L - \cdot 2\,D)\,D\sqrt{2\,g\,D}$$

$$= \cdot 4146\,(L - \cdot 2\,D)\,D\sqrt{64 \cdot 4\,D} \quad . \quad (1)$$

Q = quantity of water passing in cubic feet per second; L = length of weir in feet, not less than one-third width of river; D = depth of water over weir, as measured by staff, S, in feet; C = ·622; g = 32·2.

The next thing is to measure total head, H, in feet; this is done by the ordinary operation of levelling.

If H = head of water in feet (H in sketch); Q = cubic feet flowing per second; G = weight of a cubic foot of water in pounds = 62·4; and P = gross power of fall in foot-pounds per second, then

$$P = H\,Q\,G \quad . \quad . \quad . \quad . \quad . \quad (2)$$

If you divide this by 550 foot-pounds per second, you get the gross horse-power thus:

$$\text{Gross horse-power} = \frac{H\,Q\,G}{550}.$$

Practical results from good turbines show that the efficiency is about ·8 or 80 per cent., so that the actual horse-power you are likely to get at the shaft of the turbine will be

$$\text{Actual horse-power} = \text{gross horse-power} \times \cdot 8.$$

From a well-made dynamo of about 100 electrical horse-

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power (E.H.P.) you can expect an efficiency of 91 to 93 per cent. according to the type of machine you employ (this figure reaches 95 per cent. and over in large dynamos of good design, say 500 kw.). This gives you a combined efficiency of about ·73 to ·745, so the electrical horse-power developed will be

$$\text{E.H.P.} = \cdot73 \text{ to } \cdot745 \times \text{gross horse-power.}$$

Total kilowatts (KW.) possible will then be

$$\text{KW.} = \frac{\text{E.H.P.} \times 746}{1{,}000}.$$

The above reasoning applies equally well to other types of water motors, except that the combined efficiencies will vary. I give the efficiency of the various types of wheels below, also the combined efficiency that may be expected. It will also be found that where it is necessary for speed to employ shafting or gearing, there will be a further loss of from 6 to 10 per cent. The following table gives the efficiencies, taking the theoretical power of fall given in equation (2) as 1·00 :

Type of wheel.	Efficiency.	Combined efficiency, taking dynamo at ·93.
Undershot	·27 to ·4	·25 to ·36
Low breast	·45 to ·65	·42 to ·6
High breast	·6 to ·8	·56 to ·74
Overshot	·6 to ·68	·56 to ·63
Poncelet	·6	·56
Pelton	·8 to ·87	·74 to ·81
Turbines	·7 to ·8	·65 to ·74

—H. K. P.

Answer to No. 520 (*awarded* 5*s.*).—In order to determine the power obtainable from a stream, it is first necessary to know the weight of water passing per second and the head of water—*i.e.*, the difference in level between the surface of the water in the dam and the turbine or waterwheel. The available head of water must be determined either by levelling or by a direct measurement on the spot where the dam and turbine are to be situated. The weight of water available is best obtained by erecting a temporary weir in the river and determining the volume of water passing over it by means of the following formula :

$$Q = 5{\cdot}35\ c\ b\ h\ \sqrt{h};$$

where Q = the volume of water available in cubic feet per second ; b = the breadth of the rectangular notch in the weir, in feet (see Fig. 1) ; h = the height, in feet, of the surface of the water above the bottom of the notch, measured some distance from the weir ; C is a variable $= \cdot57 + \frac{b}{10\,B}$ for values of $\frac{b}{B}$ lying between $\frac{1}{4}$ and 1 ; B = the whole width of the stream at the weir (Fig. 1).

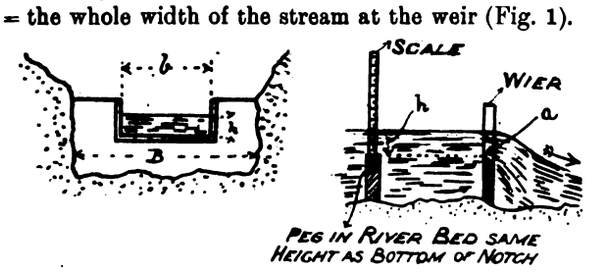


Fig. 1.

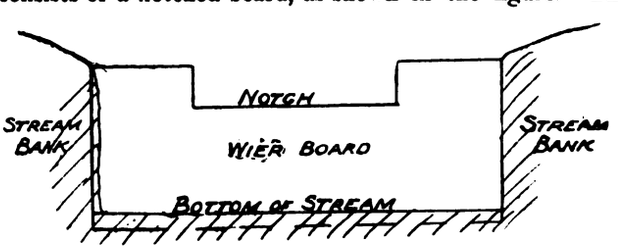
For reliable results the opening, b, should not be less than $\frac{1}{4}$ B, and at the same time it should not be so long as to make the height, h, less than about 6in. The scale for measuring h should be placed a few feet from the weir, so as to be unaffected by the small depression in level which always occurs just before the weir. Further, the opening of the weir should have its edges bevelled to a sharp angle on the side facing the current (see *a*, Fig. 1). There are various other ways of measuring the volume of water passing—*e.g.*, by the determination of the area of the stream at a given point, and its average velocity by means of a number of readings at various depths with a water velocity meter, or by the determination of the area of sluice opening necessary to just maintain a constant level. In the case of small streams, however, the weir method described above is the most satisfactory.

Having determined the minimum quantity of water, Q, in cubic feet per second available during the dry season, and the head of water, H, in feet above the turbine, the water horse-power is found by the formula :

$$\text{W.H.P.} = 62{\cdot}5 \times Q \times H \div 550,$$

there being 62·5lb. of water in a cubic foot, and 550 foot-pounds per second, corresponding to 1 h.p. This W.H.P. figure, multiplied by the efficiency of the turbine (about ·8) and by the efficiency of the dynamo (·85 to ·95), and by $\frac{746}{1{,}000}$, gives the number of kilowatts available at the terminals of the dynamo.—Q.

Answer to No. 520 (*awarded* 5*s.*).—The question in the form in which it is put is rather unique, as neither rivers, turbines, nor Pelton wheels are in the habit of generating kilowatts. This is usually left for dynamos, as it is considered to be their special function. The questioner evidently requires to know what are the maximum kilowatts which can be obtained from a dynamo driven off a turbine or Pelton wheel, the motive power being derived from the river. The question here is a little vague. We do not know if the electrical power is required continuously during the whole 24 hours of each day, or only during a part of this period. The fact that stress is laid on the possibility of damming the stream indicates that the latter is the correct interpretation. In either case, the first steps to be taken will be the same. The value of the electrical horse-power which can be generated will depend entirely upon the mechanical horse-power which can be obtained from the stream This can be readily found by calculating the volume of water flowing per given time and the amount of fall which can be utilised. To find the volume of water it is necessary to fix a weir-board in the stream. This consists of a notched board, as shown in the figure. The



notch must be wide enough and deep enough for all the water to flow through it, and if accurate results are required, the board must be so fixed that all the water flows through the notch and none escapes past the sides of the board. The width of the notch being known, the depth of the water in the notch must be carefully measured. The best way to do this is to fix about a yard up stream a rod having the bottom of the notch marked on it The height of the water above the bottom of the notch can then be readily measured. Having obtained the width of the notch and the level of the water above the bottom it is easy to obtain the volume of water flowing. All that is necessary is to consult such a table as that given in "Clarke's Pocket-Book." Here the depth of water in inches on weir is given in one column, and in the parallel column is given the quantity of water in cubic feet which will flow per minute per inch of width. The following extract is taken from this source :

Depth on weir.	Discharge per minute per inch wide.	Depth on weir.	Discharge per minute per inch wide.	Depth on weir.	Discharge per minute per inch wide.	Depth on weir.	Discharge per minute per inch wide.
1	·40	2½	1·59	4	3·22	5½	5·18
1⅛	·43	2⅝	1·71	4⅛	3·29	5⅝	5 36
1¼	·55	2¾	1·83	4¼	3·52	5¾	5·54
1⅜	·65	2⅞	1 96	4⅜	3·68	5⅞	5·72
1½	·74	3	2·09	4½	3·83	6	5·90
1⅝	·83	3⅛	2·16	4⅝	3·99	6⅛	6·00
1¾	·93	3¼	2·36	4¾	4·16	6¼	6·28
1⅞	1·03	3⅜	2·50	4⅞	4 32	6⅜	6·47
2	1·14	3½	2·63	5	4·50	6½	6·65
2⅛	1·19	3⅝	2·78	5⅛	4·58	6⅝	6·85
2¼	1·36	3¾	2·92	5¼	4·84	6¾	7·05
2⅜	1·47	3⅞	3·07	5⅜	5·01	6⅞	7·25

If the water has a greater depth than 6⅞in. in the notch, the volume of the water flowing can be found by referring to the table in a pocket-book. The way of using the above table is this : Suppose that the notch is 7 2in.

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wide, and the level of the water in the notch is 3⅜in., by referring to the table we find that for every inch of width 2·5 cubic feet of water flows over the weir-board when the level of the water in the notch is 3⅜in. Hence, if we multiply 72 by 2·5, we get 180 cubic feet, which is the quantity of water which flows per minute down the stream. Now, to find the horse-power this represents, we must multiply its weight, which is 11 250lb. (in measurements of water power the weight of a cubic foot of water is taken as 62½lb.), by the height available, say in this case 100ft. This will give us the foot-pounds per minute. Dividing by 33,000 we get the answer $11,250 \times 100 \div 33,000 = 34$ h.p. approximately. To convert this to kilowatts we must multiply by 746 and divide by 1,000, which gives us 25·4 kw. approximately. From such a stream this number of kilowatts will not be obtained, however. In the first place there will be a loss of power due to friction in the pipes; then there will be a loss in the turbine, the efficiency of which may be anything between 70 to 85 per cent.; and, finally, there will be a loss in the dynamo, the efficiency of which may be 90 per cent. Taking the efficiency of the pipes and turbine as 75 per cent., and that of the dynamo as 90 per cent., we get as our final result 18 kw. as the total kilowatts that can be generated continuously.

Attention must be paid to the point that our English streams are all very much dependent upon surface water, and rapidly rise after a shower, falling again with dry weather; hence it is not sufficient to make one test only. On the contrary, repeated tests should be made, spread over a long period of time, say six months. If greater power is required for a part of the day only, the water may be collected in a dam and the outflow increased during the desired period. In this case care must be taken not to infringe any existing water rights. Although "D. E. McD." has a perfect right to utilise the water which flows through his property, he may not injure any person using the water lower down on the stream, so that if he intends to dam the stream in any way so as to accumulate the excess water due to freshes or to save the water flowing at one period of the day for use at another, he should engage a solicitor to see what are his water rights and what amount of compensation water he must allow to flow continuously or during stated hours for the benefit of others possessing water rights in the stream. Unless he is very careful in this respect, he may easily find that in place of water power being economical, it is, when charged with law costs, one of the dearest of all forms of power.—M.

Answer to No. 520 (*awarded* 5*s.*).—The energy to be obtained by means of a turbine or a waterwheel varies as the product of the weight of water falling in a given time into the vertical distance between the levels. The first thing for the querist to do is to find the speed of the river's flow and its sectional area. To get the speed an instrument called a current meter (listed at about £6) may be employed; this instrument works in a similar manner to the patent logs used for recording speed of ships. A cheaper and readier method is to float a piece of wood down stream, and note time of passing between two measured points on the bank. If the velocity thus obtained be called V, and v stand for the mean velocity,

$$v = V \times \frac{7{\cdot}71 + V}{10{\cdot}28 + V}.$$

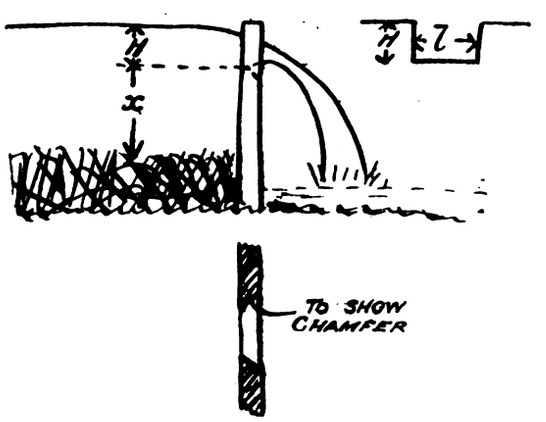
If, then, this mean velocity be multiplied by the sectional area, we have amount of water flowing in a given time.

A more reliable way, but one that will give considerably more trouble, is to use a weir or notch board. This board must bar the river, so that the flow takes place through the notch. It may be taken that the same amount of water passes over the board that would pass were the river not obstructed. We then have

$$Q = C\, l\, H \div \tfrac{2}{3} \sqrt{2\, g\, H},$$

where Q = quantity in cubic feet per second; l = length of notch in feet; H = head in feet; C = a coefficient. (C, although varying with H and l, may be taken generally as ·62). The board must be chamfered (see figure), so that chamfered edge is down stream.

Whichever method is used, several measurements should be taken and an average worked out. When using a floating body due allowance must be made for windage. The Pelton waterwheel, which has cups in place of flat floats, is



said to have an efficiency of 75 to 80 per cent. Efficiency of the turbine is from 70 to 80 per cent. Then

$$\text{H.P.} = \frac{Q \times F \times {\cdot}7}{530{\cdot}5},$$

when H.P. = effective horse-power; Q = volume in cubic feet per minute; F = fall in feet; ·7 = 70 per cent. efficiency (wheel or turbine); $530{\cdot}5 = \frac{33,000}{62{\cdot}2}$ (62·2 cubic feet of water in pounds). Kilowatts at terminals will depend on efficiency of dynamo.—M. M.

ABERDEEN ELECTRICITY UNDERTAKING.

The annual report by Mr. J. A. Bell, the city electrical engineer of Aberdeen, gives a remarkably good account of the working of the electricity department during the year ending July 31 last. Speaking generally, it has been a year of exceptional activity, due largely to the work entailed at the new Ferryhill electricity station. The Council's decision to electrically equip the Union-street, Bridges, Bayview, and Circular routes of tramways has also added considerably to the work of the department. In August of last year the plant was being erected as rapidly as possible at the Ferryhill works to enable supply to be given from there in the autumn. Supply was started on Nov. 4—wooden engine-room, boiler-house, temporary chimney, piping, etc., being used for this purpose. The Crown-street cable subway not being finished, the feeder cables were supported on steel poles from St. John's-place to the cable chamber in Union-street. The change from temporary expedients has been slow and attended with difficulties due to the necessity of maintaining supply. The new chimney was first brought into use on May 27, and the fuel economisers were coupled up on July 15. The latter has had a material effect on the costs, as up to this date practically cold water was being feed into the boilers. The boiler-house buildings have now been completed and the temporary wooden shed removed; the engine-room roof is also finished, and the engineer expects that during next month he will be able to dispense with the remaining portion of the temporary engine-room. He is still using makeshift switchboards, and it will be late in the autumn before he will be in a position to run our engines condensing. Due to these delays, and to the additions made to the traction load, the Cotton-street works will have to do a large share of this winter's load. The tramway department has become a larger consumer, but, owing to the time of completion of new routes, they have not greatly affected this year's output. One hundred and seventy-two additional consumers have been coupled up during the year, 45 of which are private residences in the suburbs or west end. These additions make the total number of consumers coupled 950. The point requiring special notice is the increased consumers using motors. Ninety new motors, of an aggregate horse-power of 353, have been connected during the 12 months, 66 of these being hired from the Corporation. This brings the total number of motors on our mains to 216 representing 838 h.p.

The units sold for motors during the last three years are as follows: 1900, 42,326; 1901, 67,244; and 1902, 137,486. Electrical heating has increased by the equivalent of 621 33-watt lamps. Forty-six private arc lamps have been added during the year, making the total coupled to date 235. Public arc lamps, including harbour, now stand at 235, only four being connected, while for the corresponding period last year 69 new lamps were coupled. The total number of consumers on the

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mains for lighting, heating, cooking, motors, etc. (not including traction), on July 31, expressed in 33-watt lamps, was 101,473. Cables were laid to supply the Ferryhill district in November last. Supply has been available for Torry since February. In all, the mains laid during the period under review give an additional 3·2 miles of frontage for supply.

Excluding storage batteries, the following generating plant is installed at the works: Cotton-street, 1,200 kw.; Ferryhill, 1,240 kw. A 200-kw. set is now being removed from Cotton-street to the Ferryhill works. All station plant is in good order. Due to the reduction in the charge last year for public lighting, the average price obtained works out at 2·62d., as against 3·48d. for 1901. Owing to the increased number of units sold during the daytime for motors and heating, the average price obtained for private consumers is 4·19d., against 4·24d. per unit for the year previous. The total costs for the year for units sold, not including interest, depreciation, and sinking fund, work out at 1·46d. per unit. This is the lowest figure yet reached, and is largely due to the decreased price of coal. It will be noted that the estimate of expenditure and revenue for 1903 is worked out on the basis of a reduction of ½d. per unit for private lighting consumers, the charge recommended being 6d. for the first hour of maximum demand and 2½d. for all subsequent units. The charges for public lighting, motors, and heating, Mr. Bell recommends, should remain as they are.

TRADE NOTICES AND NOVELTIES.

New Switches.

Reverting to the notice under the above heading in our issue of last week, this should have read: "There is plenty of scope for ingenuity in the design of switchgears, and it is doubtless due to this fact that improvements, either real or problematical, are constantly being introduced. We illustrate herewith some switches designed by Mr. D. R. Broadbent, 5, Albert-street, S.W.," etc. In making up the type into page form two lines got transposed.

Handy Tools.

Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, E.C., are better known as contractors for overhead equipments and electrical apparatus of all kinds than as specialists in tools, but that they have also paid considerable attention to the requirements of the tool-chest is sufficiently evidenced by the accompanying illustrations, which show some strongly-made and simply-designed tools supplied by them for purposes incidental to electric traction work. The first of the illustrations shows an insulator wrench, which is claimed to work on the right principle, and to effect its purpose without injury to insulation; the second a Pearson ratchet jack, specially designed for replacing derailed cars, being equally adapted for any purpose for which a jack is required; and the third an "automatic" come-along clamp, which dispenses with the necessity of bolts, and is claimed to never slip. Another tool of a special character supplied by the above firm is a pole-hole auger, designed, as the name implies, for boring holes for pole-planting. These several tools, it will be seen, have their special merits, being designed in conformity to definite requirements, and prove that Messrs. Robert Blackwell and Co., Limited, are in close touch with the increasing demand for such apparatus.

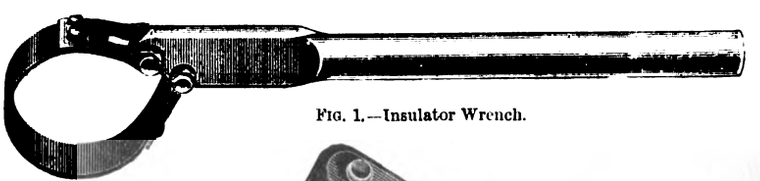

FIG. 1.—Insulator Wrench.

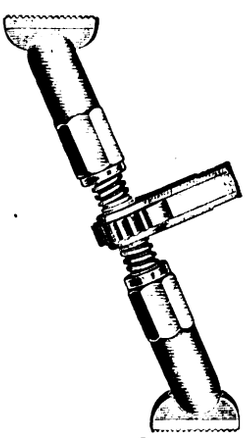

FIG. 2.—Ratchet Jack.

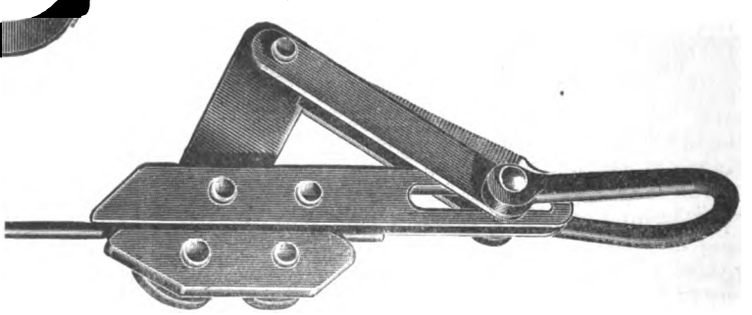

FIG. 3.—Automatic Come-Along Clamp.

Catalogues.

ENGINEERS' TOOLS.—Engineers' tools of almost every description from the gimlet to heavy lathes are dealt with in the tool catalogue issued by Messrs. Charles Nurse and Co., 182-184, Walworth-road, London, S.E. This catalogue, which has reached its twelfth edition, now runs into 336 pages, a sufficient guarantee of the comprehensive character of the contents. Beyond the introduction of various new patterns in almost all lines, the principal additions to the catalogue will be found in the inclusion of a much larger selection of smiths' tools, and also pulleys, shaftings, hangers, and pulley blocks. Illustrations and prices are given. We understand that Messrs. Nurse and Co. are prepared to supply a copy of this catalogue free of charge to all public corporations and also to established firms.

HOWARD TROUGHING.—The Howard Conduit Company, Limited, Trafford Park, Manchester, have sent us a copy of a handy reference card which they are issuing, concerning the use of their asphalt solid system, more especially for services. On referring to this card, the most suitable sizes, and the prices of same, which are given fully in tabular form, may be seen at a glance, and an idea obtained as to the quantities of bitumen and asphaltic concrete required. We understand that the card has been designed with a view to saving engineers and mains superintendents the trouble and time wasted in wading through catalogues, an endeavour which will doubtless be appreciated.

JANDUS ARC LAMPS.—From Messrs. Drake and Gorham, Limited, 66, Victoria-street, Westminster, S.W., we have received a copy of their new catalogue of Jandus arc lamps, for which latter they are the sole agents. In this catalogue the leading characteristics of "Jandus" continuous-current and alternating arc lamps are briefly discussed, and an illustrated description given of the Jandus patent trimming device. Then follows a comparison of the distribution of light from Jandus (long-burning) and ordinary short-life arc lamps, and after that we have illustrations of the different patterns made, with specifications and prices. Auxiliary apparatus and accessories are separately dealt with.

ELECTRO-MEDICAL INSTRUMENTS.—We have received from Mr. K. Shall, 55, Wigmore-street, London, W., a copy of a publication which is at once a useful treatise on electro-medical instruments and their management and a price-list of electro-medical apparatus, both sections being admirably illustrated and compiled. We gather from the preface that the aim of the author has been to explain as simply as possible the physical laws which are of importance in using electricity for medical and surgical purpoes, also to describe the construction of the necessary apparatus, to give a few practical hints about the apparatus best suited to different conditions, and to show how faults may be avoided, or, at any rate, how they may be detected and remedied. The price-list attached is comprehensive in its scope, including electro-medical apparatus of all kinds. An index facilitates reference to particular pieces of apparatus.

GAS AND OIL ENGINES.—From the Dudbridge Ironworks, Limited, Stroud, Glos., we have received a copy of their new catalogue of gas and oil engines and gas-producing plants. The increased demand for their engines has necessitated the extension of the firm's premises, we are told, new buildings having been erected and new machine tools of the most modern design installed. Capital illustrations are given of some of the productions of the works, one of them showing a Dudbridge oil-engine coupled to a dynamo, and making a compact combination. In every sense the catalogue is a creditable production.

NEW COMPANIES REGISTERED.

Electric Mercantile Agency, Limited. — Capital, £1,200. Objects: to carry on the business of an electric light company and of electricians, electrical, mechanical, and general engineers, suppliers of electricity, manufacturers of electrical apparatus, etc.

Rangoon Electric Construction Syndicate, Limited.—Capital, £1,000. Objects: to apply for and obtain from the proper authority in Burma concessions and powers for constructing and working electric tramways and electric lighting works, and to turn the same to account,

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GREENOCK ELECTRICITY ACCOUNTS

From the accounts of the Greenock electricity department for the period from Jan. 1, 1901, to June 30, 1902, it appears that the total expenditure on capital account amounts to £69,537. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Public Works Loan Commissioners—balance due	75,666	13	4
Sinking fund—for repayment of loan	4,333	6	8
Accounts due	1,299	8	3
Balance to provide for irrecoverable arrears	23	2	1
	£81,322	10	4

Assets.	£	s.	d.
Capital account—amount expended for works	69,537	12	1
Stores on hand	1,007	19	9
Outstanding revenue	2,800	18	1
Advanced to police department—streets and sewers	4,000	0	0
Cash in bank	2,584	6	9
Cash in hand	1	10	7
Balance at debit of net revenue account	1,390	3	1
	£81,322	10	4

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity—Coal, etc.	2,621	3	8
Oil, waste, water, engine-room stores, etc.	337	18	11
Wages at station	905	0	0
Repairs and maintenance of machinery and plant	186	7	11
	4,050	10	6
Distribution of electricity	312	16	5
Public lamps	349	7	6
Rents, rates, and taxes	474	9	5
Management expenses	712	6	9
Special charges—insurances	46	11	7
Total expenditure	£5,946	2	2
Balance carried to net revenue account	5,052	18	9
Balance to provide for irrecoverable arrears	23	2	2
	£11,022	3	1

Dr.	£	s.	d.
Sale of current per meter	5,866	9	0
Less paid for free wiring	41	14	3
	5,824	14	9
Public lighting	1,335	16	8
Rental of meters and other apparatus	19	13	0
Sale under contracts to tramways company	2,949	11	10
Rents and maintenance of cableways tramways	150	0	0
Minimum supply of energy to tramways	741	0	0
Miscellaneous receipts—recharging batteries	1	6	10
	£11,022	3	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units			1,061,400
Quantity sold	Public lamps	94,066	
	By contract (tramways)	468,038	939,946
	Private consumers by meter	377,842	
Quantity used on works			86,244
Total quantity accounted for			1,026,190
Quantity not accounted for			35,210
Total maximum supply demanded (kilowatts)			600

Number of public lamps, 50.

EAST HAM ELECTRICITY ACCOUNTS.

The accounts of the East Ham electricity department for the period from June 22, 1901, to March 31, 1902, show a total expenditure on capital account of £63,938. Abstracts of the revenue account and general balance-sheet are given herewith.

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Mortgages and loans	64,902	11	5
Cash due to bankers (capital account)	1,421	18	4
Extinguished debt and depreciation reserves	1,574	9	11
Sundry creditors on revenue account	1,600	13	11
Cash due to bankers (revenue account)	3,745	7	11
	£73,245	1	6

Cr. Assets.	£	s.	d.
Capital outlay—amount expended for works	66,976	18	3
Revenue account (deficiency)	1,666	18	3
Sundry debtors for current supplied	2,870	7	0
Insurance premiums paid in advance	73	7	0
Stocks and stores on hand	1,657	11	0
	£73,245	1	6

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity—Coal	1,698	11	0
Oil and other lubricants	220	3	0
Engine-room stores	56	10	1
Water	42	12	6
Salaries	125	11	7
Wages	928	10	1
Repairs and renewals	136	11	10
Removing rubbish	2	13	5
	3,211	3	6
Distribution of electricity	49	13	5
Maintenance of public lamps	291	0	10
Special lamps (artisans' dwellings)	18	12	0
Management expenses	503	16	8
Rates, taxes, and insurance	273	13	5
Bad and doubtful debts	15	6	2
	4,363	6	0
Balance carried to net revenue account	2,731	9	9
	£7,094	15	9

Cr. Income.	£	s.	d.
Sale of current—Tramways	3,419	11	0
Public lighting	1,568	10	10
Private consumers	2,083	8	6
Artisans' dwellings	18	13	0
	7,090	3	4
Testing fittings, etc.	4	12	5
	£7,094	15	9

LEGAL INTELLIGENCE.

"TUBE" COMPENSATION CLAIM.

Mr. Under-Sheriff Burchell and a special jury on Tuesday heard the case of Matthews *v.* the Great Northern and City Railway Company, which was a claim for compensation in respect of structural injury alleged to have been caused to the leasehold premises Nos. 110 and 126, New North-road by subsidence due to the construction of the new "tube" railway from Finsbury Park to the City. The claimant stated that from the end of the year 1900 until recently various structural defects had developed. The wife of a tenant stated that the creaking and cracking noises at night were such that she thought the house was haunted. Mr. Houchin, an architect, and other witnesses expressed the opinion that in addition to being recouped for his outlay on repairs, the claimant ought to receive compensation for the probable diminution of the market value of the leases. On behalf of the company counsel contended that the method by which the "tubes" are constructed, by means of the "Greathead shield," precluded the possibility of any movement or subsidence of the soil through which they are driven; and that the houses in question were 60 or 70 years old and rested on very shallow foundations.

In the result the jury returned a unanimous verdict for the defendant company that damage had not been done by the construction of the "tube," but that it was the work of time.

Judgment accordingly.

AN ARC LAMP DISPUTE.

In the Westminster County Court on Wednesday Judge Woodfall tried the case of Stewart *v.* Murray, in which the plaintiff, an electrical engineer of Soho, sued the defendant to recover the sum of £5. 3s. 4d. in respect of an arc lamp supplied. It appeared that the defendant had been supplied by Messrs. Verity and Co. with three arc lamps, and that owing to improper usage one of them burnt out. The plaintiff supplied, at the request of the defendant, an arc lamp in place of the old one, and he now claimed payment for it in the sum named. The defendant contended that he merely hired the lamp in question during the time that the old lamp was being repaired, and denied liability.

His Honour said he was satisfied that the old lamp could not be repaired, and that the plaintiff supplied a new one to the defendant's order. Judgment would be for the plaintiff for the amount claimed, with costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Swindon.—The Corporation invite tenders for direct-current electricity meters. Tenders by Oct. 29. See advertisement.

Wigan.—The Corporation invite tenders for 18 bogie cars, double-deck, four-motor equipment. Tenders by Oct. 20. See advertisement

Aston Manor.—The Urban District Council invite tenders for condensers for their electricity generating station. Tenders by Oct. 31. See advertisement.

Burton-upon-Trent.—The Corporation invite tenders for the overhead equipment of their tramway lines, etc. Tenders by Nov. 5. See advertisement.

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Great Western Railway.—The Directors invite tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1903. Tenders by Oct. 20. See advertisement.

Batley.—The Corporation invite tenders for the supply, delivery, and erection, at the electricity works, of one re-cooling tower and tank. Tenders by Oct. 28. See advertisement.

Tientsin (China).—Mr. A. W. Harvey Pellingham, secretary of the British Colony at Tientsin, China, invite tenders for installation and working of electricity works. Tenders by Nov. 30.

Abacete (Spain).—The Municipality invite tenders for the installation and working for 20 years of electric lighting. Tenders to the above at Abacete, Province of Bonillo, Spain, by Oct. 20.

Wigan.—The Corporation invite tenders for the electrical equipment of a short length of new tramway and of a portion of their existing tramways. Tenders by Oct. 20. See advertisement.

Cambridge.—The Saxon Portland Cement Company, Limited, require tenders for the supply of calcium carbide in weekly quantities of 8cwt. for a period of six months commencing Oct. 31, 1902.

Ipswich.—The Corporation invite tenders for main switchboard, motor boosters, connections in generating station, and overhead construction for tramways. Tenders by Oct. 22. See advertisement.

Wigan.—The Corporation invite tenders for the construction of a short length of new tramway and for the reconstruction of a portion of their existing tramways. Tenders by Oct. 20. See advertisement.

Chester.—The Corporation invite tenders for the supply of open-type arc lamps. Particulars may be obtained from Mr. F. Thursfield, city electrical engineer, Electric Light Station, Chester. Tenders by Oct. 25.

Sunderland.—The Corporation invite tenders for one steam-driven three-phase generator, motor-generators, and static transformers, and high and low tension switchboards. Tenders by Nov. 28. See advertisement.

Hammersmith.—The Electricity and Lighting Committee invite tenders for the supply of prepayment electricity meters for use on single-phase alternating-current system. Tenders by Oct. 24. See advertisement.

Nottingham.—The School Board invite tenders for the installation of electric light at the Bath-street Schools. Apply immediately to the architects, Messrs. Evans and Son, Eldon-chambers, Wheelergate, Nottingham.

Paris.—The Municipal Wood Paving Factory at Javel requires five electric motors of 7 h.p. to 30 h.p. Particulars may be obtained at that factory. Tenders will be opened at the Town Hall, Paris, at 2.30 p.m., on Oct. 22.

Lancaster.—The Visiting Committee of the County Asylum invite tenders for the supply of a new direct-coupled dynamo of not less capacity than 700 c.p., and switchboard. For particulars apply to the Medical Superintendent. See advertisement.

Dudley.—The Corporation invite tenders for supply of arc lamp carbons. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on 18th inst.

Mansfield.—The Corporation invite tenders for electric light wiring of the town hall premises. Specification, etc , may be obtained from Mr. E. Holcombe Hewlett, at the Electric Lighting Station, on and after 20th inst. Tenders by 5 p.m. on 31st inst.

Tunbridge Wells.—The Town Council invite tenders for the construction of main flues at their central electric light station, Tunbridge Wells. Specification, etc., can be obtained on application to the Borough Surveyor, Town Hall, Tunbridge Wells. Tenders by Oct. 18.

London, S.W.—The London County Council invite tenders for the supply for one year from Jan. 1 of engineers' goods and electrical fittings. Particulars may be obtained from the Clerk of the Council (Stores Branch), 19, Charing Cross-road, W.C. Tenders by 10 a.m. on 27th inst.

Paris.—The French Government have decided to invite tenders for the supplying and laying of the following cables: (1) from Brest to Dakar; (2) from Tamatave to Réunion and from Réunion to Mauritius; (3) from Saigon to Pontianak, at Borneo. Tenders must be sent in by Oct. 21 next.

Bootle (Lancs.).—The Corporation invite tenders for the wiring of the new fire station in Strand-road for the purposes of electric lighting. Specification, etc., may be obtained at the office of the architects, Messrs. Anderson and Crawford, 36, Dale-street, Liverpool. Tenders by noon on 18th inst.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and erection of two electric car traversers at certain of the Council's depôts in the south of London. Specification, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 21.

Wakefield.—The Guardians invite tenders for the electric lighting of old workhouse buildings, including supply and erection of steam dynamo, pipe work, switchboards, and wiring. Specifications and particulars may be obtained from Mr. H. Beaumont, clerk, Union Offices, Tetley House, Wakefield. Tenders by 18th inst.

Gefle (Sweden).—The City Architect requires tenders for supply and erection of electrical machinery, accumulators, etc. Drawings, specifications, etc., may be obtained from the Gefle stads byggnadskonter against payment of 25 kroner, which will be refunded. Tenders by Oct. 15, addressed Anbud a elektriskt maskineri, Drätselkammare Stads, Gefle, Sweden.

Shanghai.—Messrs. Preece and Cardew are authorised to receive tenders for the supply and delivery c.i.f. of two 500-kw. steam alternators (the engines to be enclosed double-acting type and alternators to have stationary armatures, pressure 2,100 volts, periodicity 100), switchboards, and two condensers and circulating water pumps. Tenders by Oct. 30. See advertisement.

Newcastle-upon-Tyne.—The Tramways Committee invite tenders for the supply and erection complete of a new triple-expansion direct-coupled engine, of 3,000 h.p., at the power station, Newcastle-upon-Tyne. Specification, etc., may be obtained from the general manager and engineer, Mr. A. E. Le Rossignol, M.I.E.E., Manors Power Station, Newcastle-upon-Tyne. Tenders by Nov. 8.

St. Petersburg.—The St. Petersburg Stadt Amt (Town Council) invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Stadt Amt, St. Petersburg, Russia.

Irun (Spain).—The Municipality invite tenders for the installation and working for 25 years of electric lighting. Tenders to the above at Irun. Amongst the conditions are the purchase for 150,000 pesetas of the already existing municipal central station. The following income may be expected: 300 pesetas per horse-power per annum for not less than 25 h.p. and not more than 50 h.p. for public lighting; and for private lighting 2½ pesetas per month for each 10-c.p. lamp, 1½ pesetas for each 5-c.p. lamp; 80 cmos. per kilowatt-hour for lighting, and 50 cmos. per kilowatt-hour for power. A deposit of 75,000 pesetas will be required. Tenders by Oct. 19.

Glasgow.—The Corporation invite tenders for the construction, supply, and erection, under one contract, of the whole of the machinery and accessories required for the mechanical equipment of the machinery buildings at the Dalmuir outfall works. Amongst the more items are: four Lancashire boilers, centrifugal pumping engines, screening and elevating machinery, penstocks, valves, electrical generators for lighting and power, electric motors, auxiliary pumps, steam and water pipe connections, lime-mixers, and other sewage treatment plant, overhead water-tank, etc. Specifications, etc , may be had on application at the Office of Public Works, City Chambers, 64, Cochrane-street, Glasgow. Tenders by Oct. 28.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

Madrid.—The Directorate-General of Posts and Telegraphs, Calle de Caretas 10, Madrid, as well as in the offices of the civil Governments of the provinces of Barcelona, Cordoba, Valladolid, and Zaragoza require tenders by Oct 28, which will be opened five days afterwards in the Directorate-General of Posts and Telegraphs, Madrid, for the supply of 35 tons of galvanised iron wire four millimetres in diameter, 10 tons of galvanised iron wire three millimetres in diameter, three tons of copper wire two millimetres in diameter, four tons of copper wire ⅛ of a millimetre in diameter, and four tons of copper wire ⅛ of a millimetre in diameter, for the telegraph and telephone lines of the State, at the upset prices of 570 pesetas, or about £17, per ton for iron wire, and 2,890 pesetas, or about £86, per ton for copper wire. A provisional deposit of 5 per cent. of the amount of the contract at the upset prices is required to qualify any tender. A translation of the general conditions of the contract has been received through the Foreign Office from his Majesty's Embassy in Madrid, and, together with the particulars of the requirements which the wire must fulfil, may be seen by those interested on application to the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W., on any day between the hours of 10 a.m. and 5 p.m.

RESULTS OF TENDERS.

Fulham.—The tenders received for the installation of electric light at the mortuary and coroner's court have been referred to committee.

Pemberton.—The District Council have accepted the tender of the Hadfield Steel Company for points, crossings, and tools in connection with the tramways.

Brechin.—The Police Commissioners have accepted the tender of Middleton and Son, Brechin, at £27, for an installation of electric light at the municipal buildings.

Bristol.—The Electrical Committee have accepted the tender of C. A. Hedges, Thomas-street, Bristol, for foundations, culverts, subways, etc., at the Avonbank electricity works.

Motors.—The Electric Construction Company have obtained the order for 59 motors for the small-arms factory at Ishapur, for which a specification was recently issued by his Majesty's Government.

Blackpool.—The Electricity and Tramways Committee have accepted the tender of H. R. Griffin and Co., 2A, Southwark-road, S.E., for about 310 yards of 20in. gauge tramway rails and 10 wagons, to be supplied to the electricity works, West Caroline-street.

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BUSINESS NOTES.

TRACTION.

Maidstone.—A number of small main extensions are to be made.

Cheshunt.—A report on electric lighting will shortly be laid before the Council.

Devonport.—Steps are being taken to put a stop to the overcrowding of the tramcars.

Morecambe.—Mr. Pape is preparing a report on the subject of high-pressure mains.

Harrogate.—Several extensions of electricity mains were agreed to at Monday's meeting.

Leyton.—The Electric Lighting Committee show a profit of £709 for the last half-year.

Auckland.—A start with the construction of the tramways in this district will be made very shortly.

Johnstone.—Mr. Murphy is hopeful of being able to begin the construction of the electric tramways here soon.

Clacton.—The promoters of the light railway scheme are anxious to take over the Corporation's electric lighting order.

Datchet.—The tramways company do not propose to proceed with their application to extend their system to this place.

British Schuckert Electric Co.—Mr. Arthur Jacob, M.I.E.E., has been appointed general manager to this company.

Hucknall Torkard.—Sir Bache Cunard's light railway scheme in this district has been approved by the District Council.

Shoreham.—The Brighton Corporation have offered the Council to provide electricity for public and private purposes in Shoreham.

Coseley.—The British Electric Traction Company will probably commence to electrically equip the Princes End line about January.

Montrose Asylum.—The Managers have authorised the expenditure of £120 for the introduction of the electric light into the infirmary.

Jarrow.—A special meeting of the Council has been called to consider plans of proposed tramways from the British Electric Traction Company.

Lyndhurst.—The light railway scheme for this district has been joined to the electric lighting scheme, and the two are to be carried out together.

Ayr.—The Corporation have increased the salary of Mr. Fred. Coutts. tramway manager, by £50. An extension of the car station is to be proceeded with.

Ipswich.—The Local Government Board will shortly hold a local enquiry in regard to the loans required for the construction of the proposed new tramways.

Bournemouth.—The municipal telephone service proposed by the Corporation will form the subject of a conference of the local authorities interested in the scheme.

Standish.—An effort is being made to have included in the application of the Wigan Corporation for tramway extensions a line to Standish Lower Grounds.

Rochester.—Mr. E. Rotter, the consulting engineer to the City Council for the tramway scheme, estimates the total cost of the proposed works at £125,860.

Whitefield.—The Electricity Committee of the District Council are still conferring with the Bury Corporation Tramway Committee, and also with the Salford Committee.

Withington.—A committee of the Council is discussing with the Manchester Tramways Committee a proposal to run trams from Brooks's Bar to Chorlton-cum-Hardy.

Buxton—The Council have adopted the engineer's suggestion to give their consumers the option of the demand indicator system. An extension is to be made in Corlar-road.

Londonderry.—Mr. P. C. Cowan, M.I.C.E., has held an enquiry into the proposal of the Corporation to borrow £35,000 for a private electric lighting installation in the city.

Southport.—A report on the month's working of the tramcars shows that the earnings per car mile were 10·874d.—a slight increase as compared with the same period last year.

Bath.—The tramways company are to be requested to lay down either wood or macadam in place of the present granite pitching between and at the sides of the tramways.

Handsworth.—The Board of Trade have sanctioned the purchase by the District Council of that portion of the South Staffordshire tramways within the Handsworth boundary.

Indo-European Telegraph Co.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum, tax free, payable on Nov. 1 next.

Excessive Speed.—A driver of one of the electric cars at Liverpool has been fined 10s. by the local bench for driving at an excessive speed, alleged to have been at the rate of 18 miles an hour.

Kingswear.—At a recent meeting of parishioners a resolution was passed in favour of adopting the Lighting Act and lighting the parish by electricity, on the basis of not exceeding a 6d. rate.

Newport (Mon.).—The electrification of the tramways is being delayed from the fact that the committee are unable to get possession of the land required for the widening of Chepstow-road.

Burton.—The Town Council have agreed to adhere to the overhead system of electric tramway traction, instead of having recourse to the Lorain surface-contact system, as had been suggested.

Reading.—Very good progress is being made by the contractors with the construction of the electric tramways here; also at the power-house, where the foundations for the engines are in preparation.

Thornhill.—The dispute between the District Council and the British Electric Traction Company with regard to the position of the poles for the light railways has been settled by the Board of Trade.

London and South-Western Railway.—It is stated that this railway is contemplating the adoption of electric traction on their suburban lines. No authoritative statement has, however, yet been made.

Slough.—The Light Railway Commissioners will open an enquiry here next Wednesday as to the expediency of granting the application of the London United Tramways Company for powers to run tramways in the district.

Walsall.—The Council propose to purchase a piece of freehold land containing 558 square yards, at a price of £150, as a site for a transformer station to be used in connection with the supply of electricity for tramway purposes.

Dudley.—At a special meeting of the Town Council this week, resolutions were adopted in favour of purchasing all the tramways and light railways in the borough, the price in case of dispute to be decided by the Board of Trade.

Branksome.—The Urban District Council having received a proposal from the Bournemouth Corporation to establish a municipal telephone, a special committee is about to confer with the Bournemouth Corporation upon the matter.

Accrington.—Nothing has yet been settled between Accrington and the Corporations of Haslingden and Rawtenstall respecting the purchase of the Accrington Tramways Company's undertaking. The matter, however, is under consideration.

Plymouth.—The Town Council at their meeting on Monday approved a recommendation to apply for powers to extend the tramways. Six new routes are proposed. A proposal to order dry seats for 10 of the cars was referred back.

Aston.—The tramway and electrical experts have advised the Tramways Committee that the character of the district is not suitable for centre-pole construction, and, in the circumstances, it has been decided to adopt the side-pole construction.

Willington Quay.—The Tyneside Tramways Company have refused the application of the District Council to lower the fares on the tramways from Willington Quay to North Shields and to Wallsend on the ground that it is "commercially impracticable."

Sheffield.—The recent opening of the tramway extension between Firth Park and Brightside provides a circular means of communication between the city and those two places. The extension from Heeley to Wood Bank-crescent will be opened on Nov. 1.

Morley.—The borough electrical engineer, Mr. Drewett, in his last report stated that the output from the electricity works during the four weeks ended Sept. 6 was 5,276 units, against 4,807 units for the corresponding period of last year, being an increase of 469.

Sunderland.—Work has been commenced on the Fulwell-road section of the tramways. Messrs. Dick, Kerr, and Co. have the construction of the permanent way in hand, and the overhead lines and electrical equipment is being done by Messrs. Siemens and Co.

Southend.—In the course of a discussion on lifeguards at the last Town Council meeting it was stated that those at present in existence were ineffectual. Experiments were being made, and as soon as there was one they thought they could adopt, they would probably do so.

Shanghai.—We understand that the offer of the Brush Electrical Engineering Company to establish tramways in Shanghai has been accepted by the Municipality. The Brush Company have also recently acquired the concession for the city of Bombay for tramways, light, and power.

Tees Valley.—A conference has just taken place regarding the proposed construction of a light railway from Langdon Beck to the Middleton terminus of the Tees Valley Railway. The support of Lord Barnard, a large landowner in the district, is hoped to be obtained to the scheme.

Newcastle.—Arrangements have been made for bringing forward a proposition at the Town Council meeting in November for a tramway along Newgate-street and Percy street, from Clayton-street, to join the line at Barras Bridge. The Tramways Committee are considering an extension of the line to Newburn.

Glasgow.—On Saturday night two tramcars collided in Cathcart-road, owing, it is said, to the brakes failing to act. The passengers were more or less severely injured. The short extension of the tramways to the Battlefield Memorial, Langside, is now completed, and the line was opened for traffic on Friday.

Northampton.—The responsibility of the proper carrying out of the construction and electrical equipment of the proposed electric tramways has been placed in the hands of Mr. Fidler, the borough engineer and surveyor, in order to avoid, if possible, the expense of engaging an expert to carry out the scheme.

Wimbledon.—We notice the following changes in the staff of the electricity department: chief electrical engineer, Mr. H. Tomlinson Lee, A.M I.E.E.; chief assistant engineer, Mr. R. N. Torpy A.I.E.E.; engineers-in-charge, Mr. E. F. Jones, Mr. H. L. Percy, and Mr. T. R. Stancombe; chief clerk, Mr. R. V. Treacher.

Bacup.—The British Electric Traction Company have declined to undertake a scheme of electric tramways from Bacup through Whitworth to the boundary of Rochdale, on the ground that they should not receive sufficient traffic to justify the large expenditure which the carrying out of the scheme would necessitate.

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Geneva.—The tramway strike here continues. The employés have refused the last concession offered by the company, and the strike has now extended to various branches of trade. At a meeting of trade unions on the 8th inst. it was decided to declare a general strike. It is estimated that there are 10,000 on strike.

Dewsbury.—We understand that the response to the appeal for subscriptions towards installing the electric light at the Dewsbury infirmary - although all the money required has not been raised—has been so far successful as to warrant the committee who have the matter in hand inviting tenders for the carrying out of the work.

Brierley Hill.—The Council have agreed to the laying of a double line of tramways in High-street by the Dudley and Stourbridge Tramways Company. The draft agreement with the Quarry Bank and Rowley Regis Councils for the obtaining of a joint order by the three Councils under the Light Railways Act was approved.

Manchester.—The electric tramway service in Corporation-street had to be stopped for about an hour on Monday afternoon. From some cause a portion of the road near the corner of Fennel-street suddenly fell in, and it was thought best not to allow the cars to pass the hole in case of a larger fall. The rain was heavy at the time.

Exeter.—The Electric Traction Committee have instructed the city surveyor to prepare all plans and estimates, and to prepare and serve notices to frontagers in connection with the electric tramway scheme. The electrical engineer is to co-operate with the surveyor, especially in connection with the electrical equipment of the line.

Warrington.—The South Lancashire Tramways Company have informed the Rural District Council that the proposed tramway from Newton to Warrington is under consideration. There is a probability of the Corporation taking up the light railway order and continuing the Wilderspool tramway to the centre of Stockton Heath in the near future.

Aberdeen.—It is decided that on the different tram routes a modified service of Sunday cars shall be run in the forenoon to suit churchgoers, and also at an hour to accommodate people coming from church. From about 12.50 the cars on the various routes will cease running until three o'clock in the afternoon, when they will run on till nine o'clock.

Tonbridge.—The Urban District Council have agreed to supply the Acme Chemical Company with electrical power for their new works, provided that the company entered into an agreement to repay the amount spent on outlay—namely, £400—in five years—viz., 20 per cent. on outlay—and pay a rate of 2d. per unit on motive power supplied to them.

Dover.—A Local Government Board enquiry has been held respecting the application of the Corporation to extend their borough boundaries, taking in St. Margaret's Bay and several adjoining villages. The proposed extension includes four miles of valuable elevated sea frontage, over which powers have been given for an electric tramway connecting with the Dover system.

Acton.—The District Council have decided to adjourn the consideration of the question of the electric lighting of the parish until its next meeting, and have directed the clerk to report on the position of the Council in reference to its electric lighting order, and to produce the plans prepared by Messrs. Lacey, Clirehugh, and Sillar in reference to this matter.

Brighton.—Mr. Kincaid, the consulting engineer, recommends that the route along Vernon-terrace to Montpelier-road should be adopted for the tramway from Dyke-road to the sea-front. A post-card poll of the ratepayers in the West Ward has resulted in 293 voting against the proposed extension of the tramways from Seven Dials to Preston-street, and 173 in favour.

Hawick.—The principal streets of Hawick were lighted for the first time by electricity last week. In High-street and Bridge-street 10 arc lamps of 1,000 c.p. have been erected, the pillars being about 22ft. high. On each pillar there are also two small lamps to be lighted after the arcs are extinguished. All the other streets will shortly be lighted with the electric light.

Dingwall.—A draft agreement has been prepared by the Town Council for transmission to Major Blunt requesting a supply of electric light for the burgh at 4½d. per unit for public lighting and at not more than 6d. per unit to private consumers, the town to be permitted to buy the plant at the end of 10 years or before the expiry of 20 years, the price to be fixed by arbitration.

Electrical Mail Vans.—The success attending the recent trials, made by the postal authorities in the E.C. district with the "Oppermann" patent electrical mail van, has induced them to further test the suitability of this type of motor van on another and more difficult route. The one chosen for the present trials, which commenced on Tuesday, is in the Battersea district.

Proposed New Tube Railway.—In the next session of Parliament a tube railway to run under the Central London Railway from the City to the Marble Arch will be promoted. The idea is to connect the North-West London Railway—from the Marble Arch to Cricklewood—which was authorised a couple of years ago, and so form a through route from the North-West to the City.

Pemberton.—At the last District Council meeting the receipt of application from 16 individuals for electric current and of two applications for the current for motive power was reported, and it was resolved to increase the application for further borrowing powers from £45,000 to £50,000, so as to include £2,700, the balance overdrawn at the present time, and £2,300 for the purchase of motors.

Brighton Railway.—It is stated that the directors of the London, Brighton, and South Coast Railway Company are about to seek parliamentary powers to adopt electric traction on their main lines. We understand that the system to be used has not yet been decided on, but the *Daily Mail* says that at any rate it will not be the monorail, Mr. Behr's proposals in this direction having been rejected.

Leigh.—It is stated that the South Lancashire Tramways Company had intended to open the Leigh, Atherton, and Bolton sections of their system on Monday next, but that the opening will probably be indefinitely postponed owing to the attitude assumed by the Tramways Committee of the District Council, who insist upon certain widenings and works being completed before the cars are allowed to run.

Hucknall Torkard.—The Electric Light Committee have under consideration the question of supplying the electric light in the district, and are in communication with Messrs. Ford and Barker, who represent the electric power company. The cost of the transformer would be from £600 to £800. The company are erecting their general station at Ilkeston, and hope to be able to supply Hucknall about the middle of next year.

Southend.—The Town Council are now able to supply electric light night and day. They have 117 consumers connected, representing about 8,016 lamps of 8 c.p. In July the pier trams were transferred from their own generating plant to the station supply, and have consumed 22,354 units, for which the Lighting Committee will receive £186. 5s. 8d. They claim to have saved the Pier Committee considerably over £500 this season.

Paris.—A collision which occurred here on Sunday evening at the intersection of the Avenue de la République and the Avenue Gambetta, between the Romainville Opéra and the Bagnolet Opéra electric cars, injured 39 passengers. An automobile going at an alarming speed along the narrow Boissy d'Anglais dashed into a carriage at the door of the Cercle Artistique, inflicting fatal injuries upon the coachman and hopelessly damaging the vehicle.

Newcastle-under-Lyme.—A sub-committee has been appointed to consult with the borough surveyor, the gas manager, and the consulting engineer as to getting out plans and specifications and obtaining tenders for the erection of the engine-house and buildings, with power to carry out the necessary works and details for the electric supply in the borough. It has also been decided to appoint an electrical engineer to carry out the work.

Halifax.—Sir Douglas Fox has reported to the Tramways Committee on the proposed lift at Salterhebble. He is of opinion that such a lift would be a much safer mode of conveying passengers than by a tramway up Salterhebble-hill, with its steep gradient, and that it would facilitate the convenient working of the tramway system as a whole. He estimates the cost of the scheme at £10,500. A ratepayers' meeting is to be held on the question.

Dundee.—Six of the new cars which are intended for the service of the Constitution-road route have arrived in the city. The vehicles, which have been designed by Mr. Peter Fisher, the manager, are of the double-bogie combination type. There is an enclosed compartment containing seating accommodation for 30 passengers, and at each end there is an open platform for six passengers. The canopy is continued over the platforms, and there are screens for protection in inclement weather.

Manchester-Liverpool Monorail.—The London correspondent of the *Liverpool Courier* is authoritatively informed that the promoters of the Manchester and Liverpool Electric Express Railway now have their arrangements so far completed for the construction of the line that they hope to have a section in the neighbourhood of Warrington in full working order by next June, and they intend then to demonstrate the practicability of a train running at the full speed of 110 miles an hour over this section.

Ashton-under-Lyne.—The question of terms for a lease of the Hurst lines was discussed at the last District Council meeting, and it was resolved that a representative of the Corporation and a representative of the Hurst District Council should go into the question of interest and sinking fund accrued during construction of the Hurst lines and report thereon. It was also agreed that on certain cars a uniform fare of 1d. be adopted. The Hurst Council are in favour of the running of Sunday cars.

Cork.—An analysis of the accounts of the working of the electric tramways at Cork, which we have received, shows that the total receipts for the year ended Dec. 31 last amounted to £23,921, compared with £21,421 in 1900 and £19,768 in 1899. The number of passengers carried was 5,714,325, compared with 5,137,141 in the previous year and 4,744,528 in 1899. The number of car miles run was respectively 855,332, 732,607, and 613,113. The receipts per car mile averaged last year 6·71d., in 1900 7·01d., and in 1899 7·73d.

Worthing.—The income of the Council's electric light undertaking for the past 12 months, the first year, was £3,160, the expenditure £3,150. The latter sum includes £530 for stock now in hand, and items totalling roughly another £500 which will not recur, such as the wiring of the generating station. On the other hand, the capital charges equalled £2,110 for the year. At the present time there are actually connected with the mains the equivalent of 9,127 8-c.p. lamps, while over 1,100 more have been applied for.

Derbyshire.—The promoters of the Derby, Nottingham, and district and the Erewash Valley light railways intend to apply in the next session for parliamentary powers to enable them to construct and work the light railways on the same roads and districts as those of the schemes rejected by the Light Railway Commissioners last year. The County Council at their last meeting decided to give their consent to the schemes in the main without prejudice to any rights to raise objections on various points which may afterwards arise.

Hampstead.—The Hampstead Heath Protection Society calls attention to the fact that the Charing Cross, Euston, and Hampstead Railway Bill, which asks for powers to tunnel under the centre of Hampstead Heath, is now awaiting its third reading in the House of Commons.

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The society considers that the construction of a railway under the Heath will create a very bad precedent, and they fear that, notwithstanding any protective clauses that might be inserted in the Bill, the picturesqueness of the Heath will be seriously injured before many years have passed.

Nelson.—The work of laying the tramlines from Reedyford Bridge to Nelson is being pushed rapidly forward, and a large number of workmen are engaged. It is expected that the trams will be running on this and the Leeds-road route by Christmas, if not before. A deputation visited Rugby last week with the object of making enquiries with respect to the purchase of cars. No definite arrangement has yet been come to with Barrowford, but the Nelson Town Council decided a week or two ago to proceed with the construction of the light railway from Colne to Barrowford.

Additional Traffic Returns.—Anglo-Argentine, £99 decrease; Barcelona Ensanche y Gracia, £28 increase; Barcelona, £349 increase; Brisbane, £429 increase (month of September, £9,757, increase £994); Buenos Ayres and Belgrano Electric, £202 decrease (month of September, £12,476, decrease £150); Calcutta, £844 increase; Cape Town (month of August), receipts £15,450, expenditure £7,801; Isle of Thanet Electric, £43 decrease; Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £157 increase; Port Elizabeth (month of August), receipts £4,014, expenditure £1,979.

Walsall.—At the last meeting of the Town Council it was reported that the National Electric Wiring Company have completed their contract for the overhead equipment of the Bloxwich section. The electrical engineer has been requested to submit a design and specification for a car somewhat similar to those in use in Manchester, but with reversed staircase, the weight to be between six and seven tons, with accommodation for from 40 to 50 passengers. The car is to be warmed by electric heaters in cold weather. It was decided that the committee before accepting any tender should submit the matter to the whole Council.

Crosby.—In connection with the discontent which has been manifested recently regarding the service of tramcars on the Seaforth-Crosby system of the Overhead Railway Company, a meeting of property owners and ratepayers of the district was held on Wednesday to discuss the questions of an accelerated service and cheaper fares. It was suggested that the local council be asked to subsidise a motor company to run a service in opposition to the railway and the tramway. After some discussion it was resolved that a committee should be appointed to wait upon Mr. Cottrell, manager of the Overhead Railway Company.

Northfleet.—The District Council and the British Electric Traction Company, who run the electric trams in this district in connection with the Gravesend system, are in conflict with regard to the lighting of the car-shed at Northfleet. The company wish to take current off the trolley wire for this purpose, but the Northfleet Council are objecting. In a letter to that body, which was read at last week's meeting, the company pointed out that as the Northfleet Council do not supply the current, but the Gravesend Corporation, they can have no possible cause of complaint. It will be interesting to see how this little controversy will end.

Wolverhampton.—The tramways revenue account shows a total expenditure of £7,394, whilst the income for the year has amounted to £9,112. This includes £8,912 received from passengers and carriage of parcels on the Tettenhall, Willenhall, Bilston, and Dudley-road lines, and £200 receipts from advertising on cars. On capital account there was expended up to March 31 last for the provision of electric traction a total of £88,322. This includes construction of track, etc., £64,231; car depôt, £8,691; and cars, £5,617. Everything is ready on the new Willenhall-Darlaston and Bilston-Bradley electric sections for the Board of Trade inspections. Trial trips over the lines have proved eminently successful.

The Dolter Surface-Contact System.—There is at present to be seen at the Brighton Electrical Exhibition a working model of the above system, which is being exhibited by the Dolter Electric Traction Company, of London. In common with other surface-contact systems, the current in the Dolter system is gathered by the brushes on the cars from studs placed at distances of about six yards apart in the centre of the track. The company have taken precautions against any risk of the studs remaining alive after the cars have passed over them by the adoption of a "safety skate," which is placed at either end of the cars. The working model is to be seen at Brighton any day during the continuance of the exhibition.

Worcester.—The Electricity Committee have been authorised to engage, as the necessity arises, the following staff for the Tybridge-street generating station: two engine-drivers at 30s. per week each, with 7d. per hour for overtime; two stokers at 28s. per week each, with 6d. per hour for overtime; one fitter at 25s. per week, with 6d. per hour for overtime; one labourer at 24s. 6d. per week, with 5d. per hour for overtime; one switchboard attendant at 15s. per week; one additional assistant at £90 per annum. We understand that before the end of the month some of the power for street-lighting will be supplied from this station. The Tramway Committee are under agreement to use 200,000 units during the year commencing Dec. 1.

Hull.—The city of Hull tramway traffic receipts for last week show that 511,786 passengers were carried, and the total receipts amounted to £2,132. 8s. 10d. This is considerably less than the receipts of last year's Hull Fair week, when the number of passengers was 550,780, and the total receipts £2,294. 18s. 4d. The sub-committee of the Hull Corporation which has in hand the negotiations with the North-Eastern Railway Company concerning the rebuilding of Whitefriargate Bridge have held a meeting, as a result of which it is hoped that a satisfactory settlement will be come to soon. With a new bridge the Corporation will be able to extend their electric car service into the old town as far as the pier by way of Alfred Gelder-street and Lowgate.

Middlesbrough.—A report has been presented showing that the cost of electric lighting the proposed area with 40 arc lamps would be £800 per annum, all the lamps to burn up to midnight and one-half to be turned out after that time. The matter is in abeyance pending further reports. The total revenue during September was £571. 3s., against £337. 12s. 1d. in September of last year, and the cost of production 1·95d. per unit, against 2·74d. per unit in September of last year, a decrease of ·79d. per unit in the year. The profit for the month was £323. 0s. 6d., whilst the accounts rendered during the June and September quarters amounted to £2,277. 13s. 4d., against £1,117. 0s. 2d. in the same quarters of last year, an increase of £1,160. 13s. 2d.

Bournemouth.—The proposed Bath-road tramway is to be dropped for the present, and the application to Parliament next session will be confined to the following purposes: (1) confirming the Corporation's alleged lapsed powers under the order of 1900; (2) the addition of powers to the Corporation to purchase by agreement tramways within or without the borough constructed in connection with the tramways of the Corporation; and (3) power to the Board of Trade to grant the Corporation provisional orders for further tramways without the borough in extension of any tramways for the time being owned by the Corporation. The tramways in Holdenhurst, Ashley, Portman, and Gladstone roads are now completed, and only the sanction of the Board of Trade is wanted to open them for traffic.

Doncaster.—Mr. E. J. Little has been engaged as chief assistant electrical engineer. The borough electrical engineer in his last monthly report stated that the fuel economiser had been fixed and was now in use. The number of applications received since Sept. 1 up to the present date was equivalent to 78 8-c.p. lamps; number of consumers on books, 220; number of 8-c.p. lamps applied for up to present date, 14,766; number of 8-c.p. lamps connected, 14,032; number of 8-c.p. lamps awaiting connection, 734; number of consumers awaiting connection, 6; maximum load, Oct. 1, 1902, 176,565, being equivalent to 5,960 8-c.p. lamps. An application for extension of the electric cables to Waterdale having been received, enquiries will be made with the view of ascertaining how many other likely consumers there are at present in the neighbourhood.

Barrow.—The last difficulty of the Corporation in completing arrangements with the British Electric Traction Company for laying down a system of electric tramways has been settled. There was a desire on the part of the Corporation to increase the width of the present tramways from 4ft. to the standard gauge of 4ft. 8½in., but the Furness Railway Company opposed this change, because they claim that the high-level bridge across from the town proper to Old Barrow has been constructed for the narrow gauge, and is not strong enough to carry the standard gauge. The tramways will therefore remain at the old 4ft. gauge, but it is proposed to make the body of the tramcars wider than those of the steam-cars now in use. The work of taking up some of the old tramlines has been commenced, and it is expected by next autumn that new electric cars will be running.

Bradford.—The Corporation this week decided that an offer be made to take on a 21 years' lease the following lines authorised to be made by the Shipley Urban District Council: (1) from the Bradford and Shipley boundary at Thackley, through Shipley, to the Rosse Hotel, Saltaire; and (2) from the centre of Shipley to the Branch Hotel, Keighley-road, on terms to be settled by the Board of Trade arbitrator when dealing with the question of the Frizinghall and Saltaire line now worked by the Corporation. The Corporation have also made an offer for the proposed extension from the Rosse Hotel to the Shipley boundary at Nab Wood end, when the projected line from Bingley should be constructed to connect with it. The city surveyor has been instructed to double the existing single line on Wakefield-road between Paley-road and New Hey-road, at an estimated cost of £2,140.

New South Wales.—In connection with the adoption of the eight-hour system on the railways and tramways of New South Wales, it is estimated that the increased cost in wages since the introduction of the system has been at the rate of £38,000 a year on railways and £22,451 a year on tramways. The estimates for the year given in our last issue were, of course, greatly influenced by the adoption of this system. With regard to the tramway service and the demand for weekly periods of 48 hours instead of fortnightly periods of 96 hours, the Railway Commissioners consider that the fortnightly period is a fair and reasonable arrangement. The extra cost of the extension of the eight-hour system on a fortnightly computation amounts to about £61,000 per annum. If based on a weekly computation, it is estimated that it would amount at least to £66,000 per annum. During the year ended June 30 last the sum of £45,452 was paid for overtime on railways, and £6,760 for overtime on tramways.

Light Railways.—The Board of Trade has confirmed the following light railway orders: (1) Wakefield and District Light Railways (Extensions) Order, 1902, authorising the construction of light railways in the city of Wakefield, the borough of Ossett, and in the townships of Horbury, Lofthouse-with-Carlton, Thorpe, Rothwell, Sandal Magna, Oulton-with-Woodlesford, and in the parishes of Rothwell, East Ardsley, and Outwood, in the West Riding of the county of York; (2) South Norfolk Light Railway (Extension of Time) Order, 1902, amending the South Norfolk Light Railway Order, 1898; (3) Spen Valley and Morley Light Railways (Extensions) Order, 1902, authorising the construction of light railways in the borough of Morley and the urban districts of Birkenshaw, Drighlington, and Gomersal, in the West Riding of the county of York, and for other purposes; and (4) Bentley and Bordon Light Railway Order, 1902, authorising the construction of a light railway in the county of Southampton from Bentley to Bordon.

Auckland (N.Z.).—There appears to be some little friction between the Auckland Electric Tramways Company and the Neuchatel Asphalt Company. Correspondence laid before the Auckland City

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Plymouth, has been dissolved by mutual consent. The estate of T. Morley, 16, Whalley-road, Accrington, has been released from trusteeship.

Shoreditch.—After being closed for three months, and having £4,000 expended upon its restoration, Hoxton parish church was on Tuesday reopened with some ceremony. The church, which was consecrated in 1826, has been made bright with an installation of electric light.

Ilford.—On Friday last Mr. Gilbert R. Spurr, assistant engineer to the Urban District Council, was presented by the staff and employés with a marble clock, suitably inscribed, on the occasion of his marriage. Mr. Arthur H. Shaw, the resident electrical engineer, made the presentation.

Islington.—The following rates for motor power have been agreed to: from 12.30 a.m. to sunset, 2d. per unit; from sunset to 12.30 a.m., 5d. per unit. Low-tension distributing mains are to be laid in Hornsey-road and Liverpool-road at a cost of £360, and in Caledonian-road at a cost of £133.

Battersea.—The Guardians have approved of the recommendation of the Works Committee that, as the extra cost for lighting the new receiving wards by electricity was under £300 the Board have the building lighted by this illuminant, having only a few gas jets in the building in case of emergency.

Ayr.—A Babcock and Wilcox boiler is to be substituted at the refuse destructor works in place of a Lancashire boiler. A heating surface of 2,852 square feet and a working pressure of 250lb. per square inch will be provided. The extra cost is £150. We understand that the tender of Messrs. Meldrum Bros. is to be accepted.

A Useful Contrivance.—We have received from Mr. E. L. Collins, the patentee, a most practically arranged and well-bound drawing, tracing, and photo-entry book, with columns and index. The former might possibly be increased so as to allow of entries of dates of forwarding and return to firms by whom drawings have been borrowed.

Hanley.—Electric energy is to be offered to large consumers at the following rates: for the first 1,000 units in one quarter, 6d. per unit; for the second ditto, 5½d.; for the third, 5d.; for the fourth, 4½d.; and for any additional quantity beyond 4,000 units, 4d. per unit, the charge to be subject to the usual discount allowance of 5 per cent. if paid within 21 days.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in Calcutta Electric Supply Corporation's further issue of 20,000 shares of £5 each, and to allow the Colombo Electric Tramways and Lighting Company's £120,000 5 per cent. first mortgage debenture stock to be quoted in the official list.

Faversham.—The Kent Electric Power Company have informed the Council that they would be in a position to supply energy well within a year, and that they were prepared to negotiate with the Corporation. The town clerk has been instructed to reply stating that on receipt of a more definite offer the Council would be prepared to give the matter their consideration.

Stockton.—The Town Council have referred back to committee a recommendation to supply current to the Stockton Rural District Council at the rate of 4¼d. per unit up to a minimum of 17,000 units for a term of 10 years, and to offer to supply energy to the Stockton Co-operative Society for their new battery in Dixon-street at a minimum charge of £16 per annum for a period of five years.

Newport (Mon.).—The question of providing a separate electric installation for the asylum, which is estimated to cost £3,433, has been deferred pending arrangements with the Corporation for a supply from the central station, which in duplicate mains and transformers would mean an outlay of about £2,800. The Electrical Committee say they can supply the current, and leave the decision to the Lunacy Committee.

Cable Rates.—The Secretary to the General Post Office notifies that on and from Nov. 1, 1902, Press telegrams will be accepted for transmission between the United Kingdom and Sweden (*via* the cables of the Great Northern Telegraph Company), between the hours of 6 p.m. and 9 a.m., at half the rates for ordinary telegrams, with a minimum charge of 10d. per telegram. Particulars respecting the general condition, will be furnished on application.

Wednesbury.—The Council have adopted a scheme of electric lighting to be carried out in conjunction with an agreement with the Midland Electric Power Company, by which the latter will supply to the Corporation electric energy in bulk for both power and lighting purposes, and have instructed Mr. F. J. Warden-Stevens, their consulting engineer, to proceed at once with the necessary plans and specifications. Application is to be made for sanction to a loan of £11,000 to defray the cost of the work.

Devonport.—The Admiralty are considering a comprehensive scheme for supplying electric light and power from a station in the dockyard. The capital expenditure to date on the electricity undertaking amounts to £82,803, leaving £4,047 spent in excess of sanction obtained. The Electric Power Committee have instructed the electrical engineer to prepare an estimate of the probable outlay required for the purpose of carrying out works in contemplation with the view to the Council making application for a further loan.

Diary.—The first of the hardy annuals has made its appearance in the shape of the "'Mechanical World' Pocket Diary and Year Book for 1903." It is published by Messrs. Emmott and Co., Limited, *Mechanical World* Offices, Manchester, and 118, Chancery-lane, W.C. We note that a considerable amount of new matter has been introduced this year, especially in the section dealing with electrical transmission of power. The acknowledged usefulness of this little book of rules, tables, and data has also been enhanced in various other directions.

Continental Telephones.—The *Daily Chronicle's* Brussels correspondent says the telephone cables at present being laid between Denmark, Hamburg, and Berlin, the completion of which is promised for next month, will be shortly connected with Brussels and Paris. The London-Brussels telephone will not, it appears, be ready as soon as had been expected, as the trials have so far only been successful as far as London. Attempts to communicate with English provincial towns were unsatisfactory. This defect must be put right before the line will be opened to the public.

Dorking.—Mr. W. H. Trentham's estimate of the proposed capital expenditure on electric lighting is £20,000, including two boilers, superheaters, and stokers, £1,975; two steam dynamos (90 kw. each), £3,136; steam-exhaust and water-pipe work, £801; switchboard and cable connections, £1,282; accumulators, testing instruments, £1,930; underground mains, street works, etc., £4,500; buildings, £3,000; land, £800; fees and contingencies, £892. The Council have formally approved the estimates and will submit them with Messrs. Edmundson's plans to the Local Government Board.

Lowestoft.—The Electric Lighting Committee's last report states that there are now 288 consumers, and applications from 26 consumers yet to be connected. In answer to applications for private lighting, two cables are to be laid at a cost of £550. Cables for public lighting are also to be laid in Suffolk-road, Waveney-road, and Whapload-road. These roads will be lighted with Nernst lamps, placed upon temporary posts, at an approximate cost of £300. The committee also propose to remove the arc lamps along the Esplanade, and to substitute the incandescent lights for the winter months.

Dundee.—An arrangement has been arrived at with the co-operative society to the effect that, provided the society consume during the year from May 15 last not less than 25,000 Board of Trade units for lighting purposes, the charge for units consumed for lighting purposes up to May 15 last would be at the rate of 2½d. per Board of Trade unit, and on the 25,000 units and over consumed for lighting purposes from the year from said May 15 at the same rate of 2¼d. per Board of Trade unit—it being understood that the current used for motive power shall not be calculated in making up the 25,000 minimum.

Bognor.—An application has been received from the National Telephone Company to erect poles within the urban district, in order that Bognor might be brought into communication with Chichester and the rest of the country. Sufficient subscriptions having been obtained, the company intended opening an exchange very shortly. The Council have pledged themselves to support the Post Office by promising to subscribe, but the latter have so far not taken any action. The Council will now write to the Postmaster-General enquiring, before they sign any agreement, when the Post Office system was likely to be established.

Parcel Post Trade.—We have frequently referred to the expansion which might be given to parcel post trade, so well developed elsewhere, and have just received quite apropos from Messrs. Neale and Wilkinson, 32, St. Mary-axe, London, E.C., a tariff of rates and information useful to those who have occasion to send packages abroad. By the arrangement of the book the cost of conveyance to almost any part of the world may be seen at a glance. We are informed that to South Africa, India, Australia, etc., packages can be sent cheaper than by parcel post and without any limits as to size and weight, and that a copy will be sent post free to any of our readers who care to ask for it.

Dalkeith.—Messrs. Crompton and Co., Limited, have, with the approval of the Town Council, acquired ground in Croft-street as a site for a generating station in connection with the provisional order granted by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, and the Electric Lighting (Scotland) Act, 1890. Messrs. Crompton and Co. have undertaken to lay down distributing mains for the purpose of a general supply of electric light within a period of two years. The Council have arranged for the street-lighting by electricity, and have the option to take over the whole undertaking upon a graded system of payments within six months of the expiration of a period of 10, 17, 24, or 31 years.

Accidents.—At the inquest into the death of a man who died at Sutton Coldfield recently while working on a feeder pillar connected with the electric cables which have been laid in the borough, the jury returned a verdict that the deceased died from electric shock owing to having a weak heart. A fire occurred on the 14th inst. in the East United Free Church, Aberdeen, and a splendid organ recently erected was destroyed. The organ was worked by electricity. It is supposed that the fire was caused by the fusing of the electric wires, as the seat of fire was near the electric motor. A breakdown in the supply of electricity occurred in Nelson recently owing to the fusing of a cable, which threw an amount of pressure on to the other mains they were not able to bear. In some cases damage was done by the bursting of the lamps, while the fuses were also damaged.

Leeds.—Dr. Panton, chairman of the Bolton Corporation electricity works, sends us some correspondence which has passed between him and the Lord Mayor of Leeds (Alderman Butler) relative to a statement and figures given by the latter at an inspection by the Leeds City Council of the new buildings and plant at the city electric lighting works, referred to in our issue of Oct. 3, p. 502. Dr. Panton gives the following costs per Board of Trade unit taken from a contemporary: ·96d. for Bolton, ·97d. for Cork, 1·00d. for Bradford, 1·00d for Liverpool, and 1·04d. for Leeds, thus putting Leeds fifth instead of first (as in report) as to cost of production. These figures differ slightly from those in the "Electrical Engineer's Central-Station Directory," just issued, where the figures are: Bolton, ·96d.; Cork (no returns received); Bradford, 1·14d.; Liverpool, 1·03d.; and Leeds, 1·18d. These are costs per unit sold, not including interest and repayments,

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Grimsby.—The Electricity Committee are holding an exhibition at the town hall to illustrate the uses of electric current for lighting, cooking, heating, and the driving of machinery. An artistic souvenir has been prepared descriptive of the application of electricity, and containing many beautiful illustrations. The text is by Mr. W. A. Vignoles, the borough electrical engineer, who has worked very hard to make the exhibition a success. In the souvenir he has given a host of useful information with regard to the use of the various motors and appliances, while the blocks which illustrate these methods are exceptionally good.

Paddington.—When the surveyor submitted his report upon the necessary alterations to the electric lighting arrangements in the town hall, he estimated the cost at £34, and he was instructed to have the work executed at a cost of not exceeding the amount of his estimate. During the recess the surveyor obtained quotations, and that of Mr. C. Mickleburgh, for £42. 10s., was accepted, he being a local man, although his price was 10s. above that of the lowest tender. This naturally led to a debate last week, where the opponents of this parochialism, not to call it worse, had decidedly the best of it. A strong protest was entered against the system which prevailed in the Council of asking different firms to tender and then not accepting the lowest tender sent in.

Fulham.—It is proposed that an electric motor, of not less than 3½ h.p., and a sawbench with boring apparatus and all accessories complete, be erected at the Borough Council's depôt at an estimated cost of £90. The London County Council having agreed to advance the Borough Council the sum of £25,000 (further part of the loan of £120,000 applied for) in connection with the extension of its electric light undertaking upon the terms that it is taken up at once and repaid with interest at the rate of £3. 10s. per cent. per annum, the latter body intend to provide out of a sinking fund established for that purpose, or from maintenance account for all renewals and replacements during the currency of the above-mentioned loan of £25,000 of plant or machinery provided with the proceeds thereof and to pay the costs of the loan.

Portsmouth.—The municipal telephones will be opened to subscribers in a few days. The completed area at present covers Portsmouth and Portsea, and includes about 240 subscribers. Owing to the rapid increase in the electric lighting of the borough, and the fact that the Electric Lighting Committee will shortly have to light several of the large Government departments, it has been decided to augment the plant at the electric light station by two 500-kw. sets. It is estimated that the probable increased income for the year will be about £4,500. It is not at present proposed to extend the existing buildings. Already the contract for lighting the new naval barracks has been approved and sealed by the Admiralty authorities, and negotiations are proceeding for fitting installations at the Gunwharf and Eastney Barracks.

Kingston-on-Thames.—The committee of the Municipal Society has forwarded to the Town Council the following resolution, which was unanimously carried at its last meeting: "That the committee of the Kingston Municipal Society has heard with great astonishment that the Kingston Town Council at their meeting on Sept. 30 went back upon their previous resolution as to the appointment of an expert to enquire into the position of the municipal electrical undertaking. That in the opinion of the committee of the society the necessity for the appointment of such an expert has in no respect diminished, and they call upon the Council in the interests of the burgesses, who are so deeply involved in the undertaking, to take immediate steps to carry out 'the searching investigation' demanded by the meeting of burgesses held at the Assize Court in March last."

Tunbridge Wells.—Colonel A. J. Hepper, R.E., has held the erquiry, already reported by us, into the Council's application for a loan of £10,000 needed in consequence of the increased development of the electric light system. From the evidence tendered it appears that in 1895 and 1896 the lamps connected were 7,066, and in 1901 and 1902 this number had increased to 43,378. In 1895 the mileage of cables stood at 14, and at the present time 64. In 1896 the gross profits stood at £657, and had reached £3,941 in the present year. The number of consumers had increased from 144 to 670. The chief items included in the £10,000 estimates for various additions and improvements were: condenser and foundations, £1,421; cooling tower, £1,200; cables, mains, etc., £2,764; 200 meters, £1,000; services and lamps, £500; feed pumps, £200; buildings, £633; boilers, £170; and several lesser amounts.

Fareham.—At the last Council meeting the Electric Light Committee drew attention to the satisfactory character of the accounts of the electricity works for the year ended March last. The committee had considered the desirability of charging in the accounts a fixed sum per annum for the public lighting, and had instructed the clerk to include in the annual accounts in future under this head a sum of £655. It was proposed in future, when the accounts justify it, to carry yearly credit balances to a reserve fund account for the purpose of accumulating a small fund to meet any contingencies. The committee were of opinion that the time had not yet arrived when a further reduction in price could be made. It was, however, hoped that the time was not far distant when, after the accumulation of a small necessary reserve fund, credit balances might be fairly taken into consideration in reduction of the price.

Bury.—An electric installation has just been completed in the Bury Athenæum at the expense of Mr. E. W. Mellor. It comprises 134 lamps arranged in 11 electroliers and four wall brackets controlled by 16 switches. The fittings and electroliers have been made to special designs by the General Electric Company, Limited, of London. The whole of the cable and wires have been supplied by W. T. Glover and Co., of Trafford Park, Manchester. The distribution and switch boards have been supplied by Dorman and Smith, of Manchester, the switches and fuses being of their latest improved high-voltage safety type. The whole of the wiring has been run in enamelled steel tubing supplied by the Simplex Tube Company. Ediswan lamps are used in 50 lights, the remaining 84 being of the latest type of Nernst lamps. The installation has been arranged and designed by Mr. J. G. Booth, electrical engineer, of Bury, and has been carried out to detailed specification under his supervision by Messrs. James Hill and Sons, electrical contractors and ironmongers, Bolton-street, Bury.

Engineering Exhibition.—From the prospectus of the International Engineering, Machinery, and Allied Trades Exhibition, which will be held at the Crystal Palace from March 2 to May 31 of next year, we note that the presidents of various engineering societies, chambers of commerce, the Colonial agents-general, foreign consuls, and a number of important personages like Lord Kelvin, Lord Avebury, etc., and the heads of many large engineering firms, have become patrons, and that there is every reason to believe that the event will be a success. During the last year the Crystal Palace has repeatedly attracted from 80,000 to 100,000 visitors per day, who *nolens volens* take an interest in the various exhibitions held there from time to time, thus guaranteeing that the display serves as a medium of bringing the exhibits to the immediate notice of a large section of wholesale and retail buyers. There are to be engineering, machinery, hardware, and allied trade sections, with a number of sub-divisions. Plans, etc., may be obtained from the organising commissioners at the Crystal Palace.

Motors.—Messrs. D. Bruce Peebles and Co., Edinburgh, are exhibiting at the Brighton Aquarium a representative collection of their standard and well-known models, including three multiphase induction motors of their completely protected type, the outputs varying from 37 h.p. to 1 h.p.; also exhibiting six multipolar protected motors, varying from 30 h.p. to ½ h.p. They particularly claim for the above machines sound mechanical construction, special attention being paid to lubrication and bearings to allow of the motors running continuously on load without heating, and absolutely sparklessly at all loads up to 25 per cent. overload for the continuous-current motors. The rest of the plant exhibited consists of a standard protected type motor of 5 b.h.p., directly connected to one of Messrs. Gwynne's twin series pumps; a standard battery booster, consisting of two P.P.P. open-type machines, directly coupled together on combination bedplate, and running at a speed of 1,000 revolutions per minute, the motor being wound for an output of 100 volts, and the generator having an output of 200 amperes at 12 volts.

King's Lynn.—At last week's meeting of the Town Council the electrical engineer (Mr. Pilling) reported that since the last meeting applications had been received for 1,034 additional lamps of 8 c.p. or equivalent (including the 400 reported at the last meeting), making a total of 13,655 lamps from private consumers. The working costs for July and August, as compared with the same months last year, were as follows: in July units generated were 13,547, last year 13,064; units sold to private consumers 6,988, last year 2,968; sold at power rates 2,610, last year 21; cost of fuel stores, repairs, and wages in station £107. 0s. 10d. (including £19. 16s. for repairs of batteries), last year £70. 1s. 2d.; cost per unit generated 1·89d., last year 1·28d.; wages of lamplighters and outside staff £21. 6s. 4d. (including cost of painting lamp-posts), last year £14. 2s. 3d. In August units generated were 16,765, last year 17,079; units sold to private consumers 5,993, last year 3,481; sold at power rates 1,409, last year 18; cost of fuel, stores, repairs, and wages in station £88. 15s. 8d., last year £87. 18s. 2d.; cost per unit generated 1·27d., last year 1·23d.; wages of lamplighters and outside staff £16. 2s. 7d., last year £15. 16s. 8d. The cost per unit generated was more in 1902 than in 1901 because repairs were higher.

Society of Working-Men's Rifle Clubs.—We have received a little book, entitled "Miniature Rifle Clubs, and how to form and conduct them," by Mr. H. Marks, the organising secretary of working-men's rifle clubs, which is extremely well adapted for the purpose for which it has been compiled. The society was inaugurated at a meeting at the Mansion House in the spring of last year, and, since the publication of the last letter on the subject in December last, has been instrumental in forming 36 miniature rifle clubs. Considering the difficulties which beset the path of every new institution, this constitutes by no means a bad record. The society was formed for the purpose of affording facilities to the working classes to become skilled in the handling of the rifle. Its aim is to induce large numbers of wage-earning people to occasionally utilise their evenings—the only time which is at their disposal—in a manner which, while interesting to themselves, will also prove profitable to the State. We are informed that the samples of various kinds of apparatus recommended for use as indoor ranges can be seen at the society's offices, 17, Victoria-street, Westminster, at any time, and any information on the subject of miniature rifle shooting will be supplied on application to the secretary at that address. The committee are now arranging the details of a miniature "Bisley"—*i.e.*, a competition open to all miniature rifle clubs, to be held in March next. Some valuable prizes have already been offered, and full particulars of this competition will be forwarded to all clubs desiring to enter.

Newton Abbot.—The Urban Electric Supply Company are erecting works on the Teign-road, near the Great Western Railway Company's goods yard, and it is expected that the first installation of the electric light will be an accomplished fact in the course of another month. Provision has been made for a pressure in the consumers' premises of 240 volts. It is calculated that one engine alone will be able to supply 6,000 lamps, and by a reserve of batteries the company has taken ample care that the supply shall be able to meet the expected demand during the coming winter months. The charge will be 6d. per unit. Torquay supplies the water which is usually used, and there is a supply in a pond opposite the works. The pond supply has

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some salt in it, and is not suitable for feeding boilers, but it will be used for the condensers, for which it is perfectly adapted. Later on pure water may be obtained from the artesian well. The company will also supply on the free-wiring system, and lend motors and arc lamps on hire. Customers who buy the installations within 12 months are to have the rental money returned, dating from the commencement of the arrangements. The company has adopted the hire-purchase system for three, five, and seven years on account of the motors and the fittings. The works are practically completed. The engine-room has been fitted with glass roofing with patent dry glazing. Messrs. Parker Bros., of Newton Abbot, are the contractors. There are two Belliss and Morcom engines of 135 h.p. and 450 revolutions each, and two Babcock and Wilcox boilers of 150 h.p. Foundations have been prepared for another engine and boiler. One engine has already been placed in position.

Yarmouth.—The Council on Tuesday adopted, without discussion, a report by the Electric Lighting Committee upon the report of Messrs. Preece and Cardew upon the present position and the probable future requirements of the electric light installation. It stated that the existing plant would supply as a maximum a load of 20,000 lamps, without allowance for spare plant. There are over 30,000 lamps connected to the mains, but as never more than two-thirds were alight at one time, the machinery was just sufficient at the present time to supply the maximum demand. The load, however, was increasing, and it was evident that additional machinery was urgently required. The committee considered that at least 15,000 more lamps would be connected within the next five years. They recommended that the boiler-house should be extended, and that a new shaft be constructed; the building would then be large enough to take 1,500 h p. in boilers. The estimated cost was £4,500. The whole of the machinery in the station was in use at times of full load; should any of the machinery break down, some of the lamps could not be supplied. The committee recommended the ordering of two 300-kw. plants, but owing to the additional buildings the outlay this year would be very heavy, and they recommended that the order for one plant be deferred till next year. When both 300-kw. plants were obtained, it would be perfectly safe to connect as many as 45,000 lamps to the mains. Assuming one plant to be sufficient for the present, the cost would be £6,700. They also recommended that the new main should be of three square inch sectional area, and be linked with the one in the Market-place by means of another length of cable. The cost of this work would be £2,300. They also included £1,500 for new sub-stations and low-tension cables. Their total estimate was £16,450.

London County Council.—At Tuesday's meeting of the Council sanction was given to a loan of £18,356 for electric lighting works to the Islington Borough Council. The Highways Committee asked for authority to expend a sum not exceeding £17,100 in the provision of a temporary station at Deptford for the electrical working of portions of the London County Council tramways; and also for this purpose to enter into an agreement with the London Electric Supply Corporation for the temporary use by the Council of a part of the company's premises at Deptford, and for the supply of steam from the company's boilers for the working of electricity generating plant to be placed there by the Council, payment in respect of such accommodation being made by the Council to the company at a rate to be agreed, but not exceeding 1½d. per unit of electricity generated, such agreement being for three years, but determinable, should the Council so desire, at the expiration of two years. Notices under Electric Lighting Acts and Orders have been agreed to as follows: From the Blackheath and Greenwich District Electric Light Company, to lay low-tension mains along Eltham-road and Granville-park; Brompton and Kensington Electricity Supply Company, high and low tension along Hollywood-road and along a portion of Earl's Court-road; Charing Cross and Strand Electricity Supply Corporation, to lay mains along Lincoln's-inn-fields and Portsmouth-street, along portions of Neal-street and Shaftesbury-avenue, Portugal-street, St. Martin's-court, portions of Drury-lane and Russell-street, along portions of the Strand, the Northumberland-avenue subway, and Great Scotland-yard; County of London and Brush Provincial Electric Lighting Company, low-tension mains along St. George's-road, high and low tension along Bell-court, and power and low-tension mains along a portion of Lever-street; London Electric Supply Corporation, high and low tension mains along New Kent-road, Warner-street, Meadow-row, Harper-street, Munton-road, Sayer-street and Tarn-street, and to construct underground converter chambers, and to lay mains of high and low tension along portions of Flood-street, Cheyne-walk, Chelsea-embankment, Sloane-street, a portion of Knightsbridge, Church-street, Elm Park road and gardens, and part of King's-road; Metropolitan Electric Supply Company, to lay high-tension mains along South-street, Blandford-street, Baker-street, York-place, across Marylebone-road, Upper Baker-street, Park-road, St. John's Wood-road, and Wellington-road; Notting Hill Electric Lighting Company to lay mains along Silver-street and the Mall to Palace-gardens-terrace, a portion of Silver-street, and along Addison-road North; St. Pancras Borough Council, to lay mains across South-grove, Euston-street, Bayham-street, a portion of Highgate-road, a portion of Eversholt-street, and a portion of High-street, Camden Town. A notice was also considered from the Metropolitan Electric Supply Company of intention to lay extra high-tension mains from the company's Willesden generating station, along Acton-lane, Harley-road, Station-road, Tubbs-road, Harrow-road, Amberley-road, Formosa-street, Blomfield-road, Edgware-road, Richmond-street, Carlisle-street, Church-street, Exeter-street, Devonshire-street, Lisson-grove, Marylebone-road, Wyndham street and place, Montagu-place, Dorset-street, Manchester-street, and South-street, to the company's station there. The proposed works, so far as the county of London is concerned, would be situated in the boroughs of Paddington and St. Marylebone. The St. Marylebone Borough Council disapproved of the works proposed to be executed in that borough, as it considered, among other objections to the work, that the route intended to be adopted for part of the mains was unsatisfactory, and the company appealed to the Board of Trade against this disapproval. The appeal was heard on Sept. 4, when the arbitrator decided that the route of the mains should be altered for some portion of the distance, and that the company should submit an amended notice and plans. The company, however, did not submit these to the Council, and as the original notice and plans referred to the laying of mains along a route which had been disapproved by the Board of Trade, the Council have disapproved the proposed works. A notice from the County of London and Brush Provincial Electric Lighting Company, under the Camberwell Order, 1896, of intention to lay low-tension mains along Wyneham-road and Beckwith-road was also disapproved. With the exception of those for a very small portion of Beckwith-road at its southern end, the works referred to in the notice would be within an area which was formerly a part of Lambeth, but which has been, in pursuance of the provisions of the London Government Act, 1899, transferred to Camberwell. As, however, this transference does not alter the area specified in the order under which the notice was served, the works referred to in the notice, excepting those in Beckwith-road, would be outside the area of supply under the order, and the Council would therefore not be in a position to approve them. The following were also approved of under certain conditions: A notice from the Blackheath and District Electric Light Company to construct five transformer boxes in Trafalgar-road; Brompton and Kensington Electricity Supply Company, to lay mains of high and low tension along portions of Fawcett-street and Hollywood-road; County of London and Brush Provincial Electric Lighting Company, low-tension mains along Jews'-row, and mains of high and low tension along Rodney-street; Kensington and Knightsbridge Electric Lighting Company, to lay mains along portions of Chapel-place, Montpelier-street, and Brompton-road; Metropolitan Electric Supply Company, to lay low-tension mains along Lincoln's-inn-fields, Carey-street, Portugal-street, Portsmouth-street, Sardinia-street, and a portion of Chancery-lane; St. Pancras Borough Council, mains along portions of Clarence-road, Hartland-road, and Tavistock-place, and along Marchmont-street and Burton-crescent, and also along a portion of Diana-place, Euston-road. The following notices served under orders granted to local authorities were received, under which the Council has no power of approval or disapproval of works: Hammersmith Borough Council, mains along Poplar-grove; Hampstead Borough Council, mains along Langland-gardens, Holmdale-road, along a portion of West End lane, and along Broadhurst-gardens and Canfield-gardens; Islington Borough Council, mains along portions of Southgate-road and Downham-road, along Stroud Green-road, Cloudesley-square and Milton-yard, Aubert-park, and a portion of Turle-road; the South London Electric Supply Corporation, mains along York road and crescent, Leigham-lane, Kinfauns-road, Northstead-road, Kingsmead-road, Knollys-road, and Leigham Valley-road; and the Stepney Borough Council, to lay mains along Sidney-street and Raven-row.

PROVISIONAL PATENTS, 1902.

OCT. 6.

21687. Improvements in brackets for carrying electric fans. John Annal, 19, Terrace-road, Upton Manor, Plaistow, London.

21706. Improvements in and relating to telegraphic recording apparatus. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

21762. Improvements in telephone signalling systems. Alfred Exström, 4, South-street, Finsbury, London. (Complete specification.)

21733. Improvements in and relating to electric fans. John Cory Fell, 1, Queen Victoria-street, London. (Walter Elswood Coleman, United States. (Complete specification.)

21734. Improvements in telephone apparatus. Gaston Houbigant, 40, Chancery-lane, London.

21736. Improvements in apparatus for producing gyratory magnetic lines of force for therapeutic purposes. R. Trüb and Co., 15, Took's-court, Cursitor-street, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 12, 1902, being date of application in Switzerland.) (Complete specification.)

21742. Improvements in electric arc lamps. Arthur Marshall Arter, 46, Lincoln's-inn-fields, London.

21748. Improvements in arc electric lamps. Frederic Stanhope Worsley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

OCT. 7.

21765. A new or improved electric rheostat. Robert Alfred Lehfeldt, 22, South Morton-street, London.

21769. Improvements in electric incandescent lamps. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

21771. Improvements relating to electric rail or track bonds. William Rushton Bowker, 20, Carlton House-terrace, Halifax

21801. Improvement in or connected with electrical terminals. Ross Dorrett, 49, Comyn-road, Battersea, London.

21831. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

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21842. Improvements in insulators. James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Edward Henry Tyler, India.)

Oct. 8.

21846. Improvements in apparatus for electro-deposition of metals on small articles. William Bate, 36, Temple-street, Birmingham.

21855. An improved electrical indicator. David Wells, 48, Dudley-gardens, Leith, Edinburgh. (Complete specification.)

21882. Improvements in or relating to electric indicating apparatus. Alexander Duvenbeck, 111, Hatton-garden, London.

21885. Improvements in electric lampholders. John Henry Hawksworth and Denis Ripley Broadbent, 25, Redgrave-road, Putney, London.

21888. Improvements in systems of electrical distribution. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 14, 1901, being date of application in United States.) (Complete specification.)

21901. Improvements in electric accumulators. Paul Schmitt and Charles Fabre, 40, Chancery-lane, London.

21913. Improvements in alternating-current motors. Leo Schüler and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

21914. Improvements in and relating to the regulation of dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.) (Complete specification.)

Oct. 9.

21935. Improvements in plug-boxes and in plugs therefor for electric lighting. George Smith, 57, Barton-arcade, Manchester.

21938. An improved automatic suspension and electrical contact appliance for apparatus requiring to be raised and lowered. Frederick James Turquand, 9, Kensington Park-road, London.

21952. Improvements in and connected with electrical signalling on railways. James Woods Tunstall, 15, Water-street, Liverpool.

21969. Electric meter. Edward S. Halsey, 96, Chicago-avenue, Chicago, Cook Co., Illinois, U.S.A.) (Date applied for under Patents Act, 1901, March 13, 1902, being date of application in United States.) (Complete specification.)

22017. Improvements in the construction of underground conduits, more especially intended for use in systems of underground electric traction. Thomas Easton Devonshire, 47, Lincoln's-inn-fields, London.

Oct. 10.

22023. Improvements in insulators used for electrically dividing into sections trolley wires as used on electric railways. Henry Brecknell, Edward May Munro, and Hugh Innes Rogers, Thrissell-street, Bristol.

22024. Improvements in lifeguards or fenders for electric cars and other road vehicles. Edward May Munro, Henry Brecknell, and Hugh Innes Rogers, Thrissell-street, Bristol.

22050. Improvements in and connected with electric switches. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

22067. Improvements in conduits for electric cables. John Holmes Sutton, 33, Chancery-lane, London.

22106. An improvement in safety fuses for electric leads. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Actien-Gesellschaft, Germany. (Complete specification.)

22107. Improvements in sockets for safety fuses for electric leads, partly applicable also to sockets for glow lamps. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Actien-Gesellschaft, Germany.) (Complete specification.)

22108. Improvements in electrical safety fuses. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Actien-Gesellschaft, Germany.) (Complete specification.)

Oct. 11.

22135. Improvements in and relating to the electrolytic decomposition of alkaline chlorides. James Dick Gilmour, 96, Buchanan-street, Glasgow.

22140. Improvements in electrical indicating apparatus. Andrea Chiesa, 1 and 4, Mitre-court, Fleet-street, London.

22147. Electrical fog signal patent for railways. Thomas Wilson, 73, Denmark-street, Possilpark, Glasgow.

22152. Improvements in telephone call-boxes. Robert Hall, 4, St. Ann's-square, Manchester.

22170. Improvements in the electrical ignition of internal-combustion engines. Frederick William Homfray and John Openshaw Howse, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22171. An arrangement for automatically changing the direction of an electric motor by temperature variations. Thomas Peder Hansen, 36, Chancery-lane, London. (Complete specification.)

22180. Improvements in electric ignition devices for gas-burners. La Société Radiguet and Massiot, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, April 9, 1902, being date of application in France.) (Complete specification.)

22184. Improvements in electrical signalling and controlling apparatus, chiefly designed for artillery purposes. Price Kinnear Lewes and Kenneth St. George Kirke, 45, Southampton-buildings, Chancery-lane, London.

22188. Improvements in overhead trolley tracks for electric tramways and the like. William James Sumner, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 16, 1902, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 30.

1901.

20187. Telegraphing and apparatus for that purpose. Casevitz.

20283. Repeaters for wireless telegraphy. Foresio. (Date applied for under International Convention, March 13, 1901.)

21701. Ships' compasses, ships' telegraph, and the like. Oppenheimer. (Actiengesellschaft Mix und Genest.)

21955. Machines for picking up and laying submarine cables. Johnson.

21984. Electric coils for oscillatory discharge. Radiguet and Massiot.

22037 Armature windings for dynamo-electric machines. Hobart.

23114. Controllers for electric motors. Newell. (Date applied for under International Convention, April 18, 1901.)

23116. Regulation and distribution of electric currents. Lamme. (Date applied for under International Convention, April 17, 1901.)

24227. Speed-regulating means for electric motors. Lamme. (Date applied for under Internation Convention, April 30, 1901.)

24228. Windings for electrical machines. Lamme. (Date applied for under International Convention, April 30, 1901.)

26285. Electric switches. Pieper.

1902.

1767. Devices for varying the speed of continuous-current electric motors. Bloxam. (Firm of Couffinhal et ses Fils.)

4905. Electro-dynamometers. Ziegenberg

5209. Magnetic ore separators. King.

5713. Magneto-electric igniter for explosion motors. Bergmann.

6494. Signalling devices for telephone systems. Cedergren. (Date applied for under International Convention, Oct. 21, 1901.)

14386. Electrolytic manufacture of chlorates and perchlorates. Pierre Louis Eugène Lederlin. (Date applied for under International Convention. Jan. 8, 1902.)

14862. Electrical controlling means for elevators or lifts and other apparatus. Otis Elevator Company, Limited. (Otis Elevator Company.)

17202. Holders for the commutator brushes of dynamo and other electric machines. Weidaw and Barney.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7¾-8¼
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	102-104
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16¼
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2¼-2¾
—— 5 per cent. Debentures	100 ..	101-106 p c
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼-¾
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	77-82 xd
—— 4 per cent. Deb. Stock, lied.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10½
—— 4 per cent, 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16-17
—— 4½ per cent. Preference	5	5½-5¾
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	99-102
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4¼-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	12½-13
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9½-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	103-105 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13-14
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12½-13
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5½
—— 5 per cent. Deb. Stock, Red.	100	104-107
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4¾-5¼
—— 4 per cent. 1st Mortgage Debentures	100	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4¾
—— 4 per cent. Debenture Stock	100	95-98
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref. } Within £1-82,500	10	11½-12
—— " " " " } £1-82,500	5	8¾-9¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	107-109
—— " " Prov. Crts.	50	81-83
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8½-9⅝
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	16s.	3 16
—— £250,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c.	80 p.c

Electric Railways.—

Central London, Ordinary	100	104-107
—— 4 per cent. Pref.	100	107-110
—— " " deferred	100	105-108
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	71-73
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	90-93

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅛-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	105-108
Bournemouth and Poole, Ordinary	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	9½-10½
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	10½-10¾
—— 7 per cent. Preference	5	10½-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7⅛-8½
—— Nos. 20,001-30,000	5	7½-8½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " " £10 Ord.	6	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	105-106
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5¼-6
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	9½-10½
—— 6 per cent. Cumulative Pref.	10	12¼-13½
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London and Brush Provincial, Ordinary	10	8¼-9½
—— 6 per cent. Cum. Pref.	10	11¼-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	111-114
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6¼-6¾
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4¼-4¾
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7⅛-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10½
London Electric, Ordinary	3	1¾-2¼
—— 6 per cent. Pref.	5	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15¾-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	110-115
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9½
—— Preference	4	6¼-6¾
Notting Hill Electric Lighting	10	13¼-14¼
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oriental, 1879	1	—
—— £5 Shares	5	—
—— £4½ Shares, New	4½	—
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	89-90
South London, Ordinary	5	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5	15-16
—— 7 per cent. Pref.	5	8¼-8½
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3¼-4¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3¼-4¼
Westminster, Ordinary	5	11¼-12½
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	6-6¼

Telephones.—

National Telephone, Preferred	100	93-95
—— Deferred Stock	100	55-57
—— 6 per cent. Cum. First Pref.	10	12¼-13½
—— 6 per cent. Cum. Second Pref.	10	11½-12½
—— 5 per cent. Non-Cum. Third Pref.	5	4¼-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	96-99
—— 4 per cent. Deb. Stock, Red.	100	102-106
Oriental Telephone and Electric Company	1	¼-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Pass'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 4	997	739	+ 257	+ 4,942	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	" 11	5,152	4,778	+ 374	+13,356	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	" 10	760	690	+ 70	+ 3,521	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	" 9	772	535	+ 237	— 18	16½	—	Mar. 31	41,818	5,809,190	753,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	" 11	457	328	+ 129	— 341	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 12	1,635	1,511	+ 124	+ 2,928	32	—		77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	" 5	3,292	1,154	+2,138	+76,406	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57*
Bristol Tramways Company	" 10	4,541	3,850	+ 691	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	Sept. 20	195	180	+ 15	+ 450	—	—	" 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	Oct. 11	6,853	6,291	+ 567	+ 8,261*h*	12	12	" 31	335,086	41,188,383	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	" 12	3,349	2,061	+1,288	+14,325	12½	9½	" 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	" 9	741	467	+ 274	+ 4,899	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	" 11	213	222	— 9	+ 71	4½	—	" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 12	112	102	— 10	— *h*	6¾	6¾	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	" 10	3,778	3,765	+ 13	} + 661	46	46	" 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	" 10	746	787	— 41											
Dundee City Tramways	" 8	811	690	+ 121	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	" 11	12,402	13,255	— 853	—	104	95	" 31	582,146*e*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	" 8	1,105	1,019	+ 86	+ 2,105	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	" 11	1,050	921	+ 129	—	48	48	Sept. 30	29,061*h*	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	" 11	2,132	2,294	— 162	+ 1,850	19	9½	" 30	72,331*h*	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	" 4	10,171	9,820	+ 351	+30,514	93	78	Dec. 31	87,707	21,065,993	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	" 12	1,470	1,425	+ 45	— 1,265	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Sept. 20	1,831	1,003	+ 828	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Oct. 12	4,134	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	" 9	947	860	+ 87	—	11	—	" 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	" 13	1,022	1,112	— 90	—	19	17	" 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *h* Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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Supplement to "The Electrical Engineer,"

OCTOBER 17, 1902.

DISTRIBUTION OF ENERGY FOR TRAMWAY, LIGHTING, AND POWER PURPOSES.

In our issue for Sept. 19 there was included in the "Questions and Answers" column a question, No. 517, which required a great deal of information in answer. We accordingly offered a reward of £3 for the best answer received. As a result, a large number of contributors forwarded to us their ideas on the subject, and the best replies to it are given below. These form a good *résumé* of the latest information available on the distribution of power over a moderate sized area. The question reads as follows:

Question No. 517.—A company holds powers for electric tramways and electric lighting in three villages through which the tramways pass. The tramways radiate in three directions, the centre being a convenient spot for a power station, being close to canal and colliery. On each leg of the tramways one of the three villages is situate, the distance from the power station to the villages varying between 1½ to 4 miles, the arms of the tramways being four, five, and six miles in length from the radiating point or power station. The radiating point is practically the electrical centre of gravity. A good demand for power may be expected, and a fair demand for lighting current. The power station will therefore be a combined lighting and traction station. Consider the all-round advantages of the following systems of generation and distribution for such a scheme: (*a*) high-tension continuous and rotatory transformers; (*b*) low-tension with reversible boosters and battery sub-stations; (*c*) three-phase and rotatory transformers (motor-generators); (*d*) three-phase and converters; (*e*) three-phase and static transformers The effect of lightning and inductive disruptive charges in the high-tension continuous system should be borne in mind.

Best Answer to No. 517 (*awarded* £3).—In the consideration of this question it will be advisable to briefly review the conditions under which the undertaking will be working. For clearness, a rough plan which approximates to the distances in the question is given. Probably the relative importance of the various sources of load will be in the following order: supply for power, supply for tramways, supply for lighting.

Now, in considering a scheme of electricity supply it is, after all, the consumer who has to receive the first consideration. By this is meant that the question of whether the supply shall be on the alternating-current system, the continuous-current system, or both, depends on the needs of the people from whom we expect the demand. We shall, in the first place, have a continuous-current system for the supply of tramway power, and the superiority of this system for lighting will be undisputed If, therefore, it is possible to meet the demands of power users with this system, there is little doubt that continuous-current distribution is the correct one; on the other hand, if there is sufficient evidence to show that alternating-current supply would meet the requirements of power users better—as these will ultimately be the chief consumers—its supply must receive due consideration. The alternating-current three-phase motor is now in undisputed possession of some sections of power work, particularly where continuous running and constant speed only are required. In mines the three-phase system is much to be preferred, and if the supply is in a colliery district this should be considered. Certainly continuous-current motors will do all that can be done by three-phase motors, and, in addition, they are easily started on full load, and can be used economically for variable speed. Their great drawback, however, is the commutator. Commutator troubles have been theoretically minimised by advocates of continuous current, but the fact remains that the continuous-current motor requires more attention, and is more liable to break down, than the three-phase induction motor. Without a survey of the district it would be impossible to say whether the requirements would be best suited by continuous-current or alternating-current motors, but taking the majority of towns the continuous-current system would have the advantage. We will assume, then, that continuous current is to be distributed in preference to alternating current, and from this standpoint we may consider the systems enumerated for generation and transmission.

The High-Tension and Rotatory Transformer System.—This system seems to have been the outcome of the desire to do away with alternating-current transmission where continuous current was used for distribution, but where the area supplied would be too great to transmit the low-tension current in the ordinary way on the three-wire system with 400-500 volts on the outers. By its adoption an uniform system throughout was possible, and the following towns have undertakings working successfully in this manner: Oxford, Walsall, Morecambe, Barrow, Bromley, Folkestone, Guernsey, and Hull.

The advantages claimed are: (1) uniformity of system; (2) no light load and idle current losses as with the alternating-current system; (3) the possibility of controlling all sub-stations from a central switching station, thus reducing the cost of sub-station attendance; (4) steadier pressure resulting from central control; (5) higher efficiency compared with other systems; (6) the transformation of pressure and current in one machine.

The disadvantages are: (1) complication; (2) risk of breakdown; (3) commutator troubles; (4) limit of voltage—2,000-3,000; (5) stress on cables through opening switches on short-circuits.

It would appear from the above that while the disadvantages are very real, the advantages are not so great. The importance of advantage (1), uniformity of system, is easily over-rated, while with (2) it is doubtful whether the loss in running continuous-current rotary transformers is less than that due to the idle current losses in the alternating-current system. The advantage claimed of being able to reduce the wages item by central control, is worth consideration; but it should not be forgotten that it would be unpractical to have highly complicated machinery running without any attendance. It is difficult to see exactly how steadier pressure is obtained by central control, though probably the uniformity of pressure over the whole system would be greater. The efficiency claimed for the high-tension continuous-current system at full load is approximately 92 per cent., and will be seen to be slightly higher than the other rotatory transformer or converter systems. The transformation of energy in one machine may be an advantage in economy and capital cost, particularly with double-wound armature machines.

Against these advantages must be placed the disadvantages: (1) The system is highly complicated, which is certainly something to be avoided. (2) The risk of breakdown due to the number of pilot wires running between the sub-stations and the switch station and to the complicated switchgear is increased, and, continuity of supply being the first consideration, any system less reliable than others must have very great compensating advantages to be in the running. (3) The commutator troubles may be greater or less according to the designs of the machines; but with the best machines there will be wear, tear, and attention, and greater risk of flashing over because of the high pressure and the presence of dust inseparable from any works. Commutator troubles may be made very light of; nevertheless, the fact remains that even with low pressures they exist, how much more are they likely to do so with high pressure. The voltage limit militates against the adoption of this system for any large area, but this would not have much weight in the case under consideration (4) The remaining disadvantage to be noted is the strain put on the cables when breaking a high-tension switch on an inductive load. This may be overcome with a special flare switch, but this is again adding complications.

If this system were adopted, some of the disadvantages would be overcome by doing away with the central switch station and simply feeding the sub-station with high-tension continuous current, and distributing and controlling from

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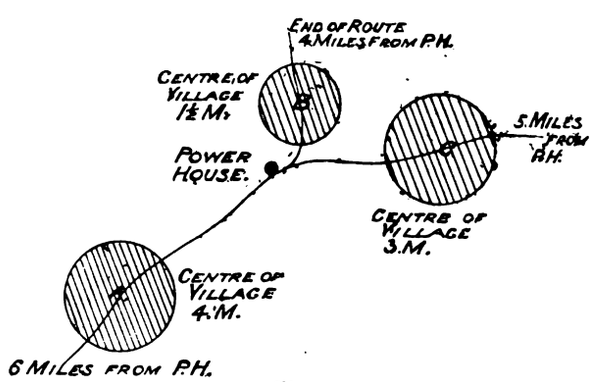
them. It may be said, then, that though this system is quite suitable for use in this case, yet in the writer's opinion the advantages as compared with the disadvantages do not warrant its adoption.

Low-Tension with Reversible Boosters and Battery Sub-Stations.—During the past few years an evolution in the use of accumulators has been taking place. Ten years ago the battery was looked on by many engineers as a very doubtful and troublesome part of the station equipment, and the uncertainty of life and depreciation doubtless long delayed the recognition of their true importance as a factor in central-station economy. Gradually, however, the merits of accumulation brought secondary batteries to the front, and as engineers became better acquainted with them, it was found the objections raised had been over-rated. The chief reason for rapid depreciation was found to be due to two main causes—viz., the lack of knowledge of accumulators, and neglect in giving them the necessary attention.

The weak point in a battery is always the regulating cells, and this, coupled with the cost of regulating appliances—switches, battery leads, etc.—and the difficulty of easily varying the battery pressure and altering from charge to discharge, has led to a number of attempts to do away with regulating cells and substitute automatic reversible boosters, which are now a success. This is undoubtedly a step in the right direction, for not only does it do away with regulating cell troubles, but it also enables the battery to be used more efficiently in conjunction with the running plant. The cost of this booster a d appliances is found to be less than the cost of extra regulating cells, battery leads, and switches.



Plan.

The claims made for the reversible booster system with batteries are: (1) the engines may be worked at a steady load, thus with convenient size of plant the sets may be always run at full load, with the consequent economy; (2) the batteries may be used to take the sudden peaks of the traction load and the peak of the lighting load, thus a reduction in the size and number of the generating sets may be made; (3) the power to keep the pressure steady through wide variations of load; (4) where battery sub-stations are used for the above purposes a saving in the copper feeders may be effected; (5) that one type of generator is suitable for either lighting or traction; (6) that the stand-by losses of the steam-raising plant are greatly reduced.

To approximately appreciate the advantages of this system, it will be necessary to consider the conditions of working.

The generating station would comprise a number of similar units of a type suitable for either lighting or traction. From the power-house the current would be fed on a two-wire system with 500-600 volts pressure to the battery sub-stations, A B C, from which it would be distributed. There would be, say, two batteries of similar make and capacity in each sub-station, and these would be in parallel with the lighting mains and traction mains respectively. In addition to the two batteries there would be three reversible boosters—that is, a complete set for both lighting and traction and a reversible booster for a stand-by. There would also be a balancer and the usual switchgear.

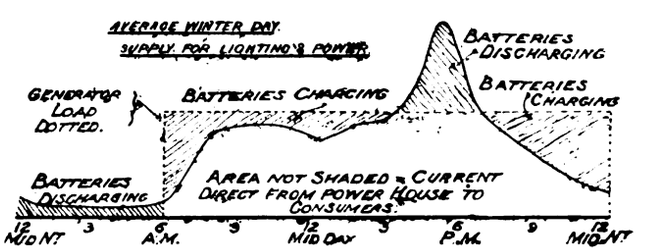
The cars will probably run from 5 a.m. to 12 midnight, the greatest demand being at meal hours, particularly between 5 and 6 p.m. and 7.30 to 8.30 p.m.

The average maximum lighting and power load would probably be as approximately shown in the curve, having a heavy peak between 4 and 6 p.m. in the winter months, when the power and lighting loads coincide. There would probably be only a small demand for light and power from 12 midnight to 5 a m.

The plant in the power-house must be such that in conjunction with the six batteries it will cope with the maximum combined lighting, power, and traction load. In addition, there must be one steam-raising unit and one generating set as a stand-by.

In the curve given the power station is shown shut down from 12 midnight to 6 a.m. One or the required number of sets are then started up, and are at once fully loaded, charging the batteries in addition to supplying the demand. As the load increases the battery charge decreases, keeping the load on the generators steady. At 3 p.m. the lighting load comes on, and the batteries commence to discharge, taking the peak of the load till about 7 p.m., when they commence to charge again, beginning with a small charge, which increases as the load goes off, until at 12 midnight the batteries are fully charged ready to take the all-night load.

The traction load will naturally be different to the lighting and power load, and much depends on the number of cars on the line as to the advantage obtained from the battery. In this case, as the number of cars would not be very great, the advantage accruing from the use of accumulators would be important. Further, the voltage would be kept up at the end of the line, and thus obviate the need of "line" or "return feeder" boosters. It will be obvious, from what has been said, that the load factor of such a station would be very high, and as the "works" and "total" costs per unit decrease as the load factor increases,



Load Curve.

economical working would result. It may be taken that for "generation costs" this system would certainly have the advantage of the other systems.

For transmission there will be three main disadvantages—viz. (1) greater weight of copper in mains, (2) $C^2 R$ losses in mains, and (3) loss in batteries. At first sight these disadvantages would appear to be very great, but further consideration shows that they are reduced in importance, owing to the peaks of the respective loads not having to be dealt with from the power-house, and to the lower cost per unit generated. There is a saving also in having two-wire feeders in place of three or four wire feeders; also, the insulation would be more cost for high than for low tension feeders. Against the $C^2 R$ losses in the mains must be placed the idle current losses in the alternating-current system, and the loss in running rotary transformers and converters with all other systems. The loss in the batteries is an interesting item. It should be remembered that the battery charge is only from what might be called surplus power; also, that *only a percentage of the whole current is accumulated*, as against, with the other systems, *all* the power having to be transformed or converted. The unshaded portion in the curve shows the amount of power sent direct from the power station through the sub-stations to the consumers, with only the losses in the mains. The efficiency of that percentage of the whole current that is accumulated may be taken at (75 to 84) per cent.

In considering the advantages of this system, it must be remembered that there are six batteries which can all, or any number of them, be used for either lighting or traction; thus the "make-up" load of the traction sets

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may be used for lighting, or that of the lighting sets for traction—in fact, quite a number of combinations may be effected. Against the heavy capital cost of the battery stations may be placed the lower capital cost of the power station, but it would be impossible to compare the total capital costs without having full particulars of the whole scheme. The uniformity of system and absence of high-tension current, with its dangers and necessary precautions, in addition to the other advantages, make this system, in the writer's opinion, a very favourable one for this particular scheme.

Three-Phase Alternating Systems.—Generation and transmission with three-phase high-tension current, and distribution with low-tension continuous current, is now acknowledged as the most convenient and economical for large schemes covering great areas. In some cases the current is delivered "in bulk" to the local authority or consumer, but the majority of cases are where the whole scheme is under one control. The chief advantages of transmission by three-phase currents are: (1) the comparative small amount of copper required for mains; (2) the high voltages that can be satisfactorily used; (3) the simplicity in "generation," and less expensive switchgear due to dealing with small currents.

There are four methods of transforming and converting three-phase high-tension current for distribution. They are:

1. (*e*) Static transformers.
2. (*c*) Asynchronous motor-generators.
3. (*c*) Synchronous motor-generators.
4. (*d*) Rotary converters.

When the load is principally or altogether a power load, and *the polyphase motor will meet the requirements of the consumer*, the static transformer is the cheapest, simplest, and most economical system. The current can be generated at the necessary voltage for transmission without difficulty, and static transformers placed near the consumers' premises if they are in an isolated position, or in suitably arranged transformer sub-stations or pits, with low-tension three-phase distribution if the consumers are in a reasonably condensed area. The lighting, however, on this system with motor loads is not satisfactory, there being much difficulty in balancing the load and keeping the voltage steady. Apart from this, the public seem to prefer continuous current, and it would only be in exceptional cases where the static transformer system would be used. There will probably be a greater field for this system in the future, when several of the objections against it can be diminished. Being practically confined to continuous-current distribution, it becomes a question as to which of the three methods of conversion from alternating current to continuous current are most suitable. Table A given by Mr. Eborall is instructive (see *Transactions*, Institution of Electrical Engineers, vol. xxx., p. 751).

TABLE A.—Comparison of Sub-Station Machinery.

Transmission: three-phase at 5,500 volts between lines and 40 cycles. Distribution: three-wire, with 510 volts between outers, neutral conductor earthed.

Type of equipment.	Asynchronous motor-generator.		Synchronous motor-generator.		Rotary converters and step-down transformers.	
Output of sub-station converter	Kw. 150	Kw. 500	Kw. 150	Kw. 500	Kw. 150	Kw. 500
Efficiency { Full load	% 83·5	% 86	% 84	% 87	% 90	% 92
Efficiency { Half-load	75·5	80	76	79	85	87·5
Overload capacity for one hour with fixed brushes.	25	25	25	25	50	50
Power factor { Full load	90	91	100-95 leading	100-96 leading	100-95 leading	100-96 leading
Power factor { Half-load	87	88				
Relative cost per kilowatt including regulating gear	20	15·6	19·1	13·2	12·4*	13·0*

* Including middle-wire booster.

The chief claim for the asynchronous motor-generator is its simplicity and the absence of complicated switchgear; also, there being no synchronising operations, less expensive labour can be employed in the sub-stations. As will be seen from the table, however, the efficiency is not very high; the power factor also is low. Further, that the comparative cost of sub-station equipment is higher than with the synchronous motor-generator, or rotary converter. It is, therefore, not employed for work of any magnitude, though it is sometimes used in conjunction with the other types in large sub-stations. The synchronous motor-generator is more complicated than the previous type, owing to the starting gear, the synchronising operations, and gear for same, and the necessary machine for excitation. It will work well with a high periodicity, and for combined lighting and power work is entirely satisfactory. It has a high power factor, slightly higher efficiency, and less cost than the previous type. The ease of controlling the current and pressure of the direct-current generator is important, and they operate successfully in parallel. For combined lighting and power work it is undoubtedly the best.

Rotary Converters.—Owing to the special character of these machines and their regulating devices, the rotary converter is the most complicated of the three types, nor can it compare with the previous ones in simplicity of operation. There are, however, advantages that have to be duly considered: (1) the high efficiency; (2) the high overload capacity; (3) relatively low cost. A great disadvantage is that it will not work satisfactorily at a high periodicity, 30 to 40 cycles appearing to be the practical limit; another is that there is greater difficulty in parallel running, the machines "hunting" from the slightest cause with the higher frequencies. If the amount of power work is great and the lighting relatively small, then rotary converters working at a low periodicity would be the most desirable. In comparing the cost of rotary converters, it should be borne in mind that there are transformers to be provided, and this will lessen the advantages in both cost and efficiency.

A possible alternative to the above systems worthy of consideration would be the supply of high-tension three-phase current to large power users, and low-tension continuous to small power users and for lighting.

Conclusions.—In the essential brevity of an answer of this description it will obviously be impossible to deal in detail with any of the respective systems enumerated, and the consideration given is but of the most superficial character. Moreover, without full particulars of the actual case, it would be useless to say definitely which system would be the correct one from all standpoints to adopt. As far as can be reasonably assumed, the choice appears to be between the two following systems—viz.: low-tension with reversible boosters and battery sub-stations, and the three-phase and synchronous motor-generators. Each should be considered on their individual merits for the particular case. The writer has merely tried to indicate on broad lines what he considers to be the underlying principles, and the respective advantages and disadvantages of the different systems.—E. T. WILLIAMS.

Answer to No. 517 (*awarded* £2).—Before deciding on any particular system, there are two points which should receive most careful attention: (1) *The machinery should be such that it will give reliability of working over long periods of time.* Efficiency is, of course, an important factor, but if in striving after a few extra per cent. the general reliability of working is jeopardised, then by all means let efficiency slide. A breakdown, or even a partial stoppage, may easily cost much more at one swoop than the saving represented by a year's working at slightly higher efficiency The past history of electrical work is unfortunately full of such instances. (2) *Rotating mechanism should be reduced to the lowest amount, and the personal factor minimised as much as possible.* Every rotating piece of mechanism, even when fitted with self-oiling bearings and all the latest improvements, is liable to require attention at any moment. The smaller items of plant especially frequently call for attention which is altogether out of proportion to their position in the general scheme. Sub-station machinery in particular should be as simple as possible, and if a system can be devolved in which the sub-station may be left to itself except for an occasional inspection, then, other things being favourable, such system should be a good one to adopt.

Before passing on to consider in detail each of the various

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systems of generation and distribution, it would be well to note that as regards the electric lighting itself there is not much to choose between continuous current and three-phase. The periodicity of the latter must be preferably fixed at 50 per second, so that the impulses are not perceptible. The ordinary open-type continuous-current arc lamp is possibly a rather more satisfactory piece of apparatus than the alternating arc, by giving a greater and better directed light. It is probable, however, that enclosed arc lamps and flame arc lamps will come more and more into use in the future, and in that case there would be no advantage for continuous current. For a given voltage there is little difference in the cost of cables and wires; the insulation of same is common to the two systems, and it forms a large proportion of the cost. Regarding the question of motors for power work, the writer considers the three-phase system is the best for all ordinary customers, because the motors are so simpler. The absence of a commutator more than covers any slight disadvantage from reduced starting torque, and the fact that the speed cannot be varied so readily. Good starting torque is, after all, merely a question of having the motor large enough, and all questions of speed variation can, if required, be arranged by suitable gearing by belts or wheels, etc.

We will now briefly consider the *pros and cons.* of the various systems in the order given by the querist, keeping principally in view the question of suitability for electric traction work.

(*a*) *High-Tension Continuous and Rotatory Transformers.*—The simplicity of this system is attractive, and for the area under consideration it could be employed quite well at the comparatively moderate tension of 1,500 volts. Owing to the extra expense of insulation, etc., the generating machinery would cost more than low-tension plant for the same output, and also more than three-phase high-tension plant. As regards the transformers, these may consist of two separate machines coupled togther, in which case they are very expensive, or of one machine with two commutators, the field being split into two parts so that a certain amount of regulation can be given. This single machine is much cheaper, because the windings are both on one core. Armature reaction is thus almost neutralised. In these high-tension continuous-current machines there is always a liability of flashing over at the commutator brushes, and there is also, of course, a good deal of danger in attending to the brushes, etc. Where the high-tension continuous-current system has been in use for some years, as at Oxford, Wolverhampton, etc., it has been successful, but not commandingly so. There is something to be said for the system—that it would be most economical in copper. There would be no change in the kind of current, assuming the tramways to be worked on the ordinary 500-volt continuous-current system.

(*b*) *Low-Tension with Reversible Boosters and Battery Sub-Stations.*—Before it was adopted in this country the reversible booster had been employed on many Continental tramway systems with considerable success. It is now coming into use in this country, frequently in the form known as the Highfield booster. It is a mistake, however, to suppose that this is the only suitable type, as any reversible booster will effect the necessary result, and, as things stand at the moment, at a much lower first cost. Batteries are convenient—in fact, may almost be considered a necessity where lighting, power, and traction are all being worked together. The energy in the cells being always on top, as it were, the peaks of the load are taken care of without there being any irregularity of lighting. Now that cells are used in conjunction with the reversible booster, the old trouble with the regulating end cells is done away with, and by being always kept fully charged, the battery works at its highest efficiency and with a minimum of expense. Further, it is now possible to obtain a maintenance guarantee from any good maker, by which the battery can be kept up to its original standard for about 5 per cent. on its first cost.

(*c*) *Three-Phase and Rotatory Transformers* (*Motor-Generators*).—The great objection to the employment of three-phase current with motor-generators is the low all-round efficiency, and the large voltage drop. Motor-generators consist of two separate machines coupled together, and even if there is a fair efficiency at full load it falls off very rapidly at low loads, as was found on the Blackheath and Greenwich supply. The large drop in volts is due to the fact that the three-phase motor is *asynchronous*, and has, therefore, a slip of 5 per cent. or so, and this must be added to the drop on the continuous-current side The continuous-current machine may, of course, be compounded, but, unless great care is taken, the machines may not work well together in parallel. The great advantage of the asynchronous motor is that it has considerable torque, and so is not subject to falling out of step as in the converter. Where the lighting is arranged on the three-wire system, one motor may be conveniently arranged to drive two dynamos, one on each side of the middle wire. Of course, as such a plant consists of three separate machines, it is expensive, and takes up a good deal of room. Being quite separate electrically from the continuous-current machines, the question of periodicity is immaterial. With converters, as we shall see below, this is not so.

(*d*) *Three-Phase and Converters.*—Compared with the motor-generator the converter is inexpensive, and at the same time, the efficiency is quite remarkably high, as much as 93 per cent. being reached. Converters run synchronously, so there is no slip to allow for, but there is the usual drop due to C R losses in the machine itself, and these need to be taken care of in some way. There are various methods for doing this, but probably the best and most scientific is that due to Dobrowolsky, in which the alternating-current conductors are acted upon by a separate field before they reach the armature of the converter, this separate field raising the voltage to any required degree. The question of falling out of step largely depends on what are the variations of the load, and also on the design of the machine itself. Some machines will continue to run under quite considerable irregularities of load, but there is always the contingency of the machine falling out of step at any moment, and this, of course, means that an attendant must be at hand. In a large system, such as at Glasgow, there are always attendants about, but on a comparatively small system it is important to do away with extra labour as much as possible. With converters, the question of periodicity is far more important than it is with motor-generators because the number of poles is governed by the periodicity. At 50 periods per second the number of poles would be excessive, and the machine expensive and inefficient, judged from the standpoint of continuous-current dynamo design. Mainly on this account 25 periods per second is usually chosen, and at this low periodicity arc and incandescent lighting direct from the alternating-current mains is not advisable.

(*e*) *Three-Phase and Static Transformers.*—Personally the writer is of opinion that, given a fair field and no favour, this is the best all-round system. Its extreme simplicity appeals to one, and there is no doubt if we were making a fresh start in lighting, power, or traction work, with our present knowledge the three-phase system of working would be practically universal. However, in the particular case before us there are points which must be taken into account. First of all the Board of Trade limits the voltage to half what is allowed with continuous current. It is very stupid of them, but there it is. Then, again, continuous currents having held the field for so long, the standard tramcar equipments have reached a high pitch of manufacturing development, and may be obtained on the open market at remarkably low prices. Three-phase plant, on the other hand, at any rate for traction work, is not so readily obtainable. When properly designed and made, it is capable of anything that can be done with continuous-current plant. There is, of course, the æsthetic objection to three-phase tramways that two trolley wires are required instead of one, but this is not nearly so apparent when one sees an actual installation In any case, it is more than counterbalanced by the fact that all electrolysis troubles are overcome, and this latter is a point which is likely to give considerable trouble in the near future, as the present Board of Trade regulation of seven volts drop is no sort of a solution. There is one feature of the three-phase system of working electric tramcars which, did he but know it, would appeal most strongly to the man in the street. It is that the speed of a three-phase motor being governed

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by the periodicity, it is impossible for the car to run away whilst the motor remains in circuit. Many very ingenious brakes have been devised, but whilst the human factor remains what it is there is always the chance of accidents such as have happened recently at Bradford, Devonport, etc., on the continuous-current system. It is somewhat difficult to compare the cost of various types of transforming plant, because a great deal, of course, depends on the maker, some firms making a speciality of one form and some of another. However, taking the static transformer, which can be supplied at rather under £2 per kilowatt, as our unit, the other forms of transforming apparatus may be roughly compared as follows: ordinary static transformer in cast-iron case, 1; three-phase converter (single machine), 3½; high-tension continuous rotatory transformer (single machine), 4; three-phase to continuous-current motor-generators (two machines), 5; reversible boosters, low-tension (two or more machines), 6. There is no question that from the point of view of the sub-stations static transformers are cheapest in first cost and running; and, taking everything else into account, the writer would suggest that the querist should adopt the *three-phase and static transformer system*.—E. KILBURN SCOTT.

Answer to No. 517 (*awarded* 30*s.*).—To make anything like an adequate comparison of the systems enumerated above it would be necessary to give a detailed description of each, and would occupy more than all the available space in this journal. Therefore, whatever is done in that respect must necessarily be somewhat in abstract. In comparing the above systems there are two points upon which such comparison should be based—namely, reliability and durability. Such comparisons will be made more clear by first reviewing some points which are common to all, such as the question of

Earthing.—In the case of the low-pressure distribution, the object of earthing is not to diminish the cost of insulation, for no appreciable saving is effected by using a pressure of 200 volts instead of 400; nor is it to secure safety to life: the chief object is to enable the consumer to be supplied at such a pressure that no conductor is brought into his house exceed the limit defined by the Board of Trade as low pressure. In the case of traction systems the object is to enable the rails to be used as one conductor, chiefly with a view of simplifying the working, and to enable the conducting power of the rails to be utilised. It is therefore obvious that the conductor is earthed throughout its length, therefore the only way to prevent the current returning by means of water and gas pipes, and also there being a difference of potential at separate points and consequently waste of energy, is to keep the potential difference very low. The most important case of earthing is undoubtedly that of tramways, and its advantages and disadvantages may be stated as follows: The extreme potential difference that can be attained by any one of the conductors from the earth is halved, and all can be handled with safety. The stress on the insulation is also halved. All three conductors may be taken into consumers' premises for all pressures up to 500 volts without contravention of the Board of Trade regulations. In the case of a short-circuit occurring in one of the outers immediate notice is given. It has the disadvantage that if a break exists on one conductor, current is continually forced through it, causing in some cases complete destruction of the insulation. A short-circuit on one side of the system is produced by a break on one conductor, unless the earth connection is removable. Balancing wires bring back but little current to the generating station, but locally heavy currents flow between various installations composing a balanced main, and the difference of potential of these currents may set up destructive electrolytic action. In regard to alternating currents, some special features arise in connection with a distributing network fed from transformer sub-stations supplied with high-pressure currents. On a three-phase transmission, with rotary converters supplying direct current to the network, it will probably be required to group the transformers star-wise with the middle earthed. Thus we should have all the disadvantages of a middle conductor earthed at several places. A much more serious case, however, arises if, in addition, the middle be opened between two sub-stations but the outers be carried through. In such an event the whole balancing current may be conveyed by the earth, and do great damage. A similar difficulty would arise with balancing transformers distributed at various points of the network, if the middle wires are not continuous throughout and the earth connection is made in the balancer. Further, there is the interference with telephone and telegraph lines.

Cost of Copper.—In this respect little can be claimed on any sides; if anything, the advantage is with the three-wire direct-current system. There are many special points that have to be taken into consideration in connection with the mains for polyphase systems which contain motors. One is that for equal loss they must be increased in section 10 per cent. above that required on the direct-current system, in order to allow for the loss due to wattless currents.

Working of Arc Lamps.—These cannot be said to work satisfactorily on alternating-current circuits, neither are they as economical as the continuous-current type. In actual working they require more attention on account of screws, etc., becoming loose. Further, they require more energy per candle-power.

Three-Phase and Rotatory Transformers (*Motor-Generators*).—This system consists in the employment of a number of polyphase induction motors driving an equal number of direct-current generators, the motor-generators being of such a size that the high-pressure currents can be led direct into them; consequently the equipment and operations are of the simplest possible character. Nothing in the way of starting gear is necessary beyond a simple rotor resistance for each motor. There is no synchronising to be done, and the regulation on the direct-current side is made on the fields of the generators, either by compounding or by hand in the usual way. The only trouble with high-pressure working without transformers, "which in this system are not necessary," appears to be in the manipulation. For feeding three-wire systems such motors are arranged to drive two direct-current generators each of half its output, one at each end of the shaft, the two machines being in series, or the motors would drive one generator of the same capacity, feeding the outers, auxiliary devices being employed in the usual way for balancing The simple nature of the working of the motor-generator leaves practically nothing to be said, providing the motors are kept running fully loaded and the air-gap is attended to, "which in a motor of which the rotor is 3ft. in diameter is only 0·1in," so that on account of the magnetic pull no diminution of this length can be allowed. In regard to overload, the important point when feeding tramways, in this respect motor-generator equipment is perfectly satisfactory, and if well designed will stand almost 90 per cent. overload for some seconds without falling out of step. On account of the considerable armature reactions, motor-generators are far less likely to hunt than rotary converters with any given generating plant. Nevertheless, some care is necessary in either of these systems to prevent oscillations in the relative motions of the generators running in parallel with the consequent interchange of synchronising currents. These oscillations can be set up by the natural variations in the turning moment during the revolutions, or by the after effect of a bad parallel or short-circuit, and are, of course, assisted by field distortion, by insufficient impedance in the armatures, and also by quick-acting governors and defective steam distribution. With regard to the important question of floor space and first cost, there is very little to choose. Comparing machines alone, there is a considerable advantage in favour of rotary converters, but when we take into consideration the transformer equipment necessary with the rotary converters and special switchgears for the same, the cost is equal to that of the motor-generator equipment. Motor-generators give the best results when operating at 40 to 50 cycles in the sub-station, and when the lighting load forms a considerable proportion of the total output.

Three-Phase and Converters.—Although the rotary converter possesses similar characteristics to those of the

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synchronous motor, and also those of the direct-current machine, yet it possesses in addition several special features which have a great influence upon its performance, the results being that even when such machines are working under the best conditions they cannot be regarded as simple. Whatever the nature of the armature of the alternator, the pressure between any two slip rings on the rotary converter is always a definite percentage of that on the direct-current side, being about 61 per cent., so that step-down transformers have always to be installed between the slip rings and the high-pressure feeders. In systems where units greater than 100 kw. are employed, separate transformers are always used for each phase of the transmission line Providing these transformers are connected up mesh-wise both on the high and low pressure side, then, in the event of one of the transformers developing a fault and blowing its fuse, the supply need not be interrupted, for the remaining two will continue to supply three-phase current to all the phases of the rotary; such reactions have the advantage of keeping the arrangement symmetrical. Under these circumstances the rotary can be kept fully loaded on the period of emergency, providing this is not too long, but the increase of the heating effect must be watched. All rotary converters having to be fed from step-down transformers, the switchgear becomes more extensive. It is impossible to operate a number of rotaries feeding a three-wire network from common 'bus bars on the alternating side, for the slip rings of the machines cannot be directly paralleled owing to the connections on the direct-current side. In respect to regulation, the pressure on either side of a rotary converter is practically independent of the field strength, consequently the direct current cannot be varied by regulating the field alone. Therefore, some method has to be adopted to regulate, which adds to the cost in the way of either an auxiliary transformer and regulating switch or induction device, yet when such regulators consist of an iron core, which is arranged in connection with a shunt and series winding in each phase in such a manner that a movement of the core decreases or increases the mutual induction between the two windings, then by the regulation of this core, which is easy and cheap to construct, a very effective regulation to within 6 per cent. up or down can be obtained. This, further, has the advantage of being readily operated from a distance, and also having no contacts or moving conductors. Another method is to compound the rotaries in order to get the desired direct-current pressure, providing a certain amount of self-induction already exists, by inserting choking coils in the various leads The power factor of all rotary converters depends on the field excitation, thus, by suitable proportions of the reactance and the field windings, excellent pressure regulation can be effected in this way in a perfectly automatic manner, it being easy to arrange the direct-current pressure by over-compounding to 10 or 15 per cent. The only objection to this method of regulation is the influence it has upon the regulation at the feeder points, or at the high-pressure 'bus bars. The extent to which this over-compounding may be carried, depends upon the rating of the machine with regard to the work it has to do. Therefore, the more liberally rated the converter is, the greater is the range of regulation; if the amount of over-compounding be large, then the rotary must be large for the work it has to do. Such compounded rotary converters may be connected in parallel on the direct-current side in precisely the same manner as similar direct-current machines, equalising 'bus bars and switches being used, and with the same precautions as in a direct-current system, together with secondary batteries, if needful.

Three-Phase and Static Transformers.—The commonly-accepted multiphase alternating machine, in the first place, requires separate excitation, and, for the purpose of local supply, auxiliary transformers. It has the great advantage, however, that the current can be generated in the machine at full line pressure, and that the revolving armature and fixed fields of the direct-current machine can be departed from in its construction, and thus relieve all centrifugal strains on the insulation of the active windings by having the armature stationary. In the distribution, the most important point which gives it some disadvantage is the transformer losses, which are more or less complicated. These losses may be divided into iron losses and copper losses, but the loss which affects the efficient working of the system is the light load loss, and is composed of both. Further, with regard to the ageing of the transformers, this item must be allowed for when calculating the energy necessary. This core loss amounts in some instances to as much as 6 per cent. of the total power generated. The great disadvantage of the adoption of this system, however, at the present time is the employment of the polyphase motor on tramcars. Yet these motors compare very favourably with direct-current types both as regards speed and power, with the exception of low speeds, in which the direct-current motor has the advantage. For example, a continuous-current equipment can get up a speed of 23 miles per hour with 34·7 watt-hours per ton in 30 seconds, as compared with 41·5 watt-hours in 28 seconds with three-phase equipment. Similarly a continuous-current motor gets up 24 miles per hour with 39·5 watt-hours in 37 seconds, as against 45·1 watt-hours in 30 seconds for the three-phase motor. Thus for lower speeds the continuous-current motor uses 84 per cent. of the energy used by the three-phase motor, while for higher speeds the proportion is 87 per cent., while in the latter case the three-phase motor gets up full speed in 81 per cent. of the time taken by the direct-current motor. Comparing the maximum power input in the two cases, in an actual test of two systems the direct-current took 75 kw. per motor, as against 53 kw. per motor in the three-phase equipment. Thus the maximum power input with the three-phase motors is only 70 per cent. of that with direct-current motors. In the economy of starting there appears to be very little difference; if any, the advantage is in favour of the direct-current motor, at the same time occupying a longer time in getting up speed. In regard to speed regulation, if a resistance be placed in circuit of the rotor so as to increase the total resistance, any speed at any required load can be obtained. The polyphase motor is, therefore, in this respect capable of perfect regulation for all loads. The efficiency at reduced speeds is, of course, less on account of heating of the rheostats. The polyphase motor herein resembles the direct-current motor, but it has the disadvantage in comparison that it is not possible to couple two polyphase motors together in the same way that direct current motors can be—that is, in series-parallel method of control. When cars equipped with polyphase motors are descending a grade, the speed of the motors increases above synchronism; thus a negative torque is applied and the motor acts as a generator, returning current into the line, and thereby retarding the motion precisely as if mechanical brakes were applied. The maximum torque thus set up is greater than the break-down torque, but the slip at maximum torque is the same. Thus it is a feature of great importance, for not only does the polyphase motor act as an efficient brake in descending a grade, but the energy of descent is returned into the line.

Low-Tension with Reversible Boosters and Battery Sub Stations.—In regard to the question of cost in this system, there is not the slightest doubt where reliability is considered that the inclusion of a secondary battery on a traction system means a material saving both in the first cost and operating expenses. In the undertaking such as the one in question the mean day load will be approximately one-third of what may be termed the peak load of the line. To meet this load effectively, the plant without a battery would have to be capable of generating three times the mean day load, with the consequent results of inefficiency during a considerable part of the day. Systems operated on the above principle with reversible boosters, illustrate the best manner of operating a battery on traction systems. No matter whether installed at the power-house or at sub-stations, the arrangement is perfectly automatic and controlled by the winding of the booster and the battery pressure, and these together take charge of the whole variations, whether above or below the normal or mean day load. The general features of the arrangement may be summed up as follows:

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The first cars of a morning can be operated entirely from the battery, thus obviating the necessity of starting up the power station for a few early cars two or three hours before the general load comes on, the advantage of which will be self-evident. Further, the plant is always working at full constant load, which ensures the greatest possible economy, the running hours of the plant are shortened, and the unprofitable hours of the days are avoided. The minimum amount of plant is running necessary to operate the load, and the general working conditions are favourable to the life of both the plant and battery.

High-Pressure Continuous Current and Rotatory Transformers.—The commutation difficulty is a fatal bar to the use of direct currents of extra high pressures, and since the power transmitted, other things being equal, is proportional to the square of the applied pressures, the alternating current, of whatever description, must always be preferred for long-distance transmission. The only direction in which an advantage can be obtained with the use of high-pressure direct-current machines, together with dynamotors, is in the saving of copper: therefore, for the system to be efficient, this gain must more than balance the extra cost of the generator, the lower efficiency of the same, and the loss in transformation. For the undertaking in question, where the distances cannot be considered great, it would be a difficult problem. The meaning of high pressure in the above is taken as anything above 600 volts. In connection with distribution on this system generally, the switching arrangement is somewhat complicated, and therefore costly, and unless the dynamotors are worked in conjunction with batteries, the only way in which the plant can be thoroughly efficient is by constant work at normal load.—K.

Answer to No. 517 (*awarded* 30*s.*).—The five different systems which are given in the question comprise all the practical methods which could be adopted. Much could be said in favour of any one system, either from the results of previous successful installations, or from advantages which are peculiar to the particular system. The old saying, "Many men, many minds," is so true that if five electrical firms were called in to advise on this scheme, it is more than possible that each system would find a supporter; each firm would strongly support that particular system with which they had had the most experience. Therefore, in considering the various replies to the question, it must be remembered that each reply is only one man's opinion, founded on the amount of experience he has had with one or two of the systems proposed. In making a selection between the various methods, it will not do to be guided only by the results that have been obtained in the past. Such a method of settling any engineering question would infallibly lead to the abandonment of all progress, as old methods would always be adopted, and any new system could only be most unsatisfactorily tried on small experimental lines. It appears to the writer that the best manner of dealing with the subject is to take each system proposed *seriatim*, briefly giving its benefits and disadvantages, and then, finally, to make a comparison between them. Proceeding in this way, we will deal with the systems in the order given.

High-Tension Continuous and Rotary Converters.—There are many advantages which may be claimed for this system. In the first case, owing to the distance the power has to be transmitted, it is most important, in order to transmit the current economically, that it should be at a high E.M.F. in the feeders; the longest distance being six miles, a pressure of 2,000 volts or so will be ample. Direct-current machines to work at this pressure can easily be obtained, and are, as a matter of fact, successfully working at Hull and Morecambe. There is no difficulty in handling such an arrangement of plant, and there is the further benefit that we are dealing with a type of machine which is essentially English, as up to very recent times the English firms have had a far larger and more varied experience with direct-current machines than they have had with alternating plants, either mono or polyphase. This remark applies not only to the builders of the machinery, but also to the working staff. As the current has to be transmitted at a high pressure, there appears to be no valid reason why it should not be generated in the first instance at the maximum E.M.F required, and that portion of the current only have its E.M.F. reduced which is required for the particular local demand at the lower E.M.F It must always be borne in mind that there can be no transforming without a loss of power occurring. The loss will be a percentage of the power so transformed, so that in order to obtain the most economical results it is important never to transform in the first case oftener than is absolutely necessary, and, in the second place, to arrange the plant so that the quantity of power to be transformed is the minimum for the economical working of the system. These conditions the writer thinks are to a very great extent fulfilled in the adoption of this system. A further advantage of this system is that it is a system which has been largely adopted already with excellent results.

Low-Tension with Reversible Boosters and Battery Sub-Stations.—The one advantage of this system appears to be that the plant is worked at a much lower E.M.F. We know that owing to the exigencies of armature building for direct-current machines, there is always a liability of the insulation giving way. This liability is increased as the working pressure is increased; with the adoption of low-tension machines this liability is greatly reduced, and the risk of a breakdown is lessened. The system would not, however, be a cheap one to instal or an economical one to maintain or work. The cost of the battery would greatly increase the first cost, and its use would reduce the economy of the system, while at the same time the expense of maintenance of a set of batteries is under the best conditions very high, and the best conditions do not obtain at sub-stations of a power and lighting company, where the load will not be regular, and will probably be of a most fluctuating character.

Three-Phase and Rotatory Transformers (Motor-Generators).—If by this system is meant the use of three-phase motor-generators, there is little advantage to be derived from its adoption; the same results will be obtained in system (*e*) without the use of unnecessary moving parts.

Three-Phase and Converters.—The adoption of a three-phase system deserves very careful consideration, on account of the great economy of copper that is effected in the transmission lines; at the same time the distance is not long enough to fully illustrate the advantages, for, as we have already seen, a pressure of 2,000 volts will be ample over this distance to give an economy which is within the limits of what may be reasonably required in practice, and this pressure can be safely generated with direct-current machines.

Mr. Oudin, in his work on "Standard Polyphase Apparatus and Systems," gives the following table of the amount of copper required for transmission at a given loss, based on maximum difference of potential:

System.	Number of wires.	Percentage of copper.
Single-phase	2	100
Two-phase, with common return	3	147·5
Two-phase	4	100
Three-phase	3	75
Direct-current	2	50

In explaining this table Mr. Oudin remarks: "It will be seen that the direct-current system requires only 50 per cent. of the copper in the single-phase system when used in long-distance transmission of power. The advantage is not so evident, however; for, as Mr. Steinmetz has pointed out, in addition to the electrostatic stress, an electrolytic effect is set up, which does not exist to the same extent in alternating currents. The difficulties attending the utilisation of direct current of high tension are such that, with the exception of one or two special and isolated cases, its employment in the long-distance transmission has not been seriously considered."

Having generated the current as alternating, the benefits to be derived by converting it to a direct currrent are not apparent; so much three-phase work both for lighting and power installations has now been carried out in this country, that the argument that three-phase current is not suitable for lighting purposes cannot be raised. We know that if it is intended to work arc lamps off the mains a periodicity of 60 is desirable, while for motor

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work a periodicity of about 25 is the most suitable, but the figures are capable of alteration in order to meet the requirements of special cases, and both motors and arc lamps will work satisfactorily on a circuit having a periodicity of 40 cycles. Up to very recent times it has been held, especially in America, that the only method of operating tramways is by means of direct current. This idea is now exploded, and the Westinghouse Company are now engaged on the construction of a polyphase tramway at Baltimore. This line will be purely designed for polyphase working, and the current will not be converted on the cars. If a polyphase system is adopted entirely, there is always the danger of not balancing the loads between the various lines when both lighting and power requirements have to be met In the case of motors these will be fed in each instance by the three lines, but for lighting, the various circuits will be fed from two wires only in each case. It is then important that if the three lines be designated by A, B, and C, that the current supplied across A B shall be equal to that supplied across B C and A C. But, as has been shown in actual practice at all large polyphase stations, the plant will work satisfactorily even if the various lines are out of balance 25 per cent. or more, and it is no more difficult to secure approximate balance with a polyphase system than it is with a three-wire, direct-current system. The use of rotary converters would, however, do away with this necessity for balance, as they would be fed with current from the three wires, and the distribution to consumers would then be with direct current. This is one of the advantages to be derived from the use of rotary converters, especially as it can be legitimately contended that with a three-wire, direct-current system only the lighting and small motor demand is balanced, as in no case is a motor of a size larger than 7 h.p. ever connected otherwise than across the outers. This is the case, but there is no insurmountable difficulty in balancing a system with the motors. In the case of the polyphase distribution there is only the lighting to balance, as every motor would be fed from the three wires, which is equivalent as far as regards balance to connecting them across the outers of a three-wire, direct-current system.

Three-Phase and Static Transformers.—With the adoption of this system, we should still retain a polyphase transmission, with a polyphase distribution also. For final distribution the tension of the current would be reduced to accord with the Board of Trade requirements in the simplest and most economical manner. The net efficiency of a static transformer is at least as high as the net efficiency of a converter or motor-generator, while a static transformer has the advantage over any rotary equipment, that there is no moving part to require daily attention and to get out of order. The static transformers can be put in underground sub-stations, and will require the minimum of attention, while the use of rotary converters would necessitate the presence of a staff of electricians whenever the plant was working. Quoting again from Mr. Oudin's book, we find that the efficiencies of a 250 kw. static transformer was found on trial to be as follows for various loads: quarter load, 94·6 per cent.; half load, 97 per cent.; three-quarter load, 97·7 per cent.; full load, 98 per cent.; and 1¼ load, 98·1 per cent. These results will compare most favourably with the efficiencies which would be obtained with the use of any form of rotary transformer. The static transformer for a three-phase current may be of the single-phase type, or may be built specially for three-phase currents. The latter is the type which is the more commonly adopted, being the cheapest for the same output.

In now comparing the different systems to select the one most suitable for the given conditions, we may leave out (*b*), low-tension with reversible boosters and battery sub-stations, as we have seen that it possesses no special advantages over any of the others, is costly to equip, uneconomical to maintain, and high in its working charges. System (*c*), three-phase and rotary transformers, may also be abandoned, as it is not as good as either of the other three-phase systems proposed This narrows down the final selection to continuous high-tension with rotary transformers and the adoption of three-phase with either converters or static transformers. Under the circumstances given there is very little to choose between these, and much will depend upon the predilection of the consulting engineer. Had the distance been considerably longer, so that it would be found advantageous to work at a tension of some thousands of volts, there would have been no question that only one of the polyphase schemes must be selected, but with a maximum length of only six miles a tension of 2,000 volts is quite feasible, and this can be secured by the use of direct-current machinery. In favour of the direct-current system may be added that up to date all the English tramways are worked on this system. Still, too much weight should not be paid to this, for if we only slavishly follow the past there is an end to all progress. A much greater advantage is that at the present time the selection of the staff required for the working of the undertaking will not be so limited with a direct-current system. Here, again, this is only a minor point, since the rapid strides that polyphase systems are making will cause an increasing number of electrical engineers to pay attention to this branch, and soon the choice will be as wide in one branch as in the other.

System (*e*), three-phase with static transformers, stands entirely by itself in one respect—viz, outside the power-house there is no machinery having moving parts. This will result in a great diminution in the trained staff required, and also in the cost of equipment and the amount to be set aside for repairs and depreciation A sub-station is an expensive item, however plainly built, compared to the small underground chamber required for a static transformer. The cost of a static transformer is far less than the cost of a rotary transformer of the same size, whether designed for direct or alternating currents, and we have also seen that the efficiency of a static transformer for all loads is higher than what could be anticipated with a rotary apparatus. Further, as the first cost of a polyphase motor is less for the same output and speed than is that of a continuous-current machine, it will be found that for most reasons the system to be adopted is (*e*), three-phase with static transformers. In advocating the selection of this system the writer is aware of the difficulty that exists in arranging variable speeds for the motors. Special devices exist for controlling the speed of the cars, and as in the case of ordinary motors there is no difficulty in procuring a motor arranged for six various speeds, this will probably be found to answer all the requirements of the users of power in the district.

An objection which might be raised to the use of any polyphase system is the induction effects on any other wires, telephone, telegraph, etc., which may come into the influence of its field. This has to be guarded against, but as the engineers know the trouble that will arise unless care is taken, this receives proper consideration, while in the case of continuous current it is too often overlooked, with the result that either magnetic guards have later to be fixed (as was the case with the first electric tramways at Leeds to Roundhay Park), or else that the feeder wires have to be removed, or the path of the affected wires diverted.—M.

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NOTES.

Rontgen Society.—The above society will hold its inaugural meeting of the winter session on Thursday, Nov. 6 next, when the president, Mr. Herbert Jackson, F.C.S., will deliver an address. Future arrangements include a paper by Mr. Stephen Mayan, F.R.C.S., on "X-Rays in Ophthalmic Work," with lantern slides, and another by Dr. G. M. Lowe on "X-Ray Work in Private Practice."

A French Electric Post.—A report comes from Paris of the formation of a syndicate with the object of "completing the preparatory work relating to the system of electric 'triphased' motors." At the head of the concern is Mr. Brémond de Verragaude, who is harbouring a scheme for the transmission of parcels "by small electric postal railways." No particulars are given, but it is stated that the capital of the company is £40,000.

Electro-Harmonic Society.—As we have previously announced, the above society are holding their concerts this season at the Holborn Restaurant in consequence of the rebuilding operations which are in progress at the St. James's Restaurant. Arrangements have been made for six more concerts, the first of the season having been given last Friday week. There will be two ladies' nights on Nov. 14 and Feb. 27 respectively, while smoking concerts are arranged for Oct. 10, Dec. 19, Jan. 30, and April 3.

Evident Electrolytic Actions.—Mr. M. P. E. Berthelot has shown in a recent paper that an element consisting of an acid and an alkali in porous vessels is capable of giving a definite E.M.F. The current developed is continuous, and with six elements containing hydro chloric acid and sodium hydroxide 2·4 volts can be obtained. With the aid of these elements, acidified water can be electrolysed, and if pyrogallol be added the evolution of gas is evident, particularly if the voltameter be under reduced pressure.

India Electricity Act.—This measure, the main provisions of which were recently outlined in these columns, has been under the consideration of a special sub-committee of the Bengal Chamber of Commerce. Although somewhat irrelevant, if our contemporary *Indian Engineering* be correct, the main point decided by this committee is that electrical development in England has been hampered and restricted by stupid legislation. At the end of their report the sub-committee with sarcastic emphasis remark that, from the example of England, India may learn how not to legislate.

Cerium Silicide.—By heating together cerium oxide and silicon in the electric furnace cerium silicide is formed. Mr. J. Sterba, in a recent paper, states that it forms small crystals with a steely lustre, which give a black powder; the density at 17deg. is 5·67. It is only slowly acted on by water; hydrogen is without action on it. Fluorine acts in the cold on it, chlorine, bromine, or iodine only after heating. When heated to redness it burns in oxygen with a vivid incandescence, and when heated in boiling sulphur or selenium, it burns. Hydrogen chloride acts on it at a red heat. Solutions of hydrochloric and hydrofluoric acids attack it with evolution of hydrogen. Hydrogen sulphide and water are attacked at a red heat. Alkalies and ammonia do not react with it in the cold.

Electricity Supersedes Gas.—Whatever may be said to the contrary, there is little doubt but that gas as an illuminating agent is rapidly losing ground. In street-lighting gas has for some time been forced to the rear, and in interior lighting the time is fast approaching when a similar fate must overtake it. The march of progress is indicated in the news we have received from the States to the effect that all the gas companies in Boston are to be merged, and eventually will furnish gas for fuel only, which, of course, carries with it the innuendo that electricity is to be relied upon for illumination. How far this may be true we are unable to say, but in the main the information is doubtless correct, as the general idea of using gas for fuel only, relying on electricity for light and power, is entirely sound.

Telephone Disturbances. — A Berlin inventor named H. Brockelt has recently been granted a patent describing an arrangement designed to obviate disturbances to telephone circuits from light railway and tramway return currents. These disturbances are stated to be due to the fact that the counter E.M.F. in tramway motors is not absolutely constant, and can be resolved into a uniform E.M.F. and a relatively smaller alternating E.M.F. To counteract the effect of the latter, the current going to the rails passes through the primary of a transformer, the secondary of which is connected across the motor and its field. It is claimed that the alternating E.M F. in the secondary will exactly counterbalance the alternating E.M.F. of the motor, so that the current going to ground will have no pulsations.

Street-Lighting at Bermondsey.—It is with great satisfaction we note that the Borough Council of Bermondsey have not adopted the course recommended by their General Purposes Committee of extending the gas-lighting system in the streets of the borough. As it was rightly said by one speaker at the Council meeting at which this matter was discussed, a large sum of money has been spent in introducing the electric light into Bermondsey, and they cannot well draw back now. But apart from this, it was shown by the borough engineer, Mr. R. J. Angel, that street-lighting by arc lamps is very considerably cheaper than any gas-lighting system proposed, and we are pleased to see that the Council took the wise course of adopting the cheaper and better illuminant. Under the present scheme, the gas-burners in no less than nine main streets and 13 side streets are to be replaced by electric lamps, and we venture to predict that the borough authority will have no reason to regret their decision in this matter.

The Nobel Peace Prize.—Official announcement is made that in order to be eligible for this prize, which will be awarded in December, 1903, candidates must be proposed to the Nobel Committee of the Norwegian Parliament before Feb. 1 next. The following persons alone are qualified to recommend candidates—*i.e.*, members of the Nobel Committee of the Norwegian Parliament; members of the Legislatures and Governments of different countries; members of the Conseil interparlementaire; members of the Commission du Bureau international permanent de la Paix; members and associates of the Institut de Droit international; professors of law and political science, of history and philosophy, in the universities; persons who have received the Nobel peace prize. The Nobel peace prize is not confined to individuals, but can also be granted to an institution or an association. Enquiries for further information should be addressed to the Comité Nobel du Parlement norvégien, Victoria-terrasse, 4 III., Christiania, Norway.

Electrical Conduction in Gases.—Prof. Henry E. Armstrong, in a paper abstracted in the current number of the *Journal* of the Chemical Society, regards some recent work by Brereton Baker as confirmatory of his own view that the presence of an electrolyte is a necessary condition for the occurrence of chemical action, and that pure gases

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should be perfect dielectrics. The problem of electrical discharge in gases has not yet been attacked with the same accurate methods as have been applied by Dixon, Brereton Baker, and Shenstone in the case of chemical change, and the author contends that there is evidence that the discharge in a vacuum tube is conditioned by the presence of impurities (from soft glass, sulphuric acid, and commercial phosphoric oxide). In the case of the luminosity of the rare earths, the incandescence of oxides generally, and the phenomena of phosphorescence under the influence of the electric discharge, it is argued that the process in each case may be one of recurrent oxidation or polymerisation. The argument is extended to the case of emanations from radioactive substances, and to that of the "so-called" ionisation of air.

Prof. Beare on Electric Tramways.—The introductory lecture to the engineering classes of Edinburgh University was delivered by Prof. Hudson Beare on Friday last, the subject of his discourse being electric tramways. After referring to the great improvements that have marked the last five or six years in internal communication in great cities and between the centres of large towns and their suburbs, Prof. Beare remarked on the fact that Edinburgh should have adopted a system which in the United States has been rapidly superseded by electric traction. He next traced the history of the Liverpool tramways, stating that the total length of the reconstructed lines in that city is 114 miles, the whole work being completed in the short space of two years. He pointed to the good effects electric traction is having in Liverpool In the case of London, the example taken was the London United Tramways system, with regard to which the lecturer referred to the way in which this service is appreciated by the public In the future the London County Council would eventually be the owners of over 200 miles of tramways on the underground conduit system. He predicted that notwithstanding the excessive cost of installing this system of electric traction, the tramways would be financially a success.

Glasgow Technical College —The Scientific Society of the above institution has issued its programme for the session 1902 03. The president of the society this year is Mr. C. P. Hogg, M.I.C.E., and the honorary secretary Mr. J. G. Moyes, of 12, Ruthven-street, Glasgow. The session was opened on Saturday last with the presidential address of Mr. Hogg, and a paper by Mr. George Blair, B.Sc., on "Gas-Engines for Current Generation." The ordinary meetings of the society are held fortnightly, the arrangements for which are as follows : Nov. 1, "Comparison of Alternating and Continuous Currents for Different Purposes," by Mr. W. Benison Hird ; Nov. 15, a paper on "The Diesel Engine"; Nov. 29, "The Potentiometer," by Mr. James W. Peck; Dec. 13, "The Advancement of Machine Tools," by Mr. J. H. Davey; Jan. 10, "Recent Developments in the Gas-Engine and the Utilisation of Blast-Furnace Gases," by Prof. T. Hudson Beare ; Jan. 24, "Application of Electricity to Lining," by Mr. Daniel Burns ; Feb. 7, "The Science of Steam Generation," by Mr. F. J. Rowan ; Feb. 21, "Water in Steam," by Mr. James Andrews; March 7, "Low-Pressure Switchgear," by Mr. J. Menmuir ; and March 21, "Stirling Water-Tube Boilers," by Mr. Robert Baillie. The annual general meeting is fixed for April 4.

An Optical Illusion.—Lord Rayleigh contributes an article on optics in the "Encyclopædia Britannica," in which he states that perfectly transparent objects are only visible by virtue of non-uniform illumination. The moment we arrive at uniform illumination they become absolutely invisible to the eye, a fact which forcibly illustrates our optical illuminations. In other words, a transparent body, no matter what its shape, vanishes when immersed in a medium of the same refractive index and dispersion, and could a transparent substance be found with a refractive index and dispersion identical with air, its presence would not be made known by the ordinary vehicle of sight. A method has been devised by Prof. R. W. Wood, of Johns Hopkins University, Baltimore, by means of which uniform illumination can be obtained and transparent objects made to disappear. The apparatus used consists of a hollow glass globe, the outer surface of which is painted with Balmain's luminous paint mixed with hot Canada balsam ; inside is placed the object, and the hollow is viewed through a small hole drilled in the coating. If the inner surface be exposed to bright daylight, sunshine, or electric light, and the globe be then taken into a dark room, a crystal ball or the cut-glass stopper of a decanter placed inside will be found to be invisible through the aperture, a uniform blue glow filling the space, and only the closest scrutiny will reveal the presence of a solid object.

German Electrical Industry.—Up to the present there has been no great revival in the electrical manufacturing business in Germany, and the large manufacturing works in that country are still hard pressed to find orders. The competition between them for work in England is exceedingly keen, and has resulted in reduction of prices to a point at which no remuneration is gained. According to an article which has appeared in the Berlin *Borsen Courier*, the negotiations between the Allgemeine Elektricitäts-Gesellschaft and the Schuckert Company for a combination to prevent the existing competition has not succeeded. The same contemporary hints that other combinations for consolidating electrical manufacturers in Germany are likely to come forward in the near future, but that there will still remain two or three large groups of firms, which will ensure competition in the home trade. The object, however, to be gained by all these combinations is that there shall not be undue cutting for orders for England and the British colonies. These statements as to future policy confirm the opinion we have frequently expressed that the German competition is not likely to be a lasting one. As is well known, the works in that country have undertaken orders below cost price to get an introduction into this country, and they are expecting afterwards to get higher rates for repeat orders. It will be found, however, that the orders eventually placed for new plant at higher rates will go to English manufacturers

Electrolysis and its Remedies.—Following are some suggestions concerning electrolysis and its effects, which were made by Captain Wm. Brophy in a paper read before the recent convention in New York of the International Association of Fire Engineers. In the case of electric street tramways, he advocated the breaking of the continuity of the metal in the gas and water pipes by inserting insulating joints therein at suitable distances, thus preventing any flow of current over them. In such a case the carrying capacity of the track would have to be increased by better bonding, by increasing the size of the rails, or by the addition of return feeders. The author stated that this plan of placing insulators, or circuit breakers, in the pipes has been adopted in many towns in the States. He mentioned the case of one large city where a natural gas system of piping had been connected by a large cable to the dynamos of the tramway system, but electrolytic corrosion took place very rapidly at the joints. An insulating joint was, therefore, devised and inserted at suitable points in the pipe system, and the connection

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to the dynamo discontinued, since which time no corrosion of the pipes has taken place. The author recently made some measurements between the natural-gas pipes and the rails of the street railway in Wheeling, with the result that he found 300 amperes flowing from pipe to rail at a point near to the power-house, the pressure being 10 volts, or representing a little over 3 h.p. In this case also the gas company is placing insulating joints in its pipe system, and as a result the pipes have now little or no current flowing over them.

Gas and Electricity Departments.—The working of the electricity and gas departments of the same corporation under one committee and one engineer has always been open to objection. As a rule, the engineer who has charge of both undertakings has been for years connected with the gas department, and is an expert in that branch of engineering. In laying down the electrical plant he will take every care to get what, in his opinion, is the best system for the town, and in the equipment there may not be much to complain of. The trouble arises when the electrical department does not show a prompt return on the capital spent. The engineer then loses interest in what he considers the non-paying department under his care, and in certain instances we know of, the undertaking is allowed to slide. We have one such case before us at the present time, in which supply was started so long ago as 1895, and even now the number of units sold per annum has not reached 300,000. The mains exist much as they were first put down, and the plant has not required to be extended appreciably. The result is that a large number of private plants are being installed, which, individually, will generate per annum more than the Corporation works. We are also correct in stating that these works will generate their own supply at much under the present cost price of the municipal undertaking. The only solution of the present unsatisfactory condition is to divorce the electric lighting undertaking from the gas department and to place it under the control of a new committee, and more especially under the charge of an energetic electrical engineer, who will have his reputation to lose if the department does not go ahead.

Proposed Society of Electro-Chemists. — For some time past it has been felt by those interested in the subject of electro-chemistry that it does not receive the encouragement it deserves in this country. In Germany there are two electro-chemical societies, and a similar society has recently been inaugurated in America with great success. The opinion has been expressed that it is advisable to form an electro-chemical society in Great Britain with the view of bringing together those who are interested, both theoretically and practically, in the subject of electro-chemistry, and thus encouraging a science that is daily becoming of increasing technical and commercial importance. In March last a committee, consisting of the following gentlemen, was appointed to consider the subject: Mr. J. Swinburne, Dr. F. M. Perkin, Dr. Donnan, Mr. W. R. Cooper, Mr. S. Cowper-Coles, and Mr. H. V. Simpson. This committee has held meetings from time to time, at which the best methods of procedure have been carefully discussed. The question of working in conjunction with one of the existing societies has also been considered, and several societies have been approached on the matter, but the committee takes the view that such an arrangement is not likely, at any rate for the present, to have the desired effect. It has come to the conclusion, therefore, that the society should be independent. The idea of such a society has received considerable encouragement from those interested, and the committee is now asking for further support. The hon. secretary of the committee is Mr. H. V. Simpson, of Grosvenor-mansions, Victoria-street, S.W., and he will be pleased to hear from electro-chemists with a view to their joining the membership of the society.

Electrical Bascule Bridge.—A new form of bascule bridge, worked by electricity, has recently been erected over the Chicago River at Ashland-avenue. The bridge is the invention of Mr. J. W. Page, of Chicago. When closed it forms three spans over the river, the centre span being 168ft. long and the side spans 48ft. long. The two sections of the central span lift upwards when the bridge is to be opened, in the same way as in the case of the Tower Bridge in London. The novelty in construction, however, is that these two halves are not balanced about their pivots. Instead of this, the two side spans are made to act as counterweights. The outward ends of these side spans rest on rollers, which work on an inclined guide on the inside of the central bascule. As this moves up, the end span slides down the guide path, acting as a counterweight. The outer spans are, of course, pivoted at the shore ends. The track for the rollers carrying the outward ends of these side spans consists of steel plates 18in. wide, and the path is so formed that when the bascules are opening they are balanced on their pivots in every position. From the illustrations which we have seen in the *Western Electrician*, a good idea can be obtained as to the way in which the bridge is operated electrically. For this purpose four 38-h.p direct-current 500-volt motors are used, two being required for each half of the bridge. The details of this driving gear can hardly be understood without drawings. It is found, however, that whereas 84 h.p. is required to start the bridge in motion, 9 h.p is quite sufficient to continue the movement. In closing the bridge 57 h.p. is required to start it on its downward motion. These figures show that the designers have carefully balanced the various heavy parts which have to be moved. The total width of the bridge is 60ft. The safety gates in connection with the structure are worked by compressed air, as are also the locks which secure the leaves of the bridge together when they are down.

Electrical Manufacture of Peat Fuel. — The Jebsen process for the electrical manufacture of peat fuel, which has been in operation for some three years at Stangfjorden, in Norway, is reported to be giving entirely satisfactory results. Briefly described, the process consists in partially drying peat briquettes, which are carbonised in hermetically closed retorts by electrical heat, it being possible to heat several retorts at the same time with one dynamo. The electrical plant is driven by water power, which abounds in Norway. The process allows the peat blocks to be carbonised within a proportionately much shorter time and with much more uniformity than by ordinary methods, while the peat charcoal consists of a dense, very compact black mass showing the structure of peat. The specific gravity of the carbonised fuel in the broken condition is about 0·3, and the theoretical calorific value about 7,000 to 7,500 thermal units. An analysis of Jebsen's peat charcoal made by the Royal Norwegian High School in Christiania gave the following mean composition: carbon, 76·91 per cent.; hydrogen, 4·64 per cent.; oxygen, 8·15 per cent.; nitrogen, 1·78 per cent.; sulphur, 0·70 per cent.; ash, 3 per cent.; and moisture, 4·82 per cent. The peat yields three products when submitted to the electrical heating in the hermetically sealed retorts. The gaseous products pass away by openings in the retort cover, and after scrubbing are employed for heating the air used in the drying tunnels. The peat fuel remaining in the retort after the carbonising operation is completed is allowed to cool down to 130deg. C. before opening the retort, and is then discharged direct into wagons running beneath the retorts.

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The average yield of 100 kilos of the air-dried peat is said to be as follows: peat fuel, 33 per cent.; peat tar, 4 per cent.; tar water, 40 per cent.; and gaseous products, 23 per cent. The electrical power required for carrying out the Jebsen treatment at Stangfjorden is derived from five 80-kw. dynamos direct-coupled to five turbines of equivalent 128 h.p.

The New Westinghouse Steam-Turbine.—The *American Electrician* for the current month describes the new steam-turbine which is being introduced in America by the Westinghouse Company. The first three of these machines to be installed for commercial purposes will be included in the equipment of the power-house of the West Pennsylvania Railways and Lighting Company. The most striking constructive feature about the new turbines, which are each of 1,500 h.p., is the separation of the high-pressure and low-pressure cylinders, and the introduction between them of a reheater in order to allow of the use of superheated steam wherever possible. The construction of this reheater is similar to that employed in the Westinghouse vertical and horizontal Corliss type engines It has a heating surface of 500 square feet, and is to be supplied with live steam from the boilers. The turbine proper will be of the multiple-expansion, parallel-flow type, arranged in tandem. Steam entering at the throttle valve is passed through a strainer for removing all foreign matter, and thence through a poppet admission valve, the period of admission being controlled by a sensitive ball governor. The steam then expands through successive rows of alternate moving and stationary sets of blades in the high-pressure cylinder. At a considerably reduced pressure and correspondingly augmented velocity the working fluid afterwards enters the reheater, where the entrained moisture is entirely re-evaporated, and passes to the low-pressure cylinder dry. The exhaust steam, deprived of practically all its available energy, escapes through the exhaust part situated underneath the rear bearing of the low-pressure cylinder. It is claimed for the new turbine that it will carry continuously an overload of 50 per cent. with the condenser, or full load without the aid of the condensing apparatus. This is merely a matter of rating, but the introduction of a reheating compartment is novel. Trials alone can prove if this really is an advantage over an increased superheat of the main steam supply.

An Apparent Electro-chemical Paradox.—Under this title Mr. Carl Hering described before the recent Niagara Falls meeting of the American Electro-chemical Society a curious experiment which he and a Mr. Reed made some years ago, in which water was decomposed in visible quantities at voltages far below the theoretical (about 1·45), even as low as about 0·3 volt. The experiment consisted in electrolysing acidulated water in a strong N-shaped glass tube, which was sealed at both ends, and provided with a bend containing mercury, which enabled the mechanical pressures to be read off. The results were shown in a curve. The pressures reached about 23 atmospheres when the tube exploded. The voltage at the terminals when a constant current passed diminished rapidly and very decidedly to about 0·3 volt, at about 16 atmospheres, and then remained practically constant. Allowing for the loss due to resistance, the actual voltage of decomposition was even much lower—nearly zero. There was visible gassing during the whole test, showing that water was really being decomposed; the increasing pressures also showed this. A possible explanation was suggested, based on the assumption that some of the gases probably passed mechanically to the opposite electrode, which they could easily do in suspension, as the electrodes were very close together. These were consumed as depolarisers, so that only a fraction of the theoretical amount of gas was really liberated. This depolarisation lowered the voltage. A calculation based on the reduced amount of gas which was actually liberated, on the actual current which passed, and on the energy which must be accounted for to conform with theory, would also show that the required voltage may be very low; and the lower, the greater the amount of depolarisation. The paper concluded with a suggestion of an experiment in which water is electrolysed in a strong sealed vessel, which is completely filled so as to leave no room for the gases Some curious results may then be expected.

The American Institute.—The presidential address of Mr. C. F. Scott, the new president of the American Institute of Electrical Engineers, to the inaugural meeting at the end of last month was mainly concerned with the future of the society. Both in point of numbers and in its importance as the representative body of a great profession, the American Institute will not well stand comparison with our own Institution, and this was recognised by Mr. Scott in the course of his remarks. He stated, for instance, that notwithstanding an increase of 25 per cent. in the membership of the institute during the past year, the total number was less than half that of the British Institution, and showed that if the American Institution membership bore the same relation to the kilowatt capacity of the electrical power stations of the country as does that of our own Institution, the membership of the American Institute should be quite 25,000. As an argument in favour of the future success of the American Institute, Mr. Scott made the following interesting remarks. The United States, with only one-fifth the population of Great Britain and Europe, has two and a third times the kilowatt capacity in power stations in electric railways, and three and a half times the mileage of electric railways. The power-houses in operation and under contract in New York City would replace all the central stations for lighting and power in Great Britain or in Germany. They would operate all the electric railways of Great Britain and Europe combined. One alone would be sufficient for the railways of Germany, and the output of a single generator would run all the tramways of Switzerland. Perhaps the most interesting part of Mr. Scott's address to those on this side of the water was the announcement that it is the hope and expectation of the American Institute to have as its guest within the next few years the Institution of Electrical Engineers of Great Britain. He also advocated co-operation with similar institutions in other countries as being mutually beneficial in various ways, and expressed the desire that the American Institute should welcome the coming opportunity to extend its acquaintance and broaden its ideas.

Canadian Electrical Work.—There is now appearing in the issues of our contemporary the *Canadian Engineer* a series of descriptions of water-power development in and around Ottawa. As is to be expected, in all the installations described the water power is used to generate electricity. In the issue before us the Bronson Carbide Works are described, and also those situated on the Deschene Rapids. No less than four companies have works at this point, and use the natural fall of the river without constructing a dam. The intake is just above the rapids, and the only civil engineering work of any extent required on the river bed consists in cribb-work piers, which keep the river water out of the tail race. In this way a head of about 9ft. is obtained. The plant comprises six 72in. turbines, all coupled on to one shaft, which drives an 800-kw. generator in the dynamo-room.

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Other units are being added in the same way, but we must say we fail to see why the turbines should be multiplied rather than have larger wheels each driving its own dynamo. The generators are alternating-current, three-phase, 800-kw. machines, with 40 poles in their rotating fields, giving 60 cycles at 180 revolutions per minute. They are wound for 11,000 volts to avoid step-up transformers for transmission, and have a capacity for 46 amperes per phase at full load. Both machines and exciters were built by the Canadian General Electric Company. The switchboard consists of an exciter panel for the two exciters, two generator panels, one for each dynamo, and two line panels. Eleven thousand-volt, three-phase static ground detectors are provided, and 11,000-volt oil circuit breakers controlling the generator and line circuits are built into brick cells, but are operated from the front of the switchboard by the usual hand lever connecting through wooden rods and bell-crank connections back of the board, the line panels having automatic overload release attachments, and no fuses are used. There are two three-phase lines of No. 2 bare copper wire arranged in equilateral triangle, one on either side of the poles. It speaks well for the enterprise of the electrical engineers in Canada that now practically all the electrical machinery required in that country is being manufactured there, and not imported, as used to be the case, from the States.

Automatic Fire-Alarms.—The May-Oatway fire-alarm, which has already been described in these columns, seems to be going ahead in the provinces if not in London. Apparently, on the introduction of the appliance into any town, the first body to be won over to its side is the fire brigade, who, if they so desire, can withhold consent to a direct connection being provided in case of fire between the company's client and the central fire station. We understand that within the past few months the company has been successful in completing arrangements for direct connection in several of the large cities, notably Liverpool, Glasgow, Birmingham, and several other important centres. The Morse telegraph is used, and every building in the town which is equipped with the May-Oatway fire appliance has a particular code signal. Thus, in the event of a fire occurring at any one of these promises, the closing of the circuit indicates at the central station exactly where the outbreak is, and orders are given to the sub-stations from the central to concentrate upon a fire if the call is from a block of sufficient size to warrant it. The company has within the past year or so repeatedly demonstrated in public the practicability of its system, and from accounts which have reached us it appears that some further tests were made only this month at Glasgow. The occasion was the completion of the installation of the apparatus in one of the large manufacturing houses of the city. Small tanks of spirits were, as usual, employed to create the conditions of an outbreak of fire, and a committee of independent gentlemen who watched the tests have supplied the information that only 15 seconds elapsed between the beginning of the fire and the ringing of the alarm gong. Almost simultaneously the telegraph was set in motion, and within 2 minutes 32 seconds two engines from the central fire station had appeared on the scene. The acceptance by the fire brigade authorities in several of the provincial towns of the means of allowing direct connection being made between private premises and the central station must be regarded as extremely satisfactory, enabling the company as it does to employ its system to far better advantage than if these facilities were withheld. As for the Metropolis, the London County Council still refuse to utilise either the May-Oatway or any other automatic fire appliance, and thus the company is prevented from exploiting its system in London. Further efforts, however, are being made to remove the prejudice held by the London County Council against this automatic signalling, and it is hoped that they will eventually be brought to consent to its introduction in fire stations within the metropolitan area.

Municipal Car-Building at Sheffield.—As a typical example of what may be accomplished by municipal enterprise in England, the city of Sheffield would be hard to beat. Its electric lighting and electric tramways undertakings have been firmly established and on a profit-earning basis for some time, in proof of which we may mention that the total contribution to the rates from the tramways profits to date amounts to no less than £27,000. As an outgrowth of this latter undertaking the Corporation some time back decided to embark on an entirely new departure, that of car-building. Although the completion of the permanent buildings required to carry on this work is only lately an accomplished fact, several cars built by the Corporation are at present in constant use on the Sheffield system, and it augurs well for the future success of municipal car-building that these have so far given excellent results. The new workshops have been erected at Nether Edge on the site of the old horse stables. They have been in operation for some three months, and although the experience gained in this period must necessarily be limited, it has, nevertheless, been found that with the labour-saving machinery employed the Corporation are able to turn out car bodies in finer condition, it is said, and of better material and construction, at 25 per cent. below contractors' prices. In time, therefore, this must represent a valuable source of relief to the ratepayers of the city. The trucks and electrical equipment have, of course, to be purchased in the ordinary way, and the car bodies are fitted on at the depôt. A description of the shops which recently appeared in one of the local papers has been sent us by Mr. A. C. C. Fell, the municipal tramway engineer, and it shows how thoroughly the work has been carried out. The equipment of the machine shop is especially interesting. It is lighted throughout by enclosed arc lamps, and energy is also obtained from the Kelham Island power station for driving the machinery. In this shop are gathered together all the latest forms of labour-saving wood-working machinery that is employed in this class of work, including a mortising machine, planing machine, circular saw, and a moulding machine. This latter is especially noteworthy. It is of the vertical spindle type, and will take a pattern up to 4½in. wide at an exceedingly high speed. Then there is the tenoning and trenching machine, which, working at about 3,000 revolutions per minute, cuts out and at the same time planes, tenons, and panels with remarkable finish. The amount of time and manual labour saved by these tools is only conceivable by those who have had experience of such things. The construction shed at present has accommodation for six cars only, but it is in contemplation to extend this building as soon as the rails leading into the depôt are relaid. The cars now being built are in all stages of construction, but the department has undertaken to deliver six double-deckers and twelve single-deckers ready for running by April next. The first of these will probably be on the rails in six weeks' time. The cars are of the latest type, and are likely to prove very popular when put into service. At present 17 men are employed at the works, and when the buildings are completed 20 more will be taken on. In addition to building work, the depôt in its new form is to be extensively used for overhauling and repairing cars. Ironwork and woodwork is done on the spot, and a brassfoundry is being built at Tinsley from which the brass fittings will later on be requisitioned.

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THE RUGBY WORKS OF THE BRITISH THOMSON-HOUSTON COMPANY.

The British Thomson-Houston Company, Limited, commenced operations in this country in May, 1896, and since that date its history has been closely connected as contractors with the best and largest electrical undertakings. Amongst these are the Central London Railway, which was completely equipped with electrical machinery, and the Great Northern and City Railway work is also in the hands of the company. Amongst tramway undertakings supplied, there are the complete equipment, in the first instance, of the Dublin United and the Bristol tramways, together with the provision of the majority of the car equipments and station apparatus for the subsequent large extensions carried out on these tramways; the complete equipment of the Cork Electric Tramways and Lighting Company and the Chatham and district light railways; and the station apparatus and car equipments for the London United Tramways and the Isle of Thanet Tramways and Lighting Company. Other contracts now in hand are equally worthy of mention, but the above indicate the scope of the company's work. Up to now the bulk of the plant used by this firm has been manufactured in the United States by the General Electric Company, as they had only a small factory at Rose's Wharf, Bankside, which was not capable of producing heavy machinery. In 1899, however, the firm decided that a factory in which to manufacture on a large scale was required in this country. The progress of the electrical industry warranted its erection, and it is especially interesting to note that the Americans, who had control of the policy of the company, found it economical to expend a large capital on English works. This conclusion was arrived at after years of experience in importing standard machinery from an enormous factory in the United States. In designing and equipping the new factory the company has had the great advantage of being able to draw on the experience obtained in the shops of the General Electric Company in the manufacture of electric motors and other apparatus in quantity. This valuable experience was greatly in evidence when we had the opportunity of seeing the British Thomson-Houston Company's Rugby works on Monday last. Special machine tools for handling large quantities of tramway motor parts in the shortest possible time were at work, and other machines were to be seen for quickly turning out electric motors for stationary purposes. Contrary to what might be expected, however, these machine tools were not solely of American origin—in fact, amongst the heavier tools, those made by English manufacturers predominated. It is interesting to find that our English toolmakers have thus succeeded in regaining their reputation for special work, which a few years ago seemed to be on the wane.

The situation of the factory at Rugby was only decided upon after mature consideration. The advantages in its favour were that it is approximately in the centre of England, and is convenient both for the procuring of raw material and for the transhipment of the finished product; also, it is not far from other large engineering works, so that the supply of skilled workmen is not so limited as might be expected. The works manager informed us on Monday last that he has had no difficulty whatever in obtaining the men required, and that on the whole the quality of the labour was up to the mark. The general arrangement of these works and the means of access to them can be seen from Fig. 1. The site occupied

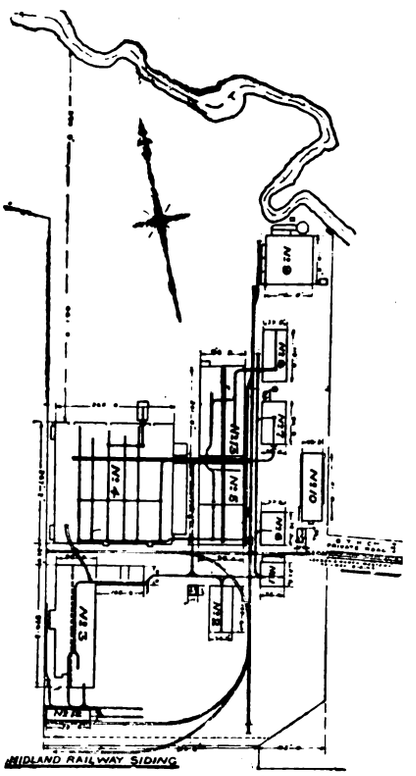

FIG. 1.—Block Plan of the British Thomson-Houston Company's Rugby Works.

was formerly the Glebe Farm, and lies north of the London and North-Western Railway Station, and west of the Brownsover Hill-road, to which it is connected by a private road owned by the company, and comprises some 25½ acres, of which about 10 acres are at present covered by roads and buildings, leaving room for further extensions. The Avon forms the northern boundary, and the tracks of the London and North-Western and Midland Railways form the southern, the land on the east and west being owned by the Rugby Urban District Council. The ground was opened on Jan. 11, 1900, and the factory buildings commenced some six months later. The interval was spent in levelling the site in order to get easy grades on the railway sidings from both the London and North-Western and the Midland Companies' systems. It will be seen that these sidings have been so designed that there is easy access to any part of the works with trucks from these railways, and that the lines have been laid out to avoid as much as possible all switchbacks and turn-tables. Besides these heavy standard

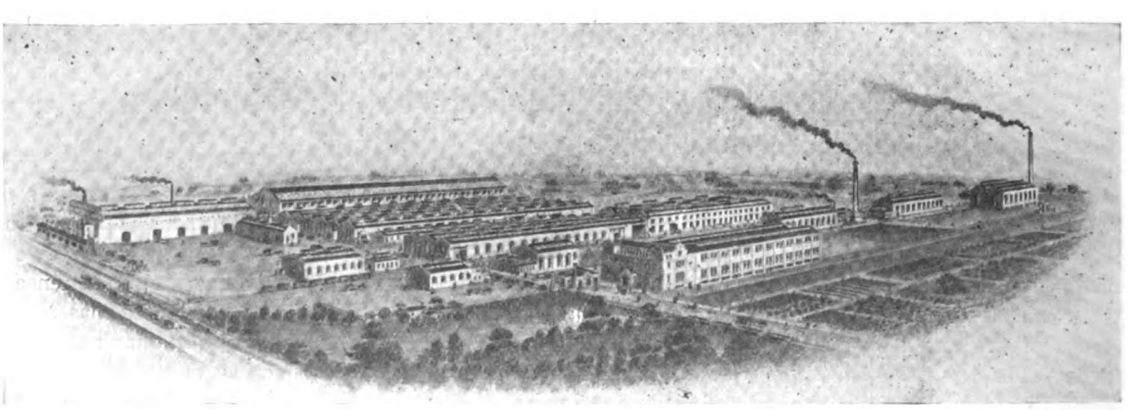

FIG. 2.—General View of the Works.

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gauge tracks which go to all buildings where raw materials have to be delivered, or from which finished goods are dispatched, a narrow-gauge railway has been laid to connect up all the buildings together. This narrow-gauge line greatly increases the ease of transport of products in course of manufacture, but the works are so designed that this class of transport is kept down to a minimum. An inspection of the block plan will show that while the raw material is delivered at one side of the site, the progress of the work gradually moves articles through the shops until they are completed and tested at the other side. In this way the moving of materials backwards and forwards is largely avoided. The total area covered by buildings is 197,220 square feet, and the floor space is slightly more owing to the offices and one or two buildings having two floors. As previously mentioned, the works consist of 14 buildings constructed of steel and bricks throughout, making them practically fireproof. They are isolated to a certain extent in order to avoid fire risks, and the serious inconvenience which has been found as a result of having all departments under one roof. Careful study has been given to the entire arrangement and grouping. On all buildings requiring the maximum of overhead light glass roofs have been erected, while large windows give ample side light. The artificial illumination is by means of incandescent electric lamps and enclosed arc reflector lamps. The heating for the majority of the buildings has been planned on the well-known hot-air blower system, the air being drawn in from the outside, passed over steam-heated coils, and then carried by means of ducts and air-pipes to the points of distribution The blowers are operated by means of small engines, so that the buildings can be warmed in the morning, an hour or so before commencing work, without the necessity of starting the larger engines in the power-house. The sources of water for all purposes are an artesian well, located near the power-house, and the Rugby town supply. The water from the artesian well is used for boiler feed and partly for condensing purposes; and the town supply for boiler feed, flushing of closets, drinking or fire extinguishing purposes, the fire-mains being entirely separate and distinct from the others. Hydrants or these fire-mains are distributed throughout the works. In those departments containing much combustible materials are equipped with automatic sprinklers.

In consulting the block plan (Fig. 1) the following numbers will be of service as indicating the use of the different departments: (No. 1) timber stores; (2) incandescent lamp department; (3) iron and brass foundry; (4) main machine shop; (5) general stores and warehouse; (6) pattern shop; (7) punch press and blacksmiths' shop; (8) meter department; (9) power-house; (10) offices; (11) gate-house; (12) sand and coke sheds; (13) extension of stores, warehouse, and shipping department; (14) oil and paint stores. The general appearance of the works is shown by Fig. 2. Of the first of these buildings little need be said here, except that the timber for patternmaking is stored in it. In department No. 2 the British Thomson-Houston Edison incandescent lamps are being made, and most carefully tested before dispatch. These lamps are rated by the English parliamentary standard candle, the method of measuring the candle-power being by rapidly rotating the lamp, which gives the mean horizontal candle-power—the true rating.

The ironfoundry (Fig. 3) is a building 90ft. by 274ft., and thus has a floor space of 25,640 square feet. The foundations go down to 10ft. below the floor line. This foundry was well at work when we visited it on Monday. The Whiting cupola at present in operation has a capacity of four to five tons per hour, and the one in course of erection (Evans cupola) will have a capacity of 10 tons per hour. An electric motor-driven blower provides the blast for the small cupola, and a similar arrangement will be installed for the large one when completed. A large casting was being made when we were in the foundry, which gave us a good idea of the excellent crane equipment. This at present consists of an electrically-operated

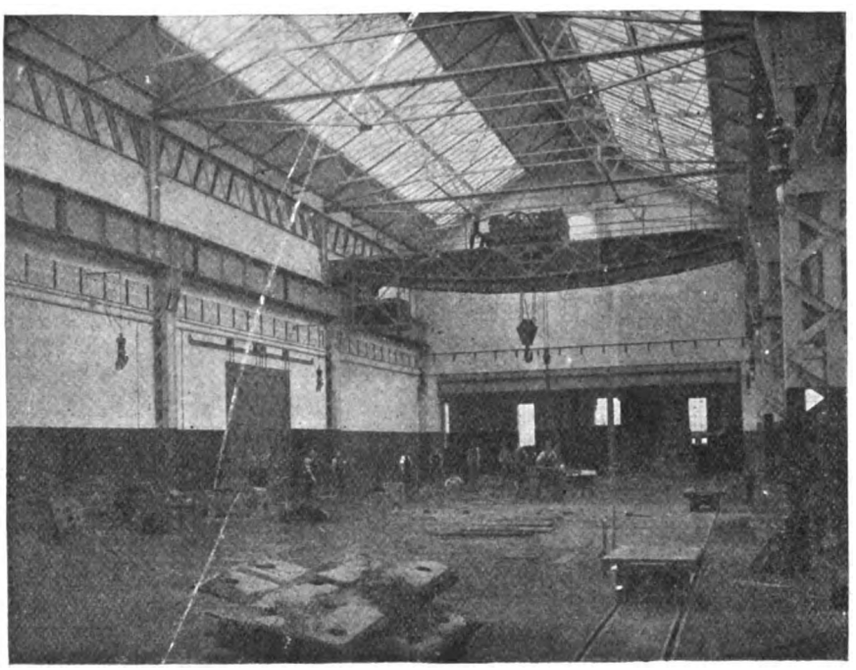

FIG. 3.—The Ironfoundry.

30-ton travelling crane with 48ft. span, having an auxiliary hoist of two tons capacity for general use. The electrical equipment comprises three motors—one for hoisting, one for longitudinal travel, and another for traversing. It is fitted with a "cage" on one end occupied by the operator, and in which are located the controller switches and resistances. The controller is of the British Thomson-Houston Universal type, which by the movement of a single lever controls any two motions of the crane. This saves much time and gives a most perfect control. The coremaking departments are conveniently located in the east bay of the foundry in close proximity to the core ovens. There are in use in this department two Pridmore moulding machines for the moulding of controller backs, etc. The brassfoundry is equipped with four crucible furnaces sunk level with the floor, a small core oven, and overhead travelling hand crane. Two Tabor pneumatic moulding machines are also in use here, which are kept constantly employed on small brass castings for controller and other work. The working of these was much admired on Monday, as they were turning out wonderfully good work in the hands of practically unskilled lads.

Directly opposite the foundry is the main machine shop, indicated as No. 4 on the block plan. This building is 267ft. long by 265ft. wide. The structural steelwork both in the walls and that supporting the intermediate

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bays of the roof is very substantial, as is required by the heavy travelling cranes used. The first bay, which opens directly opposite the foundry, is to be devoted to the construction of large dynamos It is not yet fully equipped. One of the largest tools now installed in it is the large boring mill (Fig. 4). This mill is designed to take

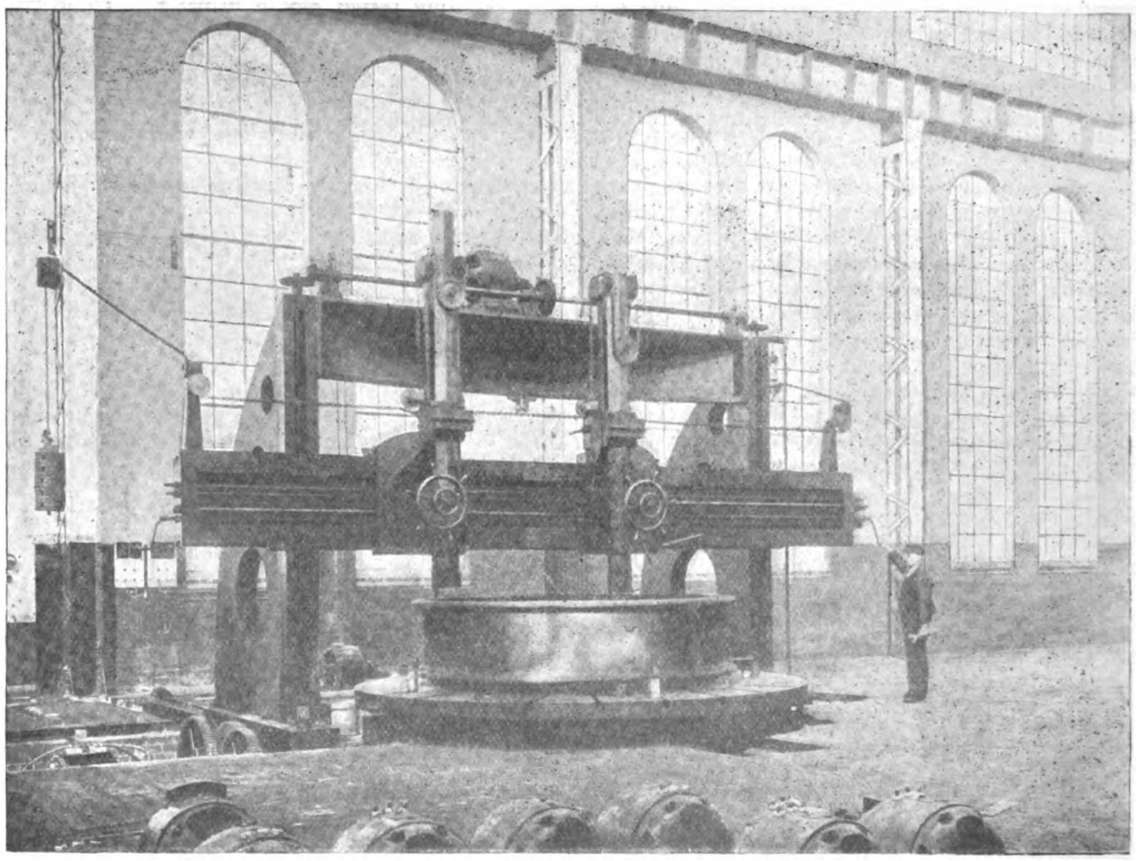

FIG. 4.—A 24ft. Boring Mill with Three Motor Equipments for Driving the various Motions.

work 24ft. in diameter, and is equipped with three electric motors, the first of which operates the table, the next the housing, and the third the cross-head, to which the tools are attached. The large planing machine in the south-west corner of this bay will deal with work 84ft. by 20ft It has an electric drive, and the reversing of the motion is done by means of two of the British Thomson-Houston magnetic clutches. With this system the electric motor is always revolving in one direction, and the reversal of motion is obtained by gearing, which avoids the use

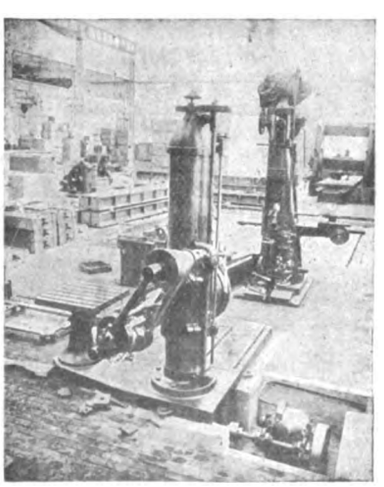

FIG. 5. Special Tools with Motors attached.

of the open and cross belts usually found on such machines. The magnetic clutches which throw one motion out and the other into gear consist of two circular iron discs, in which are embedded well-insulated exciting coils, each fed by two collector rings and sets of brushes. At the instant of throwing over the main sleeve which carries the armatures of both clutches, there is a slight slipping at the surface of the engaging clutch, which prevents the great shock frequently found in reversing planing machines. The clutch, however, soon accelerates. It is found that from 15 to 20 per cent. is saved by means of this electrical reversing device over the power required with the usual gear. At the time of our visit the planer was being used in facing-up the sections of the large surface plate which is to be used as the foundation for a number of portable tools. In the manufacture of large dynamos and alternators these portable tools will be moved round the big castings, which is found to be much more

FIG. 6. Typical Motor driving a Short Length of Shafting.

economical than the use of exceedingly large machine tools or dividing face plates on which the work can be rotated. The overhead traveller in this bay is designed for a 40-ton load, and has a span of 66ft.

The next two bays are devoted to the construction of tramway and stationary motors and small generators. As

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a contrast to the first, they are practically filled with tools, all of which were in full work at the time of our visit. The system of driving the machine tools of smaller size is clearly shown in Fig. 6. The electric motors are supported either on walls or on the steel stanchions of the buildings, and drive either by belts or by Hans Renolds chains small lengths of countershafting, to which two or three tools are connected by belting. In this way all long lines of shafting are avoided. As a rule, the special tools, in which a large number of cutting heads are arranged to work at the same time, have their own independent motors. As an example of this may be mentioned the machines with four boring heads for simultaneously boring the four bearings of railway motors. The bearings in question are for the axle and armature shaft bearings respectively. By means of this machine all marking off is avoided, and the bored surface for the armature shaft bearings are used on the next machine as a guide when boring out the pole-pieces. In the next bay the manufacture of small motor parts is now being carried out, and one is struck by the great number of tools for producing work accurate to gauge and in great quantities. The most of these heavier machines of this class are of English make.

The tool-room adjoining is equipped with special chucks, solid and expanding reamers, mandrils, internal and external micrometer gauges for turning, boring, and general dimensioning, besides other special appliances designed by the British Thomson-Houston Company for testing and inspecting of machine work. Besides the above there are special measuring standards and limit gauges by means of which the greatest accuracy is secured, and the proportion of error is limited to the least possible dimension. The testing and inspecting of apparatus in various stages of manufacture is an important item with the company, and if the work is not up to a high standard it is rejected before passing to the completed stage. In a company doing the large variety of work that the British Thomson-Houston Company do, a large number of special tools made up from time to time to suit particular lines of production in hand are required, and the tool-room is fully equipped with tools designed and invented by the company, the aim of the designers being to perfect simple yet effective devices for accurately reproducing the piece or part of machine desired. A system of limiting the workmen to a certain number of tools is in vogue in the tool-room, by which they are allowed to have at the most six tools for use at one time. Each have six tool checks given to them, for which they obtain a corresponding number of tools for the particular work they have in hand, the check being placed against the receptacle from which the tool has been taken, and immediately the tool is returned the check is also returned to the workman. This arrangement is found to work satisfactorily, and has the advantage of assisting in reducing the stock of tools it is necessary to keep on hand, besides enabling the storekeeper at any moment to locate any particular tool for which there is an urgent demand. In order that the tools may be kept in proper working order, and also to ensure the speedy return of same, every workman is required to bring all tools outstanding against him to the toolroom before leaving each Saturday noon. This enables a positive check to be kept as to the whereabouts of every tool.

The armature-winding department is shown in Fig. 7. All the coils used on these are wound on formers accurately made from experience obtained in America. It may be mentioned here that the company carry out installation tests on these coils at every stage in their manufacture, from the time that the coil leaves the steam-heated former until the armature is completed and ready for dispatch. In the first instance, the individual coil has to pass a flashing test of 8,000 volts alternating, and the completed armatures have to stand five times their working voltage—*i.e.*, 2,500 volts between the conductors and the core. Another point of interest is that the stationary motors now being turned out at Rugby are distinctly different in construction to those of the General Electric Company of America. This company uses cast-steel fields, whereas the British Thomson-Houston Company are using cast-iron yokes with laminated poles bolted to the same. The armatures are the same in each case, and the mechanical parts of the motors are arranged so that these armatures may be interchangeable. The cast-iron yoke divided into two halves meets English requirements, and we think is to be preferred magnetically to the American construction, as a more stable magnetic field is obtained. The design of the frame is such that there is no structural

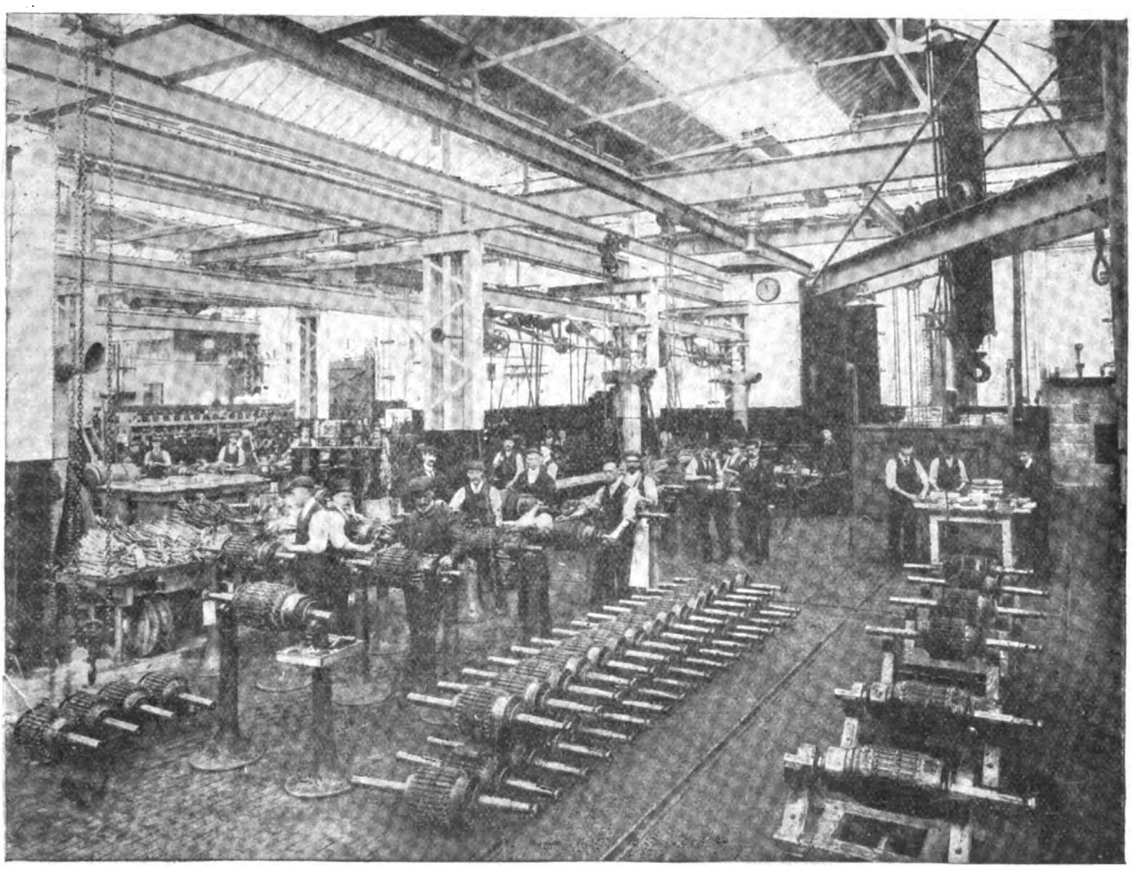

FIG. 7.—Armature Winding Department at the British Thomson-Houston Company's Works at Rugby.

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difference between the open, semi-enclosed, and enclosed motors, except as regards the attachments to the side castings. After the motor armatures and field coils have been completed they are dried out in a vacuum chamber, which is steam heated. This chamber is of the Neville type, and by varnishing the coils immediately they are taken out of it, good insulation resistance is maintained.

The testing department (Fig. 8) occupies the northern sections of the first three bays of the machine shop. In it arrangements are provided for the careful and economical testing of all types of apparatus. At the time of our visit a number of tests between tramway and other motors were being carried out on what was practically the Hopkinson method. In the case of the tramway motors, two were arranged to gear on to the same shaft, the one working as a dynamo driven by the other supplied as a motor from the works circuit. In this instance the output of the dynamo was absorbed in a liquid resistance. Equal care is taken in testing the quality, both magnetic and mechanical, of the various materials used in the motors. For instance, there is a fully equipped chemical laboratory

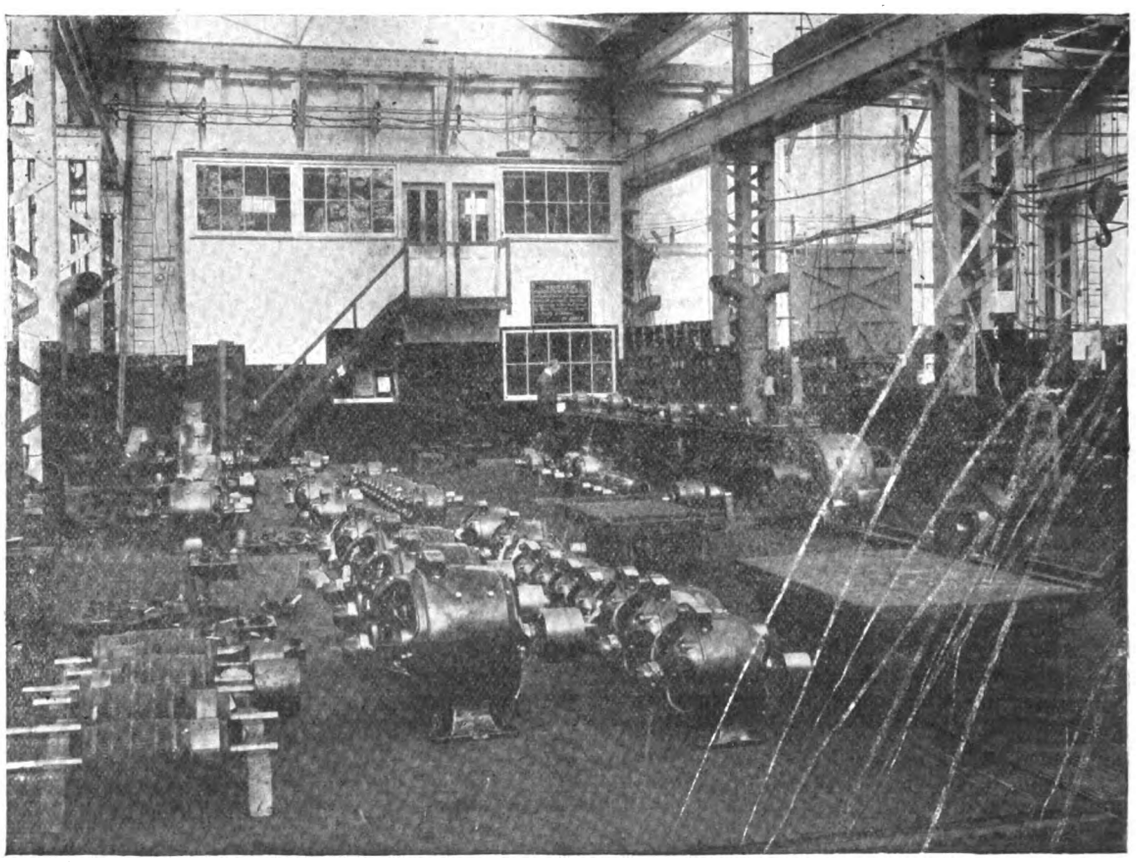

FIG. 8.—The Rugby Testing Department, with lines of Stationary Motors in the foreground.

on the works, in which regular analyses of the qualities of the cast iron turned out by the foundry is made. Arrangements are made so that with each casting there is cast a test-piece. The test-pieces are afterwards detached from the castings, turned down, and tested in the electrical laboratory to ascertain before the casting passes into the machine shop whether its magnetic quality is up to the high standard demanded. The wrought iron and mild steel used for armature stampings are investigated as to their permeability, hysteresis loss, ageing, etc. Another important item dealt with is that of varnishes, japans, etc., used for insulating purposes. These are submitted to rigorous tests for insulation and chemical purity. The purity and efficiency of lubricating oils and greases also receive attention. The very interesting and little-known subject of metal colouring is similarly studied and the discoveries applied in the dipping and plating departments. The work of the laboratories is not solely that of testing the qualities of the materials used in the works, but research is also undertaken with a view to being "one in front" of all competitors. Hence the microstructure of iron, steel, and alloys is being vigorously pursued in relation to the electrical properties of these materials, and the facts discovered tabulated and applied to the works. The arc lamp department and the switchboard department (Fig. 9) were both busy at the time of our visit. The company have a large amount of switchboard work now going through the shop.

The power-house is a building 110ft by 110ft., with a floor space of 23,000 square feet, and is divided into two sections – *i.e.*, engine-room and boiler-room The foundations and walls of same are of an exceptionally heavy character, the foundation being formed of one solid block of concrete over the whole site of an average thickness of 2ft. 6in. The foundations for the engines and boilers are of solid blue brickwork, built in cement, rising from basement to ground-floor level to a height of 10ft. The ground floor is composed of steel girders, strongly bolted together with tie-rods, and filled in with Portland cement concrete to a thickness of 15in., with a top finish of "terrazo" (mosaic). The walls of the engine house are artistically finished with glazed tile dado, with richly moulded capping and skirting; the window finishings are also richly moulded.

The power-house now contains three steam generators, two of which are of 200 kw. capacity each, and supply continuous current at 550 volts. They are coupled direct to horizontal tandem compound Corliss-type engines. The engines, of Messrs. Cole, Marchent, and Morley, Limited, make, are each capable of giving a normal output of 320 i.h.p. when running at 120 revolutions per minute, with steam supplied at a pressure of 150lb. per square inch at the engine stop valve, and with a vacuum of 25in. of mercury in the exhaust pipe. The small set is a 100-kw. 550-volt continuous-current generator, coupled direct to a Browett-Lindley horizontal tandem compound engine running at 235 revolutions per minute. The condensing plant is of the Wheeler Condenser Company's "Admiralty" type with 1,200 square feet of cooling surface, mounted on combined steam-driven air and circulating pumps. The condensing water taken from the artesian well is to be cooled in a pond, not yet completed.

The boiler-house contains two Babcock and Wilcox boilers, each having a heating surface of 2,530 square feet, and fitted with superheaters capable of superheating the steam up to 100deg. F. The working pressure is 160lb.

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per square inch. The boilers are fitted with Vicars's stokers, driven through worm gearing by a 5-h.p. motor running at 675 revolutions per minute. A third boiler is to be immediately installed. The economiser contains 320 pipes of the Clay Cross Company's make, the scraper gear being driven by an electric motor. The boiler feed pumps are two in number, one, by Pearn and Co., of the three-throw vertical type, driven by a 15-h-p. motor running at 840 revolutions per minute; and the second, by the Blake-Knowles Company, of the single-ram horizontal direct-acting type. There are also two vertical three-throw lifting pumps by Pearn and Co., each geared to a 5-h.p. motor running at 1,200 revolutions per minute. The water is treated by Tyack's water-softening process before passing into the boilers. In the pump-room there is also an air-compressor driven by a 60-b.h.p. motor running at 550 revolutions per minute. This compressor is for supplying air at a pressure of 75lb. per square inch to the pneumatic tools in the works.

A balancer set, consisting of two small generators, is installed in the station for the automatic adjustment of the three-wire lighting circuits. The switchboard is designed for the control of the three generators and balancer set, and of the output of the same for lighting and power. It is provided with a duplicate set of 'bus bars so that the circuit to the testing department may be run independently of the other circuits on either of the generators, this provision being made so that the other circuits may be free from disturbance due to short-circuits in the testing department. The lighting circuits are run off the three-wire system, and the circuit breakers protecting the two outer conductors are electrically interlocked, so that it shall be impossible for the full voltage to be thrown on the lamps on either side in the event of a short on one side of the middle wire. The board is equipped throughout with standard British Thomson-Houston magnetic blow-out circuit breakers, quick-break switches, etc., and with the latest British Thomson-Houston pattern, the astatic type, of switchboard instruments. The board is constructed of blue Vermont marble, giving a very handsome appearance by artificial light.

In connection with this power-house it is worthy of note that it is to serve for some years at least as the home of the generating plant of the Rugby municipal electricity works. The company has arranged to give this plant accommodation and to supply the steam dynamos with steam, oil, and attendance at practically cost price. The plant will, of course, provide additional load for the works boilers, and the combination is one for which both parties are to be commended. It will save the Council considerable expenditure on building at the present time, and will not prevent them from removing their plant to their own works after the undertaking has grown and become profitable.

Reviewing the Rugby works of the British Thomson-Houston Company as a whole, it is worth remarking on the careful way in which the plans have been got out. Every department is so designed that it can be quickly extended without interfering with the rest, or without interrupting the regular progress of the work from the foundry to the stores for finished articles. At the present time the equipment is fully completed only for the smaller classes of work, and we are sure that in urging forward this part of the equipment the company has worked on right lines. The standardisation of these ranges of motors now being made to stock has been carried out by a committee formed of the heads of the various departments. The result of this united action is bound to give the best possible results, and we saw every evidence that the detailed organisation of the staff was as carefully thought out and was working as smoothly as the automatic tools in the works themselves.

FIG. 9.—The Switchboard Department.

THE DUSSELDORF EXHIBITION.—III.

Strictly speaking, the Schuckert Company, of Nürnberg, with whose exhibit we shall deal in this article, are not qualified to exhibit separately at the Düsseldorf Exhibition, since their works are situated without that zone of territory constituted by Westphalia and the Rhine Province, to the manufactures of which the exhibition is restricted. The firm in question have, however, overcome this technical difficulty by erecting outside the exhibition enclosure a

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special pavilion, the contents of which are too interesting to pass over.

Among the electrically-driven machines shown, a main shaft winding engine is of primary interest. This engine, we understand, is the first of its kind built on the particular lines of construction adopted. It is noteworthy in two special ways: firstly, the design of the winding engine itself, and, secondly, in the arrangement of the electrical gear used for driving it. In designing electrically-driven winding engines, special attention naturally centres on the following points. The masses to be set in motion at starting and stopping, and the rate of acceleration required, determine the power capacity of the motors; it is desirable, therefore, to reduce these masses to a minimum. In order to keep the cost and weight of the motors required as low as possible, it is desirable not to reduce their speed more than is absolutely necessary. If the motor can be direct coupled to the drum shaft, thereby avoiding the use of intermediate gearing, the efficiency of the engine is correspondingly improved. With the friction type of winding engine with comparatively small discs it is claimed that all these advantages may be secured. The engine exhibited consists of three driving discs, as shown in the illustrations (Figs. 1 and 2), the upper one being mounted on the same shaft and directly driven by the motors, the two lower discs being driven from the upper one by friction The adoption of a flat rope obviates any difficulty due to the bending of the rope round the smaller pulleys. The friction between the rope and the upper pulley is in itself more than sufficient to prevent any slipping, and single-disc machines can be built on this design, but the adoption of the arrangement of three discs shown gives absolute security in this respect, and enables smaller discs to be employed. In this way the great weight insuperable from drum machines is avoided, the absence of large moving masses rendering the engine control much more delicate, besides reducing considerably the total cost. Further, provided the axle of the driving disc has been in the first place sufficiently heavily designed, the machine still remains large enough, even if the depth of the shaft is very considerably increased.

Another advantage claimed for the friction machine is that there is less liability to accident due to over-running, resulting in the upper travelling cage being driven into the rope pulleys. The friction machine provides good security against the upper travelling cage running too high, in that immediately the lower cage touches the bottom the greater portion of the friction between the rope and driving disc, which is dependent on the weight of the lower cage, is lost, and slipping of the rope takes place, so that the upper cage cannot reach the rope disc. If the machine is not reversed before starting, it is for the same reason impossible for the upper cage to be drawn against the pulleys. The arrangement of the two driving motors being mounted direct on the same shaft as the upper driving disc balances the shaft as regards driving, and makes only two bearings necessary, and, further, as the bearings to the two lower discs may be so adjusted as to give a pressure against the upper discs corresponding to that of the weight of disc and motors, and also the pull on the upper discs due to the rope, these bearings are thereby practically relieved of all load. Electric motors are particularly suitable for driving winding engines of the friction type, on account of the great ease with which they can be started gradually with an absence of any jerkiness or consequent liability of the rope slipping on the driving disc from this cause.

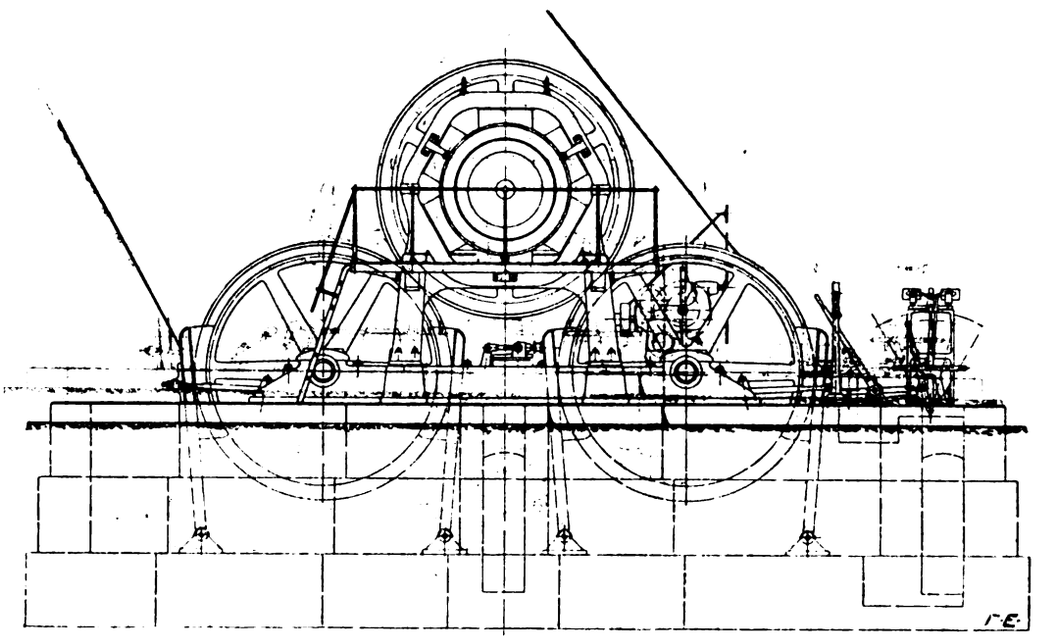

FIG. 1.—Schuckert Main-Shaft Winding Engine, Dusseldorf Exhibition.

As regards the arrangement of the electrical gear, this is as follows: Current is supplied to the switchboard 'bus bars at (say) 500 volts. From these 'bus bars a motor-generator is driven, consisting of a 500-volt motor direct coupled to a 500-volt generator. This generator is so designed that the voltage at its terminals may be varied by shunt regulation to anything between the limits of 0 and 500 volts, and the connections of the machine are further so arranged that this voltage may be either added to or subtracted from that of the main 'bus bars. By this arrangement it is therefore easily possible to obtain any voltage between 0 and 1,000 volts.

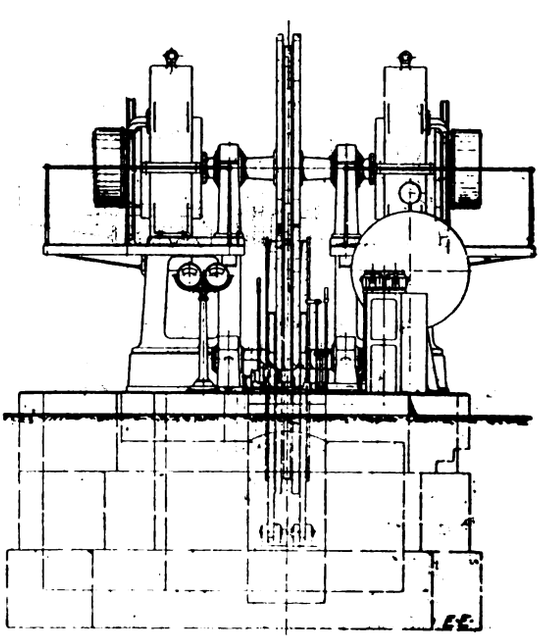

FIG. 2.—Schuckert Main-Shaft Winding Engine, Dusseldorf Exhibition.

The winding engine is driven as described above by two

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motors; one motor may be used if specially desired, but two motors give a more symmetrical arrangement and also greater safety in working. The magnets of these machines are directly excited from the 'bus bars so that the torque exerted by the motors is practically proportional to the current through them. Their armatures are connected through a reversing switch to the above-mentioned motor-generator, and may, therefore, be supplied with current at any pressure from 0 to 1,000 volts, the speed attained by the motors being practically proportional to the voltage. It will be readily seen: (1) That the whole of the speed regulation from 0 to full speed is obtained by regulating the shunt current of the motor-generator. It is not necessary, therefore, for the controller to handle large currents. (2) That the connections of this generator are reversed only when the generator is unexcited. (3) That the main reversing switch controlling the direction in which the motors run is only thrown over in the position at which there is no current in the motor circuit. The electrical connections may be seen from the accompanying diagram (Fig. 3).

The Schuckert Company are also showing in the same pavilion a miscellaneous selection of their manufactures, including a centrifugal mining pump, various electrically-driven apparatus for mining and colliery work, electrical rock drills, accumulator set for house-lighting, electric clocks, large crane magnets, a surface-contact system for tramways, an electric advertising device, etc. We understand that in the rock-drilling tests arranged by the Prize Committee of Mining Section (I.) in the boring hall of the exhibition, the combined Meyer-Schuckert electrically-driven compressed-air percussion drill showed nearly 33 per cent. better results than the second best competitor. With a pressure of 78lb. per square inch the Meyer-Schuckert drill bored a hole 404mm. deep in three minutes, while with a pressure of 40½lb. the same drill bored a hole 165mm. deep in the same time. The diameter of the piston was 75mm, and that of the hole bored in each case

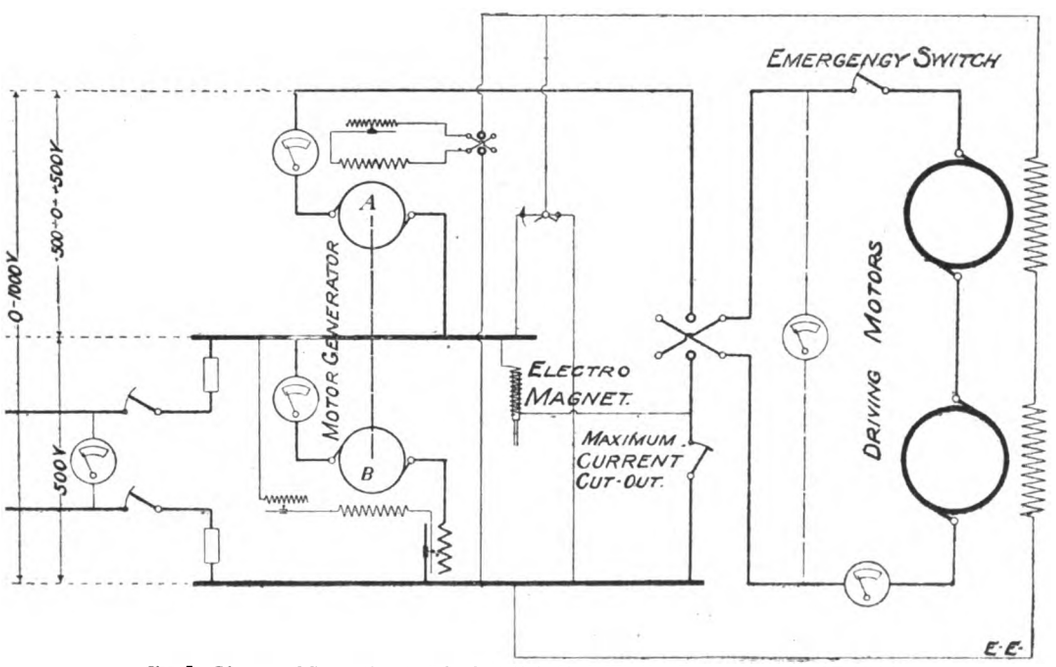

FIG. 3.—Diagram of Connections to Schuckert Main-Shaft Winding Engine, Dusseldorf Exhibition.

This renders the whole of the controller device extremely reliable, and gives rise to very little wear and tear. (4) The controller necessary to fulfil these conditions is worked easily and entirely by one lever, is of very moderate dimensions, requires no auxiliary motors, regulates with small currents only, and is, therefore, very reliable. (5) No matter what speed the engine is running at, the efficiency of the arrangement is approximately the same and very high, the losses consisting only of those in the resistances of the motor circuits and the power consumed in running the motor-generator light, no resistance in the main circuit being employed whatever.

It is also clear that when the winding engine is running at half speed—*i.e.*, when the motors are being supplied at less than 'bus-bar voltage—the condition of the motor-generator is reversed, the generator running as a motor and the motor acting as a generator supplying current to the 'bus bars. It should be further mentioned that ample safety devices are provided, including devices for preventing over-running, a governor controlling the maximum speed during the run and the acceleration during periods of starting and stopping (both when working for passengers or material), also indicators for showing position of cage in the shaft and the speed of travelling. Should the speed limits set be exceeded, the engine is brought to rest and brakes applied automatically. In addition to the ordinary brake, which is worked by means of compressed air supplied either from local service or by a small auxiliary air-compressor, an emergency brake operated by a foot lever is also provided, which at the same time opens the main switch, and which is also operated in the event of the current supply being cut off, and can only be released when the supply of current is again available.

40mm. All competitors used the same boring frame and the same stone, a very hard Black Forest syenite.

AN OPENING IN BRAZIL.

[BY OUR SPECIAL CORRESPONDENT.]

Of all the South American republics, none equal Brazil in area or the importance of their geographical position. Add the fact that in unexploited resources, in fertility, in climate, many parts of Brazil far transcend anything to be found elsewhere, and it will be apparent that it is well worth giving more than a passing thought to this vast country. Larger than nearly all Europe, it still remains without any real civilisation except on the sea border, where the principal towns are situate. The field for electrical energy is unrivalled—there is nothing to displace, there is no competing industry to fight, there is no preference for well-accustomed means of doing things. The means do not exist, or where they do are so bad that even the dullest native finds fault with them.

Chief of the federated states which constitute the new republic is the one where the capital is situate, Rio de Janeiro—an ancient Portuguese city devoid of modern improvements, a great town with a population considerably over half a million, the seat of government, and with the finest natural harbour in the world. Unfortunately the city has never been altered from the old lines on which it was laid out—narrow streets, badly lit, worse paved, jumbled together between numerous steep hills on which the houses hang like clustered bees. There is no electric light worth speaking of in the whole capital. From the great central

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railway station to the custom house, every street glimmers in indifferent gas. Not even the hotels provide electric illumination.

In a few up-country towns some endeavour has been made to introduce it—for example, Juiz de Fora—but 'tis a pale, ineffectual affair at the best. Assuredly there is scope for electric lighting in Rio. What, then, shall be said of electric traction? Let it be first clearly realised that considerable distances separates the city from its suburbs. From fear of fever, yellow or otherwise, few people sleep in town. Every morning, every evening, there is a great flux and reflux of people. Add to this the commercial nature of the port bringing many strangers thither, it becomes obvious that there must be a very considerable passenger traffic, with its attendant necessities of transporting baggage. How is this dealt with? There are no omnibuses; there are no cabs, beyond a very few highly-priced vehicles; there is no underground railway. The whole and sole means of communication are the trams. Oh, such trams! Through narrow streets, barely as wide as old Booksellers'-row, a line of rails juts out from the broken granite paving close to the narrow footway. Along this creaks, clatters, and sways an antediluvian box with seats in it, dragged by two decrepit mules; the footboard projects half across the miserable sidewalk, and unless the wayfarer discreetly retires it will inflict a severe blow on his unoffending legs. Their name is legion; they crawl about the place like bloated spiders swallowing up flies in the shape of little black men, and disgorging them further on in the pleasant suburbs. Nor are they all under one control. Several independent companies have running powers over the streets. Towards the southern quarter electric cars run on the trolley principle of a better type than the city ark. The drivers of the electric cars are usually more reckless than expert, always endeavouring to take a sharp corner at full speed, with frequently unpleasant results. With the exception of the line up Santa Theresa, worked by an American company, this is the only electric traction installed in the capital. The Santa Theresa line serves a very good neighbourhood. Starting from the Carioca, the exchanging square for most trams, it runs up the hill at a steep gradient, crosses the Col, and ends on the slopes of the Corcovado mountain. Its service is about three cars each way per hour at a fairly good tariff. The baggage arrangements are most unsatisfactory. Far too much opportunity is given to the employés of defrauding passenger and master. The railway (there is only one line out of Rio de Janeiro) caters indifferently for the suburban residents in one direction only. Across the bay lies the rising town of Nictheroy, whither large steam ferries convey many of the citizens. Here also the trams are all mule-drawn, and of the worst possible description.

A new order of things is very urgently required. There is an enormous field for electric traction. The prefect of the city really controls the whole council. Once his ear is gained, no need to conciliate this district council or take off your hat to that town clerk, as one has to do so often in England. Nor would the installation be expensive, the streets being narrow. Rosettes could be affixed to the walls, and light connections would be ample. Small cars are better adapted for use than the mammoth affairs of Glasgow or Nottingham. They would have to be run quickly and to give a constant service. Nor must provision for transporting baggage be lost sight of; at present the arrangements are barbarous. A "bagagem" car runs about once an hour, or even less frequently. If you have any sort of bag it must go by this car, so if going out to dine or sleep it is essential to pay a nigger to take the bag on beforehand by "bagagem," while you follow at a reasonable hour. The national characteristic is to take the "bond," as the tram is called; not 50 yards will a man walk if he can discover a tram. It is almost incredible that the present wretched state should exist with such a strong propensity towards assisted locomotion. Let it be again emphasised that the tram is the one and only means of getting about. It is always too hot to walk far, even in winter. How far electricity might be advantageous as a form of power it is difficult to say. There are several manufactories where electrical energy would be welcomed; many more, doubtless, would speedily arise. At present the high rate of wages, inefficient labour, and the dearness of machinery tend to restrict the erection of factories within narrow limits. There is a vast field for enterprise here. It is plain that once the impetus comes, electrical energy will afford undreamt-of facilities in Rio, yielding very great profits to the foreseeing man who provides it.

Another aspect may well be referred to. In a hot climate such as Brazil it is very unusual to find a fireplace in a room, while chimneys are never seen in private dwellings. All cooking arrangements are carried on by gas, charcoal, or by a closed slow-combustion kitchener. Electricity to supply heat for cooking is by no means too remote a possibility to entertain. The idea is certainly one that would be gladly welcomed in Rio. The mainstay, however, of electric enterprise is unquestionably in traction. Nor need it be confined to Rio de Janeiro. In many other towns the need is just as great, and in every case the facilities given to the operator are far greater than in England, while the profits are considerable.

THE OPERATION OF TRAFFIC ON STEAM RAILWAYS.

That the methods of railway management hitherto in use in this country are on their trial is evident to anyone who will take the trouble to observe the trend of events, and who has anything more than a mere local knowledge of traffic and its working. The numerous and somewhat ostentatious visits of prominent railway officials to the States, and the constant girding of sections of the daily Press at English methods, or the results of those methods, are making shareholders much more fully acquainted with the details of the working of their properties than is obtainable from the usually bald and colourless statements of the chairmen at their half-yearly meetings. The trader, too, to whom the railway companies look to provide them with a goodly proportion of their profits, is making his voice heard, and claiming a greater share of attention than he considers he has hitherto obtained.

It is a somewhat nice question how far railways can be looked at from the proprietors' point of view only—*i.e.*, as a means for remunerative investment. Railways are so bound up with the life, business, and prosperity of a country as to be indispensable, and so long as they are subject to private ownership, they must to some extent subordinate their desire for profits to the convenience of their patrons. They must give prompt service at all costs, or face the competition which will inevitably arise from dissatisfaction with their conduct of their business. In the matter of the suburban traffic, in the neighbourhood of large towns they are already feeling the effects of years of persistent neglect and slothfulness, and want of foresight and enterprise, but they are no doubt now awakening to some extent to other possibilities which are looming on the horizon. The railway interest is very large, and depreciation of the values of their properties will no doubt involve considerable hardship to many who have in no way contributed to that end, but sentimental reasons will not prevent the consummation referred to. Railways can only hold their present strong positions by being foremost. Contemplation of the advantages conferred by railways over the methods of inter-communication of the period before Watt and Stephenson began their labours, whilst still somewhat fashionable in some quarters, will not serve to satisfy the desires of those who, not knowing from actual experience the extent of the advantages conferred, grumble at the delay which too often occurs in the transport of goods from place to place.

That there is dissatisfaction amongst traders with the manner in which railways serve them is undoubted. That there is reason for the dissatisfaction is also quite true. Goods do not get transported from point to point with the facility that may be and is expected. Railway managers are well aware of this dissatisfaction, and have been for years. Yet there is no alleviation of the pressure. Why? Are all these visits to the States to be taken as a confession that they are

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unable to cope with the situation, and that they are reduced to the necessity of accepting hints from others who have made a more profound study of their business? What other construction can be put upon these visits, considering the situation at the present time, and the somewhat exuberant eulogism of American methods. If our American cousins were prone to exhibition of what they graphically call "swelled head," which, of course, they are not, could they be blamed under existing circumstances? It is not suggested that there is nothing to be learnt from such trips, but the question arises whether it might not, or even should not, have been learnt without undertaking a journey of 5,000 miles or thereabouts. Every man may learn something from every other man if he will, and it is the duty of everyone to keep himself posted in his own business first if he would be efficient. American literature is singularly rich in connection with railways, and there should be no difficulty in obtaining full details of their methods of operation. The American language is not very dissimilar to our own and is easy of acquirement.

That English railways have greatly improved within the last 30 years, or even during the last 15 years, is undoubted, but the improvements have been in matters of detail rather than principle. The worship of the locomotive is not dead yet, notwithstanding its familiarity, and we hear far too much of the performances of this or that class in terms implying more than is ascertainable by mere considerations of steam pressure and piston area. The hauling of heavy trains is a good thing no doubt, but what of the delay and congestion arising from the time which must elapse in the accumulation of these loads? What of the facilities for taking in or sending out such loads at the centres of distribution, the loading, transhipping, and unloading of goods, their collection from consignors or delivery to consignees? What proportion of the total time between collection and delivery is taken in actual transit between the centres of collection and distribution, and what proportion of the total cost of the transportation is attributable to the actual haulage between these centres? How many of these centres are designed so as to deal effectively with the traffic? How many of the yards attached to these centres are such as to allow the traffic to be effectively handled and allow of easy ingress or egress of made-up trains, and how many are in such positions as admit of adequate expansion at reasonable cost? In how many cases do we find that the tendency is to centralise work in places which are already inadequate for their purpose, and to what should we ascribe this tendency? Is it necessary to visit the States to have these matters brought to notice? It is, of course, well known that the paying load (the average) is comparatively small, and that if the trains carried a greater proportion the cost of transit would be reduced. By all means reduce working expenses to the lowest point compatible with efficiency, but these are not entirely for haulage between the points of collection and delivery. The whole question is one of system, and it is contended that in a comparatively small country like this that the system of making up heavy trains in order to reduce the cost per ton-mile for haulage is wasteful to the companies themselves and the cause of annoyance to their customers.

Railway companies are already taking the hint from the tramways in the direction of their suburban passenger traffic, and we find them preparing, where they have not already lost heart, to give a far more frequent service than hitherto. They will, of course, always be handicapped by the fact that they cannot pick up passengers at so many points as the trams, but there is no doubt that they can compete for longer distance traffic by giving a quick and frequent service. To travel by rail the passenger must subordinate his business to the time-table. With the trams he can arrange his business to suit his own convenience, with the knowledge that he can get service within a few minutes at any time. When railway companies can enable him to do this with their service they will, with quicker transit than is possible in crowded streets, successfully compete with trams for such traffic as indicated above. One does not, however, see that railway companies are awakening to the fact that other classes of traffic could be dealt with more successfully on the same plan. The present congestion does not lie upon their running lines, although we find them duplicating these at very large cost in all parts of the country. (Such duplication, of course, is primarily necessary in consequence of the great differences in the speeds and braking power of different classes of traffic.) The congestion is in the yards and warehouses. A quick service of lighter and faster trains would operate to relieve the congestion, would enable greater use to be made of the rolling-stock, would require lighter equipment throughout, give a better use of the running lines, and would tend to pacify the traders.

It requires to be understood that efficiency of service is the final test of suitability, and that the company which is most prompt in delivery will always command the most traffic; and the vexed question of rates will settle itself on an equitable basis in the long run. To get the very best service out of the rolling-stock requires its removal immediately it is loaded, and to get the best service from the line as a whole demands the occupation of all parts of it all the time. The present mixed traffic with large time margins does not allow of such continuous use. The attack of the electrical lines on the carrying traffic of the country is not half developed yet. When the county power-distributing companies get fully to work the railway companies will see things. The question for their consideration is what they will do about it. And the question is up for consideration *now*.

LEAVES FROM A TESTING ENGINEER'S NOTEBOOK.

BY FRED. W. DAVIES.

(Continued from page 556.)

[CORRECTION.—In our issue for Oct. 10, p. 518, and eight lines from the bottom of the page, the formula for end-play given as $e = \frac{\sqrt{d}}{S}$ is incorrectly printed; it should be $e = \frac{\sqrt{d}}{8}$; 8 is a constant.]

One more instance of an armature giving trouble by reason of some of its coils being "short-circuited" may be mentioned. A bipolar compound-wound dynamo (having an output of 60 amperes at a pressure of 200 volts at a speed of 975 revolutions per minute) suddenly flashed at the commutator, and then ceased to excite. In order to locate the fault the field magnet was excited independently, and the armature run at full speed, with the result that the latter (which was of the drum type, and wound with a "symmetrical" hand winding) heated all over. It was found that the insulation between two opposite coils had broken down, thus causing the whole of the winding to be "short-circuited," and rendering the machine inoperative.

A good deal of trouble was experienced once with a motor-generator, consisting of two four-pole machines with former-wound toothed drum armatures. The primary end was wound for 500 volts, and the secondary was arranged, by means of an adjustable resistance in the shunt circuit of the field magnet, to give from 300 to 500 volts as required. It was noticed that vivid white sparks would occasionally — especially when working at full load—shoot out from under one or other of the brushes, and there would be at times a violent flash, sometimes at one commutator and sometimes at the other, a sharp crack at the same time being emitted. Eventually the primary armature broke down altogether. It was noticed, also, when the machine was at rest that the mica on both commutators appeared to be burned away somewhat between several of the bars. From the mica being burned in this manner, and from the nature of the sparking (a thin vivid white spark going, or tending to go, in a circle round the commutator, being always indicative of a break somewhere in the armature circuit), it appeared likely that there were breaks in some of the armature coils. This proved to be the case, and on rewinding the faulty coils the machine ran quite satisfactorily. The breaking of the conductor was due, it may be said, to the fact that the

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wires fitted rather tightly in the slots, combined with carelessness in the winding shop.

Commutators.—The commutator of a dynamo or continuous-current motor, although of simple construction, is, nevertheless, subject to faults of various kinds. It is essential that there should not be too great a difference of potential between any two adjacent bars, caused by there being an insufficient number of bars in the commutator, otherwise there will be a danger of sparking from one bar to another, and possibly from brush to brush. Such a fault is more liable to manifest itself with carbon brushes than with copper brushes, owing to the carbon dust accumulating on the commutator. Experience shows that the number of bars in a commutator should be such that the maximum average pressure between adjacent bars does not exceed 20 volts.

A common source of breakdowns in continuous-current machines is that some of the commutator bars become accidently connected together, thus "short-circuiting" the corresponding armature coils. This is caused sometimes by metallic dust accumulating on the surface of the commutator, and sometimes by the copper being burred over the mica when turning up the commutator. It is well to occasionally examine a commutator to see if it is all right in this respect, and in a new machine it is of the utmost importance that it should be carefully examined preparatory to running the machine for the full load test.

Some of the bars in a certain commutator became partially "short-circuited" by reason of one of the micanite end-rings, by means of which the supporting annular disc was insulated from the copper bars, being fitted imperfectly into the commutator; thus allowing an accumulation of carbon dust from the brushes, which partially "short-circuited" several of the bars (see Fig. 1).

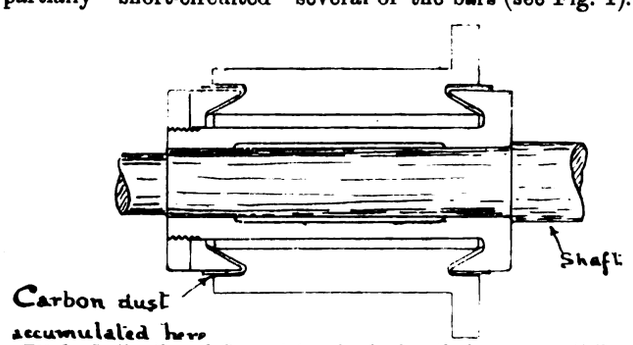

FIG. 1.—Section through Commutator, showing how the bars were partially "short-circuited" by carbon dust.

A case which will probably be of interest, on account of the means adopted to effect a *temporary* remedy, was that of a dynamo used for lighting a colliery. From the nature of the sparking at the commutator it was at once evident that there was a break somewhere in the armature circuit. It turned out that two of the lugs leading from the commutator bars to the armature coils had become loosened from their respective commutator bars. It was imperative that the machine should be kept at work; so, in order to effect a temporary remedy, the two lugs were taken out altogether (taking care that the ends of the armature coils were connected in proper sequence so as to still afford a complete circuit through the armature). It now only remained to stagger each pair of brushes (there was a pair of copper brushes on each brush arm), so that each brush arm virtually carried a brush which spanned or embraced three commutator bars. This was done in order that the current might not be interrupted when the two commutator bars from which the connecting lugs had been removed came under the brush. In this way it was made possible for the machine to go on working until a convenient time came for stopping it, when the armature was removed and the commutator lugs properly fixed.

It is not often that trouble is experienced with the armature connections, but a case of this kind at one time came under the writer's observation. The dynamo was a bipolar one, with an armature of the toothed-drum type which was hand wound. Owing to a very strong stray magnetic field at the ends of the armature, caused by the armature being a little too short, the connections, which were taken straight down to the commutator without the interposition of any lugs, broke repeatedly. This resulted in sparking, and eventually in the machine refusing to excite altogether. An attempt was made to remedy matters first of all by the plan that, naturally, first presented itself—namely, the use of pieces of thick wire leading down from each armature wire on to the commutator. These, however, soon broke away from the commutator, owing to the intense magnetic drag to which they were subjected. Then pieces of "dynamo flexible" were tried, but with the same result. At length the armature had to be rewound, and in connecting it up to the commutator, instead of taking the end of one coil and the beginning of the next one down to each commutator bar, a *single* piece of "dynamo flexible" was soldered on to these two wires close to the winding and taken down to each commutator bar. This proved a satisfactory solution of the problem, and the machine never again gave trouble by the connections breaking. The reason why the use of a *single* wire leading from the winding to each bar of the commutator remedied matters was that this single wire did not form part of the armature circuit, and, therefore, carried no current except when the commutator bar to which it was connected was under the brush; and as it would be in a neutral part of the magnetic field when in that position, it was not subjected to any drag at all. This expedient, although very simple, is, nevertheless, a valuable one, and may be used on any machines giving trouble with the connections, with the certainty that it will be a success.

Brush Gear.—The brush gear is an important factor in a continuous current machine. Faulty brush gear may spoil a machine that would otherwise be considered a good one. Brush-holders, being necessarily of delicate construction, are peculiarly liable to give trouble unless carefully looked after. Although such troubles as are occasioned by defective brush gear are usually easily put right, yet much inconvenience and annoyance is frequently caused by its getting out of order. Below are enumerated a few of the points which are liable to present themselves in this connection.

The brush rockers of small machines are often set by means of small set screws, which grip on to the seating on the bearing which receives the brush rocker. If the brush rocker does not fit the seating exactly, it will be tilted when this set screw is screwed up, thus altering the bedding of the brushes on the commutator, and causing them to spark (especially if carbon brushes are used). For this reason it is better to arrange for the brush rocker to be set in position on the seating by having it made in two halves, which are pulled together by small set screws. When this plan is adopted, it is impossible for it to become tilted on screwing it up.

Sometimes it happens that a machine sparks at the brushes owing to the brush arms not being at the correct angle to one another. The obvious way to avoid this error is to have the brush rockers marked off carefully for drilling and tapping by means of suitable templets.

The importance of good insulation between the brush rocker and the brush arms need hardly be emphasised here. It is essential that the material used for this purpose should not only have high insulating properties, but that it should be mechanically strong as well. Vulcanised fibre is hardly suitable, as it is affected by moisture and heat. There are many excellent substances for this purpose now on the market, and it would appear invidious to make special mention of any, though, perhaps, "micanite" is as good as any.

The tension with which the brushes are held on to the commutator is of greater importance than it is often considered to be. It is essential for satisfactory working that the pressure of a brush on the commutator should remain fairly constant as the brush wears away. The initial pressure of the brush is also an important matter. There is a certain pressure which, with a given type of machine and a given type of brush-holder, will be found to give the best results. It sometimes occurs, especially when carbon brushes are used, that a dynamo refuses to excite owing to there being insufficient pressure on the brushes. This is a matter that is easily remedied, yet a lot of time is sometimes spent before the cause of non-excitation is found out. It is well, therefore, when a case of non-excitation occurs,

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before anything else is done, to apply a little pressure temporarily to the brushes with the hand in order to ascertain if the brush pressure is sufficient. Insufficient pressure of the brushes, whilst resulting in non-excitation in the case of a dynamo, in a motor causes violent sparking, but does not prevent its working.

Whilst insufficient pressure of the brushes is detrimental to a dynamo or motor, excessive pressure is equally so. How often it occurs that a commutator becomes badly scored after only a few months' running, owing to the excessive pressure of copper gauze brushes.

An interesting example of a machine giving trouble through overmuch brush pressure was that of a four-pole enclosed motor. The output of the motor was 10 b.h.p. at a pressure of 400 volts, at a speed of 900 revolutions per minute. The commutator was made up of cast copper bars (which were necessarily soft, and therefore unsuitable for this purpose), and the brushes were of carbon. As already mentioned, the pressure of the brushes on the commutator was too great. This, and the softness of the commutator bars, resulted in some of the brushes—one in particular—becoming coated with copper where they made contact with the commutator. This copper coating offered a lower resistance to the current in the coils which were "short-circuited" by the brushes than the carbon would have done, with the result that the "short-circuit" current in the coils was excessive. This heated some of the brushes to a red heat, so that the motor had to be stopped until the cause of the heating of the brushes was discovered and removed. Probably this phenomenon would not have been so marked had hard drawn copper been used for the commutator, but, at all events, it shows the possibilities of giving trouble that lie latent in the practice of putting great pressure on carbon brushes.

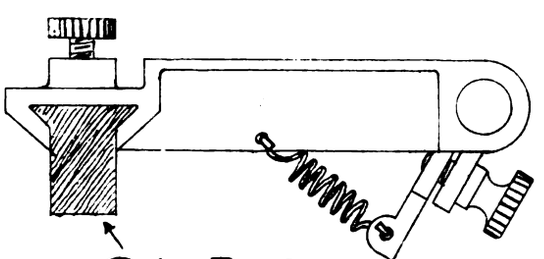

FIG. 2.—Sketch showing type of Brush-holder referred to.

One essential of a good brush-holder is that it shall be constructed so that the brush remains inclined to the commutator at the same angle as it wears away; in other words, the brush must be fed towards the commutator with a parallel movement. Those brush-holders of the type shown in Fig. 2, in which the brush moves in an arc of which the brush arm is the centre, and the distance between the brush centre and the centre of the brush-arm the radius, are liable to give trouble on account of the brush not bedding properly on the commutator after it has worn down a little. To guard against this, the distance between the centre of the brush and the centre of the brush-arm should not be too small—from 4in. to 5in. centres will be found suitable for most ordinary sizes of machines.

The thickness of the brush influences the commutating properties of a machine. Some small enclosed motors, which were provided with carbon brushes $\frac{5}{8}$in. thick, and which sparked rather badly, were materially improved by substituting for them brushes which were only $\frac{1}{2}$in. thick. The usual practice is to make copper gauze brushes of such a width that they will just span one commutator bar and one strip of mica; whilst carbon brushes, being of higher resistance, are usually made to span three bars and three strips of mica. Brushes which are too wide will get hot owing to the coils being "short-circuited" by them for too long a period; and, on the other hand, it does not do to make the brushes indefinitely narrow, as in that case the armature coils will not be "short-circuited" for a sufficiently long period. In certain cases, the heating of carbon brushes, caused by over-commutation, may be remedied by making a saw-cut in each brush radially to the commutator.

(To be continued.)

BOLTON TRAMWAY DEPRECIATION.

The interesting letters on the above subject in our last issue will be further explained by the abstracts given below from the accounts for the last completed year of working. The first of this is from the revenue account and the second from the asset side of the capital account. We are indebted to the courtesy of Mr. George Swainson, F.L.S., F S.A.A., the borough treasurer, for the report from which these are taken.

Extract I. from the Bolton Tramways Account, showing depreciation for year ended March 31, 1902.

To capital depreciation written off—	
Construction of tramline at 8 per cent. on £102,848	£8,227
Buildings, old lease, goodwill, etc., at 3 per cent. on £89,470	2,684
Electrical equipment, at 5 per cent. on £49,098.....	2,454
Cars and rolling-stock, at 10 per cent. on £27,636.....	2,763
Tools and machinery, at 10 per cent. on £1,403.....	140
Office fittings, etc., at 10 per cent. on £308.....	30
	£16,298

Mem.—This includes £10,061. 15s. 8d., loans repaid.

Extract II. from the Bolton Tramway Fund Capital Account.

Assets, March 31, 1902.

	£ s. d.	£ s. d.
Tramline construction, etc.—		
Total outlay to March 31, 1901	139,678 12 3	
Additional during the year	1,706 0 8	
	141,384 12 11	
Less total depreciation	53,284 3 7	
		88,100 9 4
Relaying permanent way—Outlay to March 31, 1901 ...		49,279 1 4
Car-sheds, goodwill, lease, etc.—		
Total outlay to March 31, 1901	89,470 4 4	
Additional during the year	15,753 14 8	
	105,223 19 0	
Less total depreciation	5,368 0 0	
		99,855 19 0
Electrical equipment—		
Total outlay to March 31, 1901	49,098 10 6	
Additional during the year	10,832 10 5	
	59,931 0 11	
Less total depreciation	4,908 0 0	
		55,023 0 11
Cars and rolling-stock—		
Total outlay to March 31, 1901	27,636 10 3	
Additional during the year	12,608 10 0	
	40,245 0 3	
Less total depreciation	5,526 0 0	
		34,719 0 3
Tools and machinery—		
Total outlay to March 31, 1901	1,403 18 10	
Additional during the year	1,310 1 5	
	2,714 0 3	
Less total depreciation	280 0 0	
		2,434 0 3
Office fittings, etc.—		
Total outlay to March 31, 1901	302 17 8	
Addition during the year	62 11 9	
	371 9 5	
Less total depreciation	60 0 0	
		311 9 5
Floating assets—		
Manchester County Bank, Limited, cash in hand	36,390 6 1	
Stock in hand	1,386 7 3	
Cash in hand with tramways manager...	120 0 0	
,, ,, electrical engineer...	10 0 0	
Amount owing by sundry debtors	1,033 0 4	
		38,939 13 8
		£368,662 14 2

Presentation.—On Monday evening last Mr. F. S. Grogan was the recipient of a handsome dressing case from his fellow-workers in Croydon, as a mark of their goodwill on his appointment to a position in the contract department of the British Thomson-Houston Company at Rugby. Mr. Grogan has for the past 18 months or so been engaged in carrying out the overhead equipment of the Corporation electric tramways at Croydon, the contract for which was held by the British Thomson-Houston Company. With the creation of a heavy traction department at the Rugby works he will go to headquarters to take up the position of contract manager for the overhead equipment and cars. The presentation was made by Mr. T. B. Goodyer, the manager of the Croydon tramways, at a smoking concert which was held at the Greyhound Hotel, Mr. C. Spurway, the electrical engineer for the tramway system, in the chair.

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CONTENTS.

Notes	577	Legal Intelligence	596
The Rugby Works of the British Thomson-Houston Company	582	Questions and Answers	596
		Trade Notices and Novelties	599
		Hammersmith Accounts	600
The Dusseldorf Exhibition.—III.	587	Aberdeen Accounts	600
		Tube Bills in Parliament	601
An Opening in Brazil	589	Appointments Vacant	601
The Operation of Traffic on Steam Railways	590	Companies' Meetings and Reports	602
Leaves from a Testing Engineer's Notebook	591	Contracts for Electrical Supplies	602
Bolton Tramways Depreciation	593	Traction Notes	603
		Lighting Notes	606
Professional Etiquette	594	Provisional Patents, 1902	610
Correspondence	595	Companies' Stock and Share List	611
Institution of Mechanical Engineers	595	Traffic Returns	612

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PROFESSIONAL ETIQUETTE

What is the value of a law which cannot be enforced? According to the answer to this or some similar question which each individual is prepared to give, so will that individual estimate the value of the "standard of professional etiquette" which has received the sanction of the Council of the Institution. It might, further, be asked what a scientific institution has to do with professional etiquette? The Council of the Institution, it seems to us, neglects the things it ought to do and does the things it ought not to do. The discussions, if not the papers, read at its meetings are too often plainly of an advertising rather than of a purely academic character, though too great stress may easily be laid upon this failing. You cannot obtain a long series of good papers from uninterested parties, but the business part might sometimes be toned down a little. Nor can practical experimental work be carried out to so large an extent outside of factories, nor can the results of these experiments be made public without crediting business men for their labour. However, putting this on one side, is not the Institution by committees and reports and suggestions being led just a little too much into matters that hardly concern it? What power has the Institution to stop a man from seeking employment? Will it keep a detective agency or inaugurate a black list, and what is the punishment for the crime? Surely the professional consulting engineers are powerful enough to put a stop to unprofessional practices without having recourse to the Institution. Take the one point of answering advertisements. Do the consulting engineers for a moment believe that if all the eminent men in the profession stop answering such advertisements, the authorities are so stupid as to remain in ignorance of the fact, and to be satisfied with the services of tenth-rate men of little or no experience? There is a good deal of interpretation required as to the meaning of this code—for example, does the sending out of a circular to state that A. B. has commenced a consulting practice on his own account constitute advertising, or the courtesy note inserted to that effect in the trade paper, or is advertising restricted in meaning to the insertion of paid advertisements in the advertising columns of the newspapers? There is advertising and advertising, and many of those who pay least advertise most. If a consultant hears that an authority is thinking about a scheme and manages to arrange to give a public lecture in the town at a particular moment, is that advertising under the code, or is it not? We cannot believe this code will do any good service unless it can create honest men. There are ways and means of doing all that is here tabooed without in the letter infringing the code. A. B. does not go and solicit for himself, but avails of the services of a friend; and this will continue as long as the world continues. It is upon the *esprit de corps* of the profession that the whole thing hangs. Let those who belong to it behave in an honourable way as gentlemen, setting their feet down upon everything base and dishonourable, educating the young men who enter the profession in what is and what is not permissible, quietly sending to Coventry those who persistently ignore the traditions, and the things the code means to condemn will cease to exist, or, if they exist at all, exist in such a manner as to be harmless. Thus far we had written before the appearance of the *Daily News* of Oct. 23. Ordinarily, we have no interests in common with this paper, but in its attack upon the *Times* it also attacks the Institution, and, in our opinion, justly so, in that the Institution ought never to have placed itself in the position of being so

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criticised. The chief aim of the Institution should be educational, the obtaining and dissemination of the latest information, and it should not initiate committees to report either on commercial or legislative questions. When it does so, it is used merely as the tool of interested gentlemen who have their own aims, their own success, and who care nothing whether the question is one that affects the industry generally. That the Institution is being so used no unbiassed man can deny. In saying this of the Institution, it need not dim our admiration for the men who are pulling the strings. We do not blame them: they may be perfectly honest in their convictions, and so use every possible method of impressing their views upon the public. If, then, they can get the weight of influence and authority of the Institution in their favour, so much the better from their point of view. But it behoves the other members to suggest caution before the Institution moves in paths that are clearly commercial. Further, the Council of the Institution ought to recognise that entering into commercial and legislative questions means setting one class of its members—those serving public authorities—against another class, and this will inevitably end in rupture and the formation of opposing institutions.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PROFESSIONAL ETIQUETTE.

SIR,—As it has come to the knowledge of the Council of this Institution, that in several cases consulting engineers have applied for employment, and in others local authorities have advertised for consulting engineers, I am instructed by the Council to forward a copy of the code of etiquette in such matters that, in their opinion, ought to govern all those belonging to the Institution. I am also instructed to urge the great importance of having electrical work well done at the most moderate outlay; and would point out that by advertising, or by employing those who solicit employment, either directly or by agents, local authorities may deprive themselves of the services of electrical engineers of high standing and great experience.

The following is the standard of professional etiquette for consulting electrical engineers, as approved by the Council of the Institution of Electrical Engineers on July 6, 1902: (1) No consulting engineer should solicit employment as consulting engineer verbally, by letter, by agent paid by commission or otherwise, or by any other means. (2) No consulting engineer should answer advertisements for consulting engineers. (3) No consulting engineer should advertise for employment. (4) No consulting engineer should pay by commission or otherwise anyone who introduces clients. (5) No consulting engineer should receive trade or other discount, or surreptitious commissions or allowances in connection with any works which he superintends. (6) A consulting engineer who is also directly or indirectly interested in any contracting or manufacturing business should inform his client in writing what his connection is with such contractor.—Yours, etc.,

W. G. MCMILLAN, Secretary.

Institution of Electrical Engineers,
28, Victoria-street, Westminster, S.W.,
Oct. 17, 1902.

BOLTON TRAMWAY DEPRECIATION.

SIR,—Mr. George Swainson's letter in your issue of the 17th explains that the repayment of loan at the rate of 3½ per cent. is included in the 8 per cent. depreciation written off each year. It does not state, however, what the borough treasurer does with the 4⅔ per cent. which is not employed in the repayment of loans. My point was that this sum taken from revenue should be invested each year, and that the compound interest would at the end of 12 years make a very appreciable addition to the amount available for track renewal. This addition did not seem to be taken any notice of in Mr. E. Ll. Morgan's report on the subject. I quite agree with the principle underlying Mr. J. Dalrymple's system of accounts, that the depreciation, quite apart from the repayment of loan, should be sufficient "to replace the assets at the end of their life." It seemed to me that in Bolton the depreciation was too much, but Mr. Swainson's letters show that this excess is but slight.—Yours, etc.,

P. T.

RE "QUESTIONS AND ANSWERS."

SIR,—Following up your most interesting answers to Question No. 517, I would suggest you asked for somewhat abridged specifications as follows: (1) overhead tramway equipment; (2) permanent way, with particulars of feeders, etc.; (3) car equipment with motors, etc.; (4) (for) direct-current system; (5) (for) multiphase system; (6) approximate equipment of the power-house, with feeders and distributing mains, etc.—Yours, etc.,

A. B.

[N.B.—The difficulty in connection with the above suggestion is that any specification is valuable only on account of its application to a special case. Unless this case is fully known, the details in the specification become either exceedingly vague or else precise and misleading. Taking the car equipment, for instance, it is now recognised that standard motors and controllers, as made in large quantities by certain firms, do not give the best possible results on systems with long continuous grades. Our correspondent's suggestion would, we are afraid, result in the drawing up of abridged specifications which would only too often be misleading.—ED. *E. E.*]

TRAMCAR LETTER-BOXES

SIR,—Your note on "Tramcar Letter-Boxes" in the current issue of the *Electrical Engineer* states in the concluding sentence, "We believe that it is the first to be permanently adopted in this country." I would beg to point out that the Huddersfield Corporation tramways were the first in this country, as boxes have been carried on both the steam and electric cars here for the last five years, and the Sheffield boxes are, I understand, copied from the Huddersfield post-boxes.—Yours, etc.,

Huddersfield, Oct. 18, 1902. H. N. THOMAS.

INSTITUTION OF MECHANICAL ENGINEERS.

The above institution held the first ordinary meeting of their current session on Friday, the 17th inst., when Captain C. C. Longridge contributed to the proceedings an interesting paper on "Oil Motorcars of 1902." In this paper the author does not attempt to describe in detail the several types of oil motorcars now on the market, but rather to advance for discussion debatable points in the principles of construction embodied in the latest cars. Referring to the types of motors in vogue, the author remarks that, with very few exceptions, petrol car engines are of the vertical single-acting Otto type, variations being made consisting chiefly of horizontal Ottos, or more often horizontal motors, in which one cylinder contains two pistons, between which explosion takes place. He holds that neither type is going to stay, but that the ultimate evolution will be the impulse-every-revolution engine, the aim of manufacturers being obviously towards elimination of change-speed gear by increasing the flexibility or elasticity of the motor. The author then goes on to describe an engine, recently patented by himself, in which impulse in every cylinder is obtained at every revolution. The advantage of high compression claimed for this engine opens up what the author terms a negative feature of present car engines, the principle which so greatly advanced the economy of gas-engines having, he points out, been scarcely yet applied to petrol motors. In the matter of piston speed this year's engines show a general return to the earlier speeds given by 700 to 800 revolutions

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per minute normal running. In discussing material and methods of manufacture, the author suggests there is plenty of room for improvement, and goes on to specify wherein this improvement might be effected. He advocates, among other things, the adoption of mechanically-operated valves in high-speed motors, giving his reasons.

As regards the question of fuel, dealt with in another section of the paper, it seems to the author astonishing that petrol should have been so long in use and yet so little known about it. He believes he is correct in stating that in this country at least neither the maximum explosion pressures of various petrol mixtures, nor the times of attaining maximum pressure, nor the rates of cooling are yet ascertained. Under these circumstances, makers, as far as carburation is concerned, must be working more or less in the dark.

Several pages are devoted to the question of ignition, but the only method considered in detail is the electric. This divides itself into dynamos, accumulators, magneto-electric, or combinations. The dynamo is rarely used alone, we are told; more generally, it serves to ignite the charge, while the surplus current goes to the accumulators, which are thus kept ready for emergency or for lighting purposes. In the author's opinion this is an excellent, if not the best, system. As regards accumulators, his experience is that they never run nearly the mileage claimed, and are otherwise troublesome. In this country, the best known magneto ignition is the Simms-Bosch. The Canstatt German Daimler Company are said to have found the Bergmann rotary magneto-electric apparatus very satisfactory. This produces alternating currents of low tension, and thus easy insulation; while the only moving part is the rotary armature. The magnets may be run at the same speed as the engine, and at very low speeds produce sparks of sufficient intensity. In whatever form it is applied, the author considers electric ignition is a notable advance over previous methods. It provides absolute immunity against fire, it furnishes a spark well suited to explosive mixtures, it increases efficiency by enabling the charge to be fired at the moment of maximum compression, and it admits of the employment of higher compressions. It is suggested, however, that existing systems admit among other directions of improvement on two lines—automatic timing and automatic consumption of current. Complaint is made as to the apparent inability of English firms to turn out motorcar axles and springs of quality and accuracy equal to the production of French and Belgian firms. The practical conclusions to which the author arrives in regard to lubrication are: (1) petrol motors should be fitted with positive feed lubricators, ensuring a sufficient and no more than sufficient oil supply; (2) that with such lubricators high flash-point oils should be used in preference to the oils now commonly employed. The high viscosity of such oils is favourable to the retention of compression; on the other hand, it tends to increase friction, and thus also the temperature of the rubbing surfaces.

In the above we have dealt very briefly with a few sections only of the paper, which is a long one, with illustrations, and well worthy of perusal by those who may be interested in the subject. Discussion on the paper is to be continued at an extra meeting of the institution to be held to-night at 8 p.m., as announced elsewhere in this issue.

LEGAL INTELLIGENCE.

CLAIM FOR ELECTRIC LIGHT.

In the Westminster County Court on Tuesday his Honour Judge Woodfall had before him the case of the London Electric Supply Corporation *v.* Lamb, by way of a judgment summons, in which the plaintiff company sought to enforce payment of a debt in respect of electric light supplied to the defendant.

The **Plaintiffs' Representative** said he had good reason to suppose that the defendant was well able to pay. He had, however, made no effort to pay the judgment debt.

The defendant did not appear, and **His Honour** said that whilst he felt that a man of his position ought to pay for his electric light, he (the judge) did not think the evidence of means was sufficiently strong to justify him in making an order of committal. He would, however, make an order for payment at the rate of £1 a month, subject to committal to prison for seven days in default.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

[We have received the following communication from the gentleman who signs all his contributions to this column with the letter "K." With respect to the same it should be remembered that while all extracts from original papers should be acknowledged and the authors' names mentioned, the original work of the contributor is not lessened in value thereby. It is original thought and the clear expression of individual opinion which we wish to encourage in this column.—ED. *E. E.*]

"In reference to my reply to Question 517, I am sorry I neglected to acknowledge the great assistance I derived from several papers which have at various times been read before the Society of Electrical Engineers, especially that of Mr. A. C. Eborall's of last year.—K."

QUESTIONS.

527. From the results of Tesla's experiments it is popularly supposed that there is no danger from electric shock when the voltage applied reaches a very high limit. A lot of misunderstanding exists on this point Explain the matter clearly, and show what is the real significance of Tesla's experiments.—M. W. K.

528. On systems of electrical distribution at high voltages (not an overhead system) it appears to be fairly common practice to arrange spark-gap devices to the feeders, apparently to discharge any accumulative static charge on the feeders. Are these spark-gap devices really necessary, and what is the explanation of the accumulative static charge on the feeders? What limit is there to the rise of voltage of this static charge if spark gaps are not used?—H. P.

ANSWERS.

Question No. 521.—Is there any economical way of disposing short lengths of carbons for arc lamps from a large system of public arc lamps?

Best Answer to No. 521 (*awarded* 10*s.*).—These short lengths of carbon rods are very useful for making microphones and telephone transmitters, but I am not aware that there is any very great demand for them. Of course, they might be ground up and used in the making of fresh rods, but then the cost of collecting and carriage would have to be considered. The carbonaceous matter used in making the rods is cheap and plentiful, but the cost of making them is considerable because of the time occupied, the appliances required, and the labour. Generally stated, the process of manufacture is somewhat as follows: In the manufacture of coal gas for illuminating purposes some of the gas is decomposed by the heat of the furnaces, and the carbon of which it is partly composed is deposited as a dense crust upon the inside of the retorts. Hence the name gas carbon. This carbon is ground up to a fine powder and is then mixed with some sticky substance, such as starch, gum, or gas tar, and worked up into a thick fluid, when it is forced by great pressure into iron moulds. It is then put into a fire and made red hot, when any gases present escape through small holes purposely left in the mould. As the carbon is heated and cooled out of contact with the air it is not burnt, but it is taken from the mould as a hard porous lump or rod, according to the shape of the mould. This is now soaked in hot tar or pitch and again put into the mould and heated to redness out of contact with the air, and so this process is continued until the whole rod (or mass) is quite homogeneous and all the pores have been filled up completely. Gas carbon can be bought of the gas companies cheap, as it is practically

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useless to them, but it is very hard, though porous, and requires a good lot of work in dealing with it. Of course, various makers vary the above process to suit their own requirements and ideas. Some put a little mineral matter to improve the colour of the light emitted by the electric arc. It will be seen from the above that these short lengths might be put to some useful purpose under some favourable circumstances, but I fear that most people can do no better than use them for fuel.—F. G. A.

Question No. 522.—An engineering works building a large extension some distance from existing steam generating plant is installing a 100-kw. steam dynamo for driving motors in new shops and lighting both new and old shops. Supply company is to be used as a stand-by for Sunday and holiday work. Continuous current on three-wire system at 205 and 410 volts is the system used. Describe how this may best be accomplished, giving diagram of connections.

Answer to No. 522 (*awarded* 7*s.* 6*d.*).—From the information "R. A. M." gives, the writer advises a 410-volt three-wire system, the motors being 410 volts connected across the outers The larger-size motors in any case would have to be 410 volts, as the supply company's engineer would not allow motors of above, say, 2 h.p. to be connected between the outer and middle wire, as they would spoil the balancer and affect the light over his system. And as 410-volt incandescent lamps are out of the question, and the dynamo will have to be 410 volts to supply the motors, it follows that the best system to suit the above conditions will be the three-wire. It will mean the addition of a balancer to work when the dynamo is running and the *lights* are on.

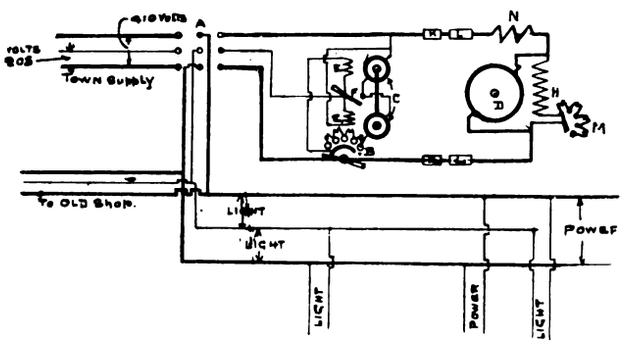


FIG. 1.

Fig. 1 shows the connections of the above system. A is a two-way three-pole switch—when over on the left the supply will be from the town, when on the right the dynamo; B, balancer starter; C, balancer; D, 100-kw. dynamo; E, balancer field coils; F, middle-wire switch to be closed after the balancer has been run up; H, dynamo shunt; K, double-pole fuse; L, double-pole switch; M, regulating switch of dynamo voltage; N, series coil on dynamo. The size of the balancer, 2-3-kw. machines with shafts coupled together. To balance: Note the lamps that are used at the same time; divide them and put one-half on each side of the middle wire. The balancer is used because the load is practically never equal

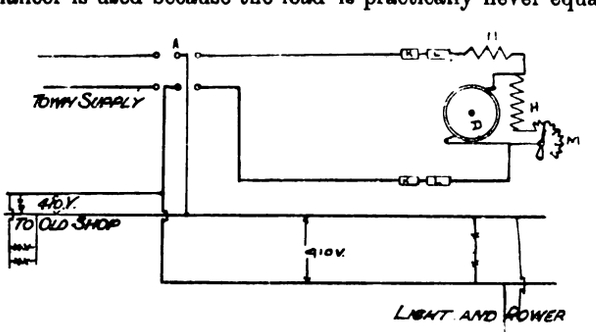


FIG. 2.

on each side of the middle wire. where the lamps are only switched on that are wanted. If, however, two lamps of 205 volts each are connected in series across the outers the middle wire and balancer are not necessary, but the disadvantage is that not less than two lamps may be switched on. Fig. 2 shows this system, A being now a double-pole two-way switch.—T. W. S. H.

Answer to No. 522 (*awarded* 7*s.* 6*d.*).—If all the motors are to be installed at the higher voltage, there will be no necessity to use the three-wire system; the lamps can either be run two in series, or in a private works the various circuits can be balanced so that the neutral wire does not carry any current. If, however, some of the motors are to be of such small size that it is considered advisable to work them off the low-voltage circuit, it will be necessary to employ a three-wire system. In this case a simple dynamo will not be sufficient.

We will first of all consider the necessary plant and connections for an isolated three-wire system, and then show what further connections are rendered necessary by the requirement that the supply mains shall be available for a stand-by in case of need at any time. In its simplest form the three-wire system requires two similar dynamos, each working at, say, 205 volts. From these dynamos two circuits are fed, but only three wires are used, the central wire being the positive lead of one dynamo and the negative lead of the other. Call these three wires A, B, C; if A is positive to C and C is positive to B, there will be a difference of tension of 205 volts between either A and C or C and B, but there will be a difference of tension equal to double this, or 410 volts between A and B. Hence all motors built for a voltage of 410 volts can be connected directly across the outers, as A and B are called, and small motors, and the lighting installation will be fed off one outer and the central. In a well-arranged installation, the circuits fed off the central and the outers will be so arranged that there is approximate balance—that is, the current taken by the circuits fed off A and C will be equivalent, or nearly so, to the current fed off B and C, consequently the size of the central wire will be small compared to the size of the wires A and B. A diagrammatic arrangement of the switchboard is given in Fig. 1.

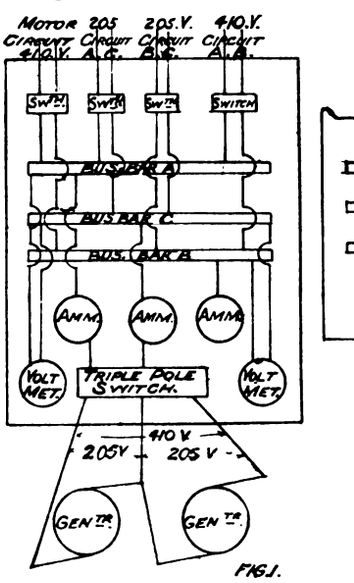


FIG. 1.

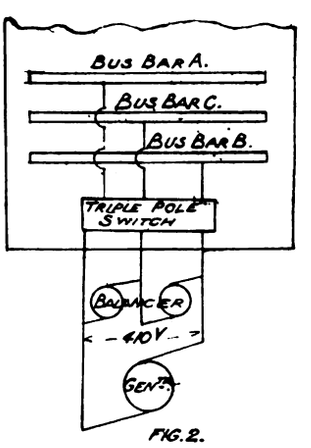


FIG. 2.

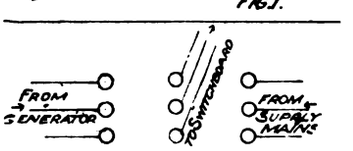
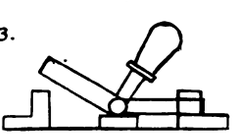


FIG. 3.



It will be seen that as perfect balance is almost impossible of attainment, the central wire must have a certain dimension, and also that the arrangement cannot be carried out with a single dynamo. If two dynamos are not installed, the usual course is to put down a balancer. This consists of two small machines, so arranged that either will act as a motor and the other as a generator. The word "small" is used advisedly, for if the total current at 410 volts is 1,000 amperes, the balancer has not to deal with this quantity of current, but only the out-of-balance current, which should not in a private installation exceed 80 amperes.

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The connections of the dynamo, balancer, and switchboard are shown in Fig. 2.

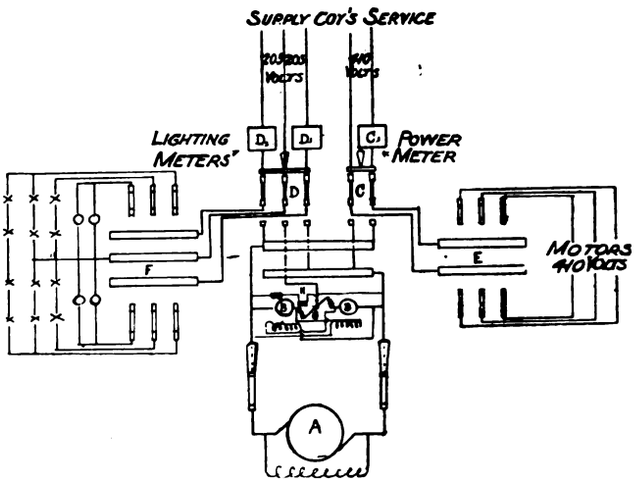
A third method of dealing with the problem exists. This is to have the main dynamo built with two distinct windings on the armature and two commutators. We come now to the case of two separate machines, only in this instance the two machines are built as one. The connections are consequently exactly similar to those shown in Fig. 1. This arrangement will probably be far cheaper than the arrangement of having two separate dynamos, each of half the full capacity required, and it will work equally as well.

Whatever method of arrangement of the generating plant is adopted, the connection to the supply mains will be the same. The essential condition is that the private generating plant shall never be put in circuit with the supply mains, whether the care of the installation is in the hands of a trained man or not. This condition is obtained by making all connections to the switchboard through a triple-pole switch, as shown in Fig. 3. A switch of this description renders it absolutely impossible for the 'bus bars on the switchboard to be connected to more than one source of supply at the same time. The switch need not be of the knife pattern as shown, but it is necessary that it be of a suitable triple-pole type.—M.

Answer to No. 522 (*awarded* 5*s.*).—In arranging a plant for lighting and power in any works several important points have to be taken into consideration, especially if it is to be operated in conjunction with an existing supply system. We will assume that lighting is required both by means of arc lamps, which would be most suitable for some of the shops, and incandescent lamps for the offices; that motors of various sizes will be required, some for driving lines of shafting and some for direct connecting to isolated tools. Since the supply company is to be used as a stand-by, we are limited as to the voltage to be used to 205 or 410 volts. In order to regulate the pressure upon their mains, the supply companies have issued rules which limit the size of the motors which may be placed upon the 205-volt side of their system to 4 h.p. or 5 h.p., and we will assume, therefore, that in this case the motors will have to be wound to work at 410 volts, which is the pressure given for the outers in the question. The arc lamps will probably be of the enclosed type, requiring, with regulating resistance, about 100 volts each lamp, so that four in series may be used across the 410-volt mains, or two in series across an outer and the middle wire.

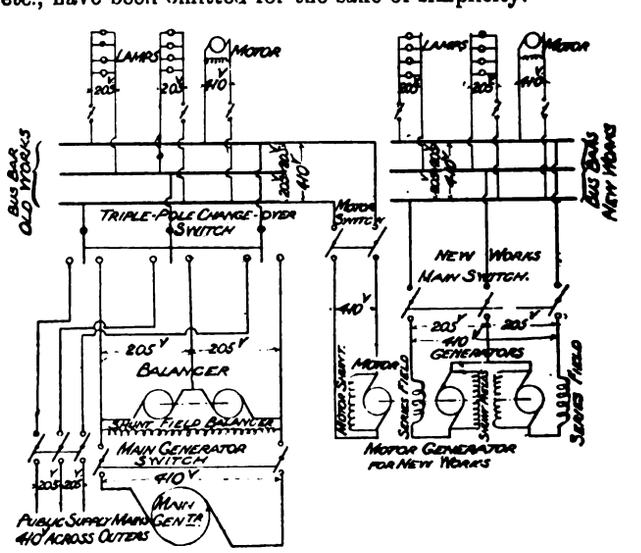
It is inconvenient, however, to run lamps in series without some balancing arrangement, so that it is necessary to provide a balancer for this purpose. The size of this machine should be so proportioned that it will be able to deal with the total out of balance load at any time and also leave a margin for possible extensions. It would add to the convenience of the plant and contribute to its economical working if the balancer was so arranged that it might be driven by a small independent steam-engine, which could be easily thrown in or out of gear by some arrangement of clutches. It is possible that steam might be available while the large generating set was not wanted, so that the balancer might then be used as a generator for lighting the offices, or even operating one or two motors without resorting to taking the supply from the outside source.

The supply company would probably charge for energy used for power purposes at a different rate to that for lighting, so that it would be necessary to provide for separate meters, and if the lighting load exceeds a certain number of lamps two meters will be required for this circuit, making three meters to be provided for in all. It will also be necessary to so arrange the connections that it is impossible to have the generator connected to the lighting or power circuits at the same time those circuits are connected to those of the supply company, and the balancer must also be arranged so that it can be out of circuit before the company's mains are connected up. The connections will be as on the accompanying diagram: A, 410-volt 100-kw. generator; B, 205 × 205-volt 20-kw. balancer, which may be run as steam-driven generator or motor-driven balancer at will; C, a main double-pole change-over switch for power; C 1, the supply company's meter for power; D, a main three-way change-over switch for lighting circuits; D 1, positive lighting meter; D 2, negative lighting meter; E, power distributing panel with double-pole switches and fuses, and diagram of circuits; F, lighting distributing panel with double-pole switches and fuses and diagram of circuits with incandescent and arc lamps; G, balancer starting switch and resistance (this switch is fitted with automatic release so that balancer automatically



shuts down when circuit is opened); H, automatic release.—A R. M.

Answer to No. 522 (*awarded* 5*s.*).—The data given in this question are not definite on all points, consequently certain assumptions must be made. It is therefore assumed that the distance between the two works does not exceed, say, 400 yards; that the new works are at a point removed from the public supply mains; that the main generator will be located at the old works, where it is stated steam generating plant exists; that three-wire distribution will be adopted in both works; that large motors and arc lamps will be taken off the 410-volt outers, and incandescent lamps and small motors off the 205-volt bars; that it is desirable to have all the machines located at the old works alongside the main generator. These assumptions being stated, the diagram is self-explanatory, it always being remembered that fuses, starting switches, meters, etc., have been omitted for the sake of simplicity.



The following is a description of the plant: The public supply mains with 410 volts across the outers, and the main generator giving 410 volts across its terminals, may feed on to the 'bus bars at the old works as desired, through the change-over switch. The lighting and power circuits for the old works are taken direct from these 'bus bars. At the old works also there is located a motor-generator, consisting of a motor driving direct on one shaft preferably two over-compounded generators, the whole being mounted on one base-plate. The function of this combination is to obtain an uniform and constant voltage in the two works

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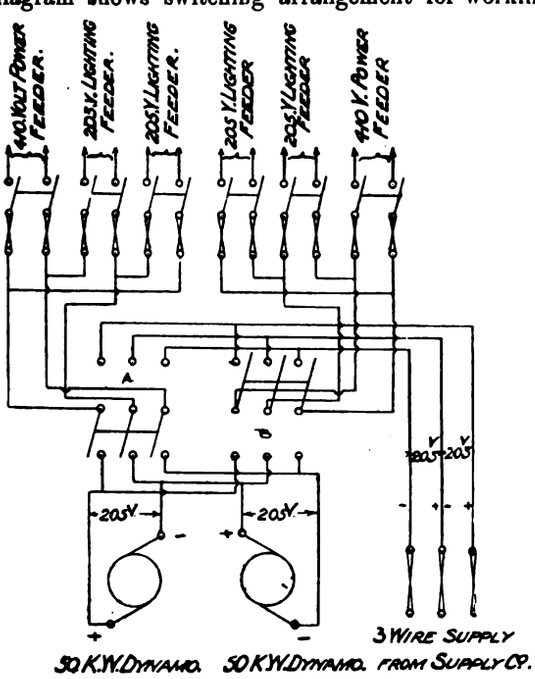
with either the public or private supply; and as the plant will be situated at the old works, with the motor driven off the 410-volt outers, the two generators must each be over-compounded to give a rise in volts across their terminals at full load equal to the fall in volts on the mains between the two works. In addition to the mains, a potential wire should be laid between the works, and connected to a voltmeter at the old works, to enable the distant voltage to be obtained at any moment. The voltmeter should be calibrated to allow for the resistance of the potential wires. The balancer is necessary to take up the inequalities on the two sides of the three-wire system at the old works, and would probably be only a very small machine.

This method would certainly be very successful, and probably also the best, unless it were preferred to use storage batteries at the new works; but such a method would be more expensive than that described above, and the utility of storage is much discounted by the presence of a public supply as a reserve in case of accident to the works plant. If it be preferred, the motor-generator could be located at the new works. In such a case the motor would have to have its fields over-saturated, so that its speed would not greatly vary under different loads, and the generator need then only be ordinary compound wound; but obviously there are objections to the plant being split up between the two works, quite apart from the probable extra cost of attendance and buildings, although the cost of the mains between the two works would be less, owing to the higher voltage and the fact that only two would be required instead of three. Any method involving only boosters pure and simple would not be likely to work satisfactorily.—ALPHA.

Answer to No. 522 (*awarded* 5*s.*).—Since the supply company's system is a three-wire one at 205 and 410 volts, the generating set at works will require to be in the form of a steam balancer—*i.e.*, the engine will drive (either by belt or direct coupled) two dynamos, each giving off 50 kw. at 205 volts, and connected up for a three-wire distribution, thus giving same voltage as supply company. Accompanying diagram shows switching arrangement for working a



generating set as above, with supply company as a stand-by. The circuit switches will be fed from two change-over switches. A and B are three-pole change-over switches. Only one is necessary, but two give the system greater flexibility, as works installation can be divided into two parts, so that, if necessary, one half can be supplied from private plant and the other from the supply company's mains, or the whole power required can be taken either from private plant or from supply company, as may be desired. The centre contacts of these switches are connected to lighting and power feeders; the necessary measuring instruments can be inserted after current leaves change-over switches. Dynamos should preferably be shunt-wound, and be provided with suitable shunt regulators, so that voltage of each machine can be altered to suit load on either side of system. The lighting will, of course, be taken off the 205-volt supply, and lighting feeders should be so arranged that system is balanced at full load. All motors should be taken off the 410-volt supply, being connected up across the outers.—G. R.

TRADE NOTICES AND NOVELTIES.

Electric Radiators.

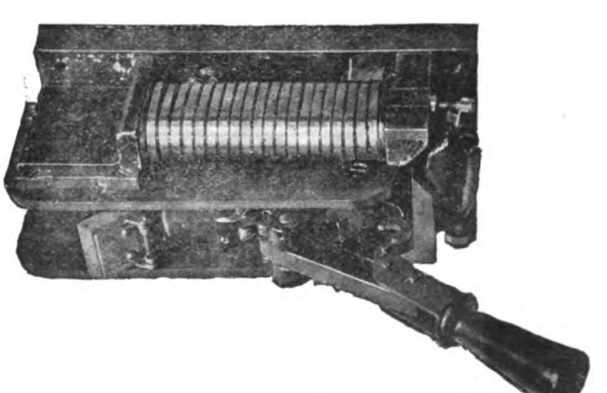
We understand that the Dowsing Radiant Heat Company, Limited, 24, Budge-row, Cannon-street, E.C., are introducing a number of new types of their patent luminous electric radiators, and, amongst others, a circular type (shown in the accompanying illustration) suitable for placing in the centre of

Circular Type Electric Radiator.

a room. The top of this radiator is made removable, so that a dish containing food can be warmed by the heat of the ascending air. A portion also of the heat radiated from the lamps is thrown on the dish. The company claim that their special form of reflector, which reflects heat rays away from the lamps, and diffuses them, at the same time forming a chamber for heated air, is quite successful in its application to heating and cooking apparatus, as demonstrated by the electrical roaster now in use at the Brighton electrical exhibition.

I. T. E. Car Circuit Breaker.

We illustrate herewith an I. T. E. car circuit breaker for the protection of car equipments, of a new design recently introduced to our notice by Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, London, E.C., the sole European agents. The illustration shows the breaker with cover removed.



I. T. E. Car Circuit Breaker.

It is claimed to be electrically and mechanically perfect, and has been designed so that its operation is practically silent, even upon the severest overload, and may be readily opened by hand. This breaker is usually made for a continuous load capacity of 150 amperes, with adjustment for overload up to 300 amperes, but

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larger sizes for heavier work can also be supplied. With regard to the construction of the instrument, it will suffice to say it is built on the principle of the firm's laminated edgwise type instrument, with which the trade is already well acquainted. Further particulars concerning the breaker are given on Leaflet No. E 3 just issued by the above firm, from whom we have also received copies of two other leaflets dealing respectively with their quick-break knife switches and the "Shaw" non-arcing type lightning arrester for traction, light, and power.

Catalogues.

TELEPHONES.—From the Berliner Telephone Manufacturing Company, 117, Queen Victoria-street, E.C., we have received a copy of their illustrated catalogue of fixed and portable telephones.

ACCESSORIES.—From the Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C., we have received copies of their price-lists Nos. 7 and 8. The first-mentioned list deals with safety fuses, cut-outs, fuse boards, fuse wires, ceiling roses, casing and covers; the second with switches, wall sockets, connecting plugs, and lampholders.

WIRES AND CABLES.—Messrs. Atkinson, Schmahl, and Co., 5, St. Nicholas-buildings, Newcastle-on-Tyne, sole agents in this country for Lynen and Co., manufacturers of wires and cables, Eschweiler Works, Aix-la-Chapelle, have sent us a copy of their recently issued price list of wires and cables for electrical purposes. The goods listed include the following: vulcanised-rubber cables, twin vulcanised-rubber cables, single pure rubber-insulated electric light wires and cables, double ditto, guttapercha-covered line wires, paraffined line wires, twin line wires, flexible light cords, shot-firing cables, arc lamp cables, and jointing materials.

HAMMERSMITH ELECTRICITY ACCOUNTS.

From the accounts of the Hammersmith Borough Council electricity department for the year ended March 31, 1902, it appears that the total expenditure on capital account amounted to £173,802. Abstracts of the revenue account, etc., are appended.

REVENUE ACCOUNT.

Dr.		£ s. d.	£ s. d.
Generation of Electricity.			
Coal, including cartage	£4,778 2 4		
Oil, waste, water, and stores	717 17 4		
Wages at generating station	1,848 9 8		
			7,344 9 4
Repairs and Maintenance.			
Buildings	85 11 5		
Engines, boilers, etc.	458 11 8		
Other machinery, tools, etc.	123 9 8		
Repairs, etc., of plant	515 18 11		
			1,183 11 8
Distribution of Electric Current.			
Wages of linesmen, etc.	358 1 1		
Repairs, etc., of mains	34 7 10		
Repairs, etc., of meters, etc.	6 12 6		
Repairs, etc., of apparatus	16 1 8		
			415 3 1
Public Lamps.			
Wages of trimmers, etc	558 13 3		
Lamp renewals, globes, etc.	408 9 8		
Carbons for arc lamps	230 16 3		
			1,197 19 2
Management expenses			1,222 19 5
Rates and taxes			1,652 10 6
Law and parliamentary expenses			3 4 0
Insurance premiums			214 14 7
			13,234 11 9
Balance to net revenue account			8,913 3 8
			£22,147 15 5

Cr.	£ s. d.
Sale of current for private lighting	17.826 15 10
Public lighting	3,888 7 2
Charges for attending private lamps	67 5 0
Laying cable for private consumer	12 10 0
Sales of lamps, apparatus, etc., to ditto	54 14 11
Interest on machinery on private premises	28 10 8
Steam supplied	162 16 0
Damages recovered	106 15 10
	£22,147 15 5

BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
London County Council mortgages	161,440 0 0
Sundry creditors on open accounts	1,373 16 4
Treasurer—overdrawn balance	4,486 7 3
Balance at credit of net revenue account	2,750 16 9
	£170,051 0 4

Cr. Assets.	£ s. d.
Amount expended for works	163,776 2 10
Sundry debtors for current supplied	5,256 14 5
Sundry debtors on open account	376 2 9
Stores on hand	642 0 4
	£170,051 0 4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		2,050,091
Quantity sold: Public lamps by contract	326,716	1,461,427
Quantity sold: Private consumers by meter	1,134,711	
Quantity used on works		438,754
Quantity accounted for		1,900,181
Quantity not accounted for		149,910
Total maximum supply demanded (kilowatts)		1,176

Number of public lamps: arcs, 164; Loftus, 50.

ABERDEEN ELECTRICITY ACCOUNTS.

The accounts of the Aberdeen Corporation electricity department for the year ended July 31, 1902, show a total expenditure on capital account to that date of £167,172. Abstracts of the revenue account, etc., are given herewith.

Dr. REVENUE ACCOUNT.	£ s. d.
Fuel	4,233 1 2
Oil, waste, water, and engine-room stores	420 9 1
Wages at generating station	1,403 17 11
Repairs on buildings	53 8 5
Repairs on plant	409 3 2
Main and service repairs	567 5 8
Meter repairs	22 7 6
Repairs on motors and depreciation	185 3 11
Rents and feu-duty	61 0 5
Taxes	1,320 12 2
Management	124 0 6
Engineer's salary (proportion)	345 16 8
General establishment charges	208 15 1
Engineer's travelling expenses	67 19 2
Stationery and printing	114 19 3
Insurance	111 6 3
Inspector's wages	40 15 4
Auditor's fee	15 0 0
Bad debts	178 17 2
Abatements	223 16 8
Special services	330 5 5
Cost price of lamps sold	61 9 1
	10,499 10 0
Balance carried to net revenue account	12,640 8 5
	£23,139 18 5

Cr.	£ s. d.
Sale of current per meter	17,102 7 4
Public lighting	2,035 12 4
Traction	3,179 2 6
Sale of lamps	67 14 8
Hire of motors	185 3 11
Attendance on harbour lamps	569 17 8
	£23,139 18 5

GENERAL BALANCE-SHEET.

Dr. Liabilities	£ s. d.
Amount borrowed on mortgage	164,390 7 6
Amount of mortgages redeemed by sinking fund	9,182 0 0
	173,572 7 6
Reserve fund	7,664 15 3
Amount due to sundry creditors	3,089 14 1
Amount deposited in security for current	224 18 0
Temporary loans	357 0 0
Balance due to bank	1,837 12 10
	£186,746 7 8

Cr. Assets.	£ s. d.
Amount expended on Cotton-street works, £110,879. 4s. 2d.; less depreciation, £13,511	97,368 4 2
Amount expended on Ferryhill works, £70,066. 13s.; less depreciation, £262	69,804 13 0
Sundry debtors for current supplied	6,963 18 10
Proportion applicable for July, 1902	1,852 18 2
Miscellaneous	1,016 2 4
Stores on hand	4,896 8 9
Reserve fund invested	4,844 2 5
	£186,746 7 8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,859,812
Quantity sold: Public lamps	186,058	1,546,569
Quantity sold: Traction	381,495	
Quantity sold: Private consumers by meter	979,016	
Quantity used in works		172,503
Total quantity accounted for		1,719,072
Quantity not accounted for		140,740
Number of public lamps		145

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TUBE BILLS IN PARLIAMENT.

LONDON UNITED SCHEME WITHDRAWN.

The House of Commons Committee on Tube Railways reassembled at Westminster on Tuesday under the chairmanship of Sir Lewis McIver. From the first the proceedings assumed a sensational character, arising out of the unexpected announcement that the London United Electric Railways Bill was to be withdrawn. It will be remembered that this Bill and the Piccadilly, City, and North-East Railways Bill had already been approved by a Select Committee of the House of Lords, and late in the last session were referred to this committee, whose labours, however, were interrupted in August by the adjournment of the House. The London United Bill was promoted by Mr. Clifton Robinson, backed by Mr. George White, of Bristol; and, in conjunction with the Piccadilly and City Bill (promoted by Messrs Morgan and Co.), provided for a tube railway running from Hammersmith-broadway to the City and thence northwards to a point beyond the London County Council artisans' dwellings estate near Palmer's Green, and for a cross line north and south from the Marble Arch to Clapham Junction *viâ* Sloane-street The two schemes were to be carried out together, but, as already stated, the former is not to be proceeded with. This announcement, which was made by Sir Edward Clarke, K.C., before the committee, revealed the fact that a split has occurred between the promoters of the two schemes, and that Messrs. Speyer Bros., who are the financial sponsors of the rival Yerkes system of underground railways and tubes, have bought the controlling interest in the London United Tramways Company. The result is that the line from Hammersmith to Hyde Park-corner will not be constructed, and Mr. Yerkes and the District Railway are now without a rival in the provision of underground electric traction in this part of London. It is almost certain, however, that the scheme for a continuous system of electric tube railways between Hammersmith and Palmer's Green, by way of Piccadilly and the City, will not be allowed to drop, and the fight for supremacy will, in all probibility, be resumed in the Parliamentary Committee rooms early next year. It is stated that the Yerkes-Speyer group will prepare another scheme to meet all the requirements of the public, and which will be a better one than the proposed joint system, which is now no more. Also next session the Central London Railway will revive their application for a complete circular railway by continuing their existing line through Hammersmith, Piccadilly, the Strand, Liverpool-street, and back to the Bank. By the withdrawal of the London United Bill, therefore, the matter has only been postponed to supply food for further controversy in the next session of Parliament. The reasons for the break in partnership between the promoters of the London United Bill and the promoters of the Piccadilly Bill will be gathered from the speech of Sir Ed. Clarke before the House of Commons Committee on Tuesday.

Sir Edward Clarke, at the opening of the proceedings, said it was right that he should say something as to the position in which matters stood, having regard to the instruction which had been passed by the House of Commons in regard to these Bills. The terms of the instruction were: "That it be an instruction to the committee to take security from the undertakers for the completion of the whole scheme of railways comprised in the Bill, either by making the rights of the undertakers under the Bills conditional upon the due performance of their whole undertaking or otherwise, as the committee may think fit." The instruction was capable of two interpretations. One was that the Bill of the London United Electric Railways Company should not be passed unless the promoters gave securities satisfying the committee as to the completion of the whole scheme of railways proposed in that Bill and the Bill of the Piccadilly, City, and North-East London Railways Company. He had to tell the committee that if that were the interpretation which they had placed upon the instruction the obligation could not be carried out. The two parties who joined in promoting this through scheme of railways from Hammersmith, *viâ* Hyde Park-corner and Piccadilly to the City, and so on to the north-east of London, had not been, and were not likely to be, able to come to an arrangement as to the management of the joint undertaking when the scheme was carried out. But the instruction was capable of another interpretation—namely, that the undertakers of the London United Electric Railways Bill were to give security for the completion of the railways contained in that Bill running from Hammersmith to Hyde Park-corner. Since this matter was before the committee in August last Messrs. Speyer Bros. had acquired a commanding interest in the London United Tramways Company, and they were also interested in the Brompton and Piccadilly-circus Railway, the Bill for which was read a third time in the House of Commons on Monday. That railway, like the one promoted by the United Electric Railways Company, contained a piece of line from Sloane-street to Hyde Park-corner. There would be no object in duplicating it and, therefore, the promoters of the United Electric Railways Bill, if they were going on with the Bill now before the committee, would not be able to undertake that their project should be carried out to the full extent. They would seek for power to abandon the piece of line between Sloane-street and Hyde Park-corner. If they were allowed to abandon that line, they would make arrangements with the Brompton and Piccadilly-circus Railway by which a through route could be obtained.

Mr. Balfour Browne, K.C., for the Piccadilly Bill, said he did not know anything about the changed condition of matters until he came into that room. The two sets of promoters were absolutely at one in July last. He was then appearing for both companies, and the instruction of the House of Commons was perfectly well known to both of them at that time. If the promoters of the United Electric Railways Bill were not prepared to come under that instruction they should have taken action then. He was appearing for them in July, and he believed until that morning that he was going to have the honour of opening and not withdrawing their Bill. Messrs. Speyer Bros., who were most largely interested in the District Railway, had now got a commanding influence in the London United Tramways Company, and he, to use a colloquial expression, had been "sold." In these circumstances he should ask the committee to allow him an opportunity of consulting with his clients before he stated what course he should pursue with regard to the Piccadilly and City Bill.

Sir Edward Clarke then read the correspondence between the two sets of promoters which led to the disruption. The principal letter was from Mr. White, of the London United scheme, to the solicitor for Messrs. Morgan and Co., which fully explained the action of the London United promoters. It showed that the main disagreement between the parties was with regard to the power-house. In July the London United promoters suggested that their power-house should supply the electrical energy for the whole system, and so obviate any further heavy expenditure of capital on the provision of a second power station Messrs. Morgans, however, "absolutely declined to discuss proposals on such a basis," with the result that the negotiations fell to the ground. Hence the present position of affairs.

The room was then cleared, and after an interval of half an hour counsel and parties were readmitted.

Sir E. Clarke said that, as a result of what had taken place outside the committee-room, he, on behalf of the promoters of the United Electric Railways Company, formally withdrew their Bill.

Mr. Balfour Browne said he was going to proceed with his Bill, and would pledge his promoters to come to Parliament next session for powers to construct the railway from Hyde Park to Hammersmith which had now been dropped by the United Electric Railways Company

A long conversation ensued between the committee and counsel as to the bearing of the instruction upon the altered position, and finally,

Mr. Balfour Browne said he would ask the committee to postpone these proceedings, to report to the House what had occurred, and to ask for a further instruction which would enable the Piccadilly and City Bill to be considered on its merits. He thought the House of Commons was strong enough not to allow the public to be "jockeyed" out of this through scheme of railway communication.

The **Chairman** said the difficulty the committee found themselves in—and they would be very glad to get over it, having regard to the expense already incurred and to the public interest involved—was that they were absolutely barred by the instruction of the House of Commons from proceeding any further with the Bill as it stood. It seemed clear to the committee that the instruction applied to the entire scheme, and. in the altered condition of things, it was impossible for them to give effect to that instruction. The committee, however, would adjourn until Thursday (yesterday) for the further consideration of the subject.

The committee adjourned.

In committee on the Piccadilly, City, and N.-E Railway Bill, **Sir Lewis McIver** on Thursday said the committee were unable to proceed with the consideration of this Bill, and found that the preamble was not proved.

APPOINTMENTS VACANT.

Testing Assistant, Public Health Department, Corporation of London, £200 per annum, Nov. 1. See advertisement.

Various Workmen, Meter-Testing Department, Corporation of London, from 4d. to 8½d. per hour See advertisement.

Resident Electrical Engineer, Hastings Corporation, £300 per annum, rising by £50 to £500 per annum, Nov. 4. See advertisement.

General and Traffic Manager, Ilford Urban District Council electric tramways, £250 per annum, Oct. 28. See advertisement.

Manager, Swansea Corporation Telephone Department, £150 per annum. See advertisement.

Cable Estimating Assistant, Glover's, Manchester. See advertisement.

Draughtsman, Glover's, Manchester. See advertisement.

Foreman. See advertisement.

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COMPANIES' MEETINGS AND REPORTS

BRITISH THOMSON-HOUSTON.

The ordinary general meeting of the shareholders in the above Company was held yesterday afternoon at the offices, 83, Cannon-street, E.C., Mr. McArthur, M.P., presiding.

The report of the directors for the past year stated that the profits, after deducting general and technical expenses, discounts, and interest, amounted to £60,587. 18s. 10d., of which sum £31,275 had been applied to various purposes, principally to depreciation of plant (£15,189), and depreciation in value of shares and debentures (£4,832). A sum of £3,878 had been written off goodwill, patents, and licenses. The available balance, which, after adding thereto the sum of £1,157 brought forward, amounted to £30,469. 16s. 1d., had been distributed as follows: £3,650. 15s. 7d. to dividend accrued June 30, 1902, on £400,000 4 per cent. cumulative preference shares in respect of which £300,000 has been called and paid from time to time; £20,000 to dividend at the rate of 4 per cent. per annum for 15 months on £400,000 ordinary shares fully paid; £3,029. 8s. to reserve, being 5 per cent. of £60,587. 18s. 10d.; £3,789. 12s. 6d. to profit and loss new account. The profit and loss account had been necessarily affected by the expenditure on the Rugby works of considerable sums, on which it had not yet been possible to earn profits. These works had been completed during the year, and other additional buildings were approaching completion. The Company were now employing at Rugby a considerable number of hands, and a large amount of work was in progress.

The **Chairman** formally moved the adoption of the report, together with the statement of accounts, remarking that the Company had but few shareholders, and it was not the custom to make any detailed statement on these occasions.

Mr. J. F. Nauheim seconded the motion, which was carried without discussion.

Messrs. G. Franklin, J. F. Nauheim, E. Thurnauer, and Sir Thomas R. Thompson, Bart., were re-elected directors of the Company, and the meeting closed.

At an extraordinary general meeting held immediately afterwards a resolution was adopted altering Article 78 of the articles of association by the addition of a proviso, that any director duly appointed "shall hold office only until the next following ordinary general meeting of the Company, and shall then be eligible for re-election."

The proceedings terminated.

EDMUNDSONS' ELECTRICITY CORPORATION.

An extraordinary general meeting of this Corporation was held on Thursday last week at the offices, Broad Sanctuary-chambers, Westminster, to consider resolutions for increasing the capital.

Mr. F. E. Gripper presided, and, in explaining the reasons for adding to the capital, said that their principal business was really that of an electric supply company, and they now had 20 central stations working in which they had the controlling interest. Additions had to be made to the generating machinery, as well as extensions to the mains, in order to meet the growing demands of customers. It was to provide for such extensions that further money was wanted, and it would be profitably employed in carrying out such work. The policy of the Board was to retain the Company's investments in these undertakings until they had been thoroughly developed and had reached their full value. Already many of their investments could be realised at a considerable profit, but it was expected that they would become much more valuable within a comparatively short time. It was not intended to issue more than £100,000 of the new capital at present. The balance would be retained for issue as and when required. He then moved resolutions for increasing the capital to £600,000 by the creation of 40,000 new shares of £5 each, and authorising the Board to issue preference or ordinary shares, as they might think fit, subject to the condition that the aggregate amount in nominal value of the whole of the preference shares of the Company for the time being should never exceed the aggregate amount in nominal value of the ordinary shares issued.

Mr. W. R. Davies seconded the resolutions, which were carried unanimously.

CUBA SUBMARINE TELEGRAPH.

Mr. Chas. W. Parish presided over the half-yearly meeting of the shareholders in this Company at the offices, Old Broad-street, E.C., on Wednesday.

The **Chairman**, in moving the adoption of the report, said that the traffic receipts for the six months to June 30 last amounted to £12,784, as compared with £9,981 during the corresponding period of 1901. From the net profits of £8,894 there had been placed to reserve account £2,752, the preference dividend absorbed £3,000, and the Board recommended a distribution on the ordinary shares at the rate of 4 per cent. per annum, free of income tax, leaving £4,532 to be carried forward. When he last addressed the shareholders, he mentioned that the Board estimated that the cost of repairing the Cape Cruz and Santiago cable would not fall far short of £6,000 to £7,000. The actual sum had been £5,752. This had been met out of the reserve, but they had been able to replace £2,750 of the amount from the profit of the half-year under review. It was of great importance that the reserve should be maintained—it now stood at £129,000—as each year their cables grew older, and the term of the Company's concessions diminished. The sum of £8,174, which they were claiming from the United States Government for damage done to their cables during the Spanish-American war, was still unsettled. The Company's legal representative at Havana had been instructed to apply for the subsidy due on their coast cables since January, 1899, and they trusted that it would be shortly paid. Referring to their recent lawsuit with the West India and Panama Telegraph Company, he said they were now adjusting with that company the accounts for the past 4½ years on the basis of the judgment given in this Company's favour, and the next half-yearly accounts would include the amount to be received in connection with the settlement.

Mr. George Keith seconded the motion.

A short discussion followed, and in reply to questions by Mr, Mountcastle, Mr. Aronson, and other shareholders, the **Chairman** said that if they obtained the payment of the subsidy of £2,000 per annum from the Government of Cuba—and they were justly entitled to it—the Company should be able to "jog along," though they could not expect to enjoy the same measure of prosperity as they had had. Moreover, their concessions had now been running for upwards of 30 out of the full term of 40 years.

The motion was carried unanimously.

ELECTROLYTIC ALKALI.

The report of the directors for the year ended Aug. 31 last, to be presented to the meeting in Middlewich on the 30th inst., states that the net profit for the year, after expenditure in keeping the plant, machinery, and tools in a state of efficiency, allowing for depreciation and interest on calls paid in advance, but without providing for directors' remuneration, is £6,420. To this has to be added the amount brought forward from the last account (£1,242), making an available balance of £7,662. The directors propose that this amount be applied in paying the cumulative dividend on amounts called up on the preference shares issued to date, calculated from the several dates of payment of instalments, to Aug. 31 last. This will absorb £7,331, and leave £331 to be carried forward to the next account. There are now two units of plant in operation, and both are working satisfactorily. The second unit was, however, only started early in August last, so that one unit has practically earned the whole of the preference dividend. During the year 100,000 additional shares (50,000 of each class) were offered for public subscription, and the whole of these were applied for and duly allotted. The preference shares were considerably over-subscribed. The process continues to work well, and the excellence of the products commands a ready market for them. The demand for the Company's make of bleaching powder is very good, and the present plant is taxed to its utmost capacity. The requirements of the Company have necessitated the provision of more convenient offices, and these are now in course of erection.

WESTERN TELEGRAPH.

The report of the directors for the half-year ended June 30 last, to be submitted to the meeting on the 29th inst, states that the revenue for this period amounted to £213,259, and the working expenses to £82,468. After providing £12,677 for debenture interest and sinking fund and £4,120 for income tax, there remains a balance of £113,994. To this is added the sum of £5,531 brought forward from Dec. 31 last, making a total of £119,525. A quarterly interim dividend amounting to £31,189 has been paid, £30,000 transferred to the general reserve fund, and £2,000 to the maintenance ships' reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, which together will amount to £51,982, leaving a balance of £4,353 to be carried forward.

MONTE VIDEO TELEPHONE.

The report of the directors for the year ended July 31 last, to be presented at the meeting on the 30th inst., shows a net profit of £11,142, after providing for all working expenses in Monte Video and London. To this amount should be added the sum of £1,064 brought forward from last year, leaving an available balance of £12,206. From this sum the directors propose to transfer £5,000 to reserve fund, and they recommend that, after payment of the full dividend at the rate of 5 per cent. per annum upon the preference shares, a dividend at the rate of 2½ per cent. per annum be paid upon the ordinary shares and that the balance of £1,064 be carried forward.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bristol.—The Electrical Committee invite tenders for arc cables. Tenders by Nov. 14. See advertisement.

Swindon.—The Corporation invite tenders for direct-current electricity meters. Tenders by Oct. 29. See advertisement.

Aston Manor.—The Urban District Council invite tenders for condensers for their electricity generating station. Tenders by Oct. 31. See advertisement.

Burton-upon-Trent.—The Corporation invite tenders for the overhead equipment of their tramway lines, etc. Tenders by Nov. 5. See advertisement.

Batley.—The Corporation invite tenders for the supply, delivery, and erection, at the electricity works, of one re-cooling tower and tank. Tenders by Oct. 28. See advertisement.

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Tientsin (China).—Mr. A. W. Harvey Pellingham, secretary of the British Colony at Tientsin, China, invite tenders for installation and working of electricity works. Tenders by Nov. 30.

Chester.—The Corporation invite tenders for the supply of open-type arc lamps. Particulars may be obtained from Mr. F. Thursfield, city electrical engineer, Electric Light Station, Chester. Tenders by Oct. 25.

Sunderland.—The Corporation invite tenders for one steam-driven three-phase generator, motor-generators, and static transformers, and high and low tension switchboards. Tenders by Nov. 28. See advertisement.

Mansfield.—The Corporation invite tenders for electric light wiring of the town hall premises. Specification, etc., may be obtained from Mr. E. Holcombe Hewlett, at the Electric Lighting Station, on and after 20th inst. Tenders by 5 p.m. on 31st inst.

London, S.W.—The London County Council invite tenders for the supply for one year from Jan. 1 of engineers' goods and electrical fittings. Particulars may be obtained from the Clerk of the Council (Stores Branch), 19, Charing Cross-road, W.C. Tenders by 10 a.m. on 27th inst.

Dumbarton, N.B.—The Council having obtained a provisional order under the Electric Lighting Acts, is prepared to consider proposals by electric companies either for the supply of electricity for the burgh or for the taking over and carrying out of the order. See advertisement.

Leyton (Essex).—The School Board invite tenders for the electric lighting, in situ concrete paving, and heating apparatus required at the Farmer-road Schools, Leyton, E., now in course of erection. Specification, etc., can be obtained on application to Mr. William Jacques, A.R.I.B.A., 2, Fen-court, Fenchurch-street, E.C. Tenders by 6.30 p.m. on Nov. 3.

Shanghai.—Messrs. Preece and Cardew are authorised to receive tenders for the supply and delivery c.i.f. of two 500-kw. steam alternators (the engines to be enclosed double-acting type and alternators to have stationary armatures, pressure 2,100 volts, periodicity 100), switchboards, and two condensers and circulating water pumps. Tenders by Oct. 30. See advertisement.

Newcastle-upon-Tyne.—The Tramways Committee invite tenders for the supply and erection complete of a new triple-expension direct-coupled engine, of 3,000 h.p., at the power station, Newcastle-upon-Tyne. Specification, etc., may be obtained from the general manager and engineer, Mr. A. E. Le Rossignol, M.I.E.E., Manors Power Station, Newcastle-upon-Tyne. Tenders by Nov. 8.

Dumfries (Scotland).—The Town Council invite tenders from companies as follows—viz.: (1) for the burgh's electric light provisional order, and alternately (2) for light and traction combined; (3) for a supply of electricity to drive the cars, if the Council resolve to conduct the traction; (4) if the Council construct the works, tenders for a lease of each. Tenders by Dec. 1. See advertisement.

St. Petersburg.—The St. Petersburg Town Council invite tenders for the reconstruction of the three town tramway lines, hitherto by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also the application forms with particulars, will be sent free at once either by post or wire. Tenders by Nov. 1 (14), 1902. Applications should be addressed Town Council, St. Petersburg, Russia.

London.—The County Council invite tenders for the supply and delivery of one 50-ton electric power overhead travelling crane, with auxiliary two-ton hoist, and for the erection of the same in the Council's electricity generating station at Greenwich. Delivery and erection of this plant at Greenwich is required as soon as the buildings are ready to receive it, which, it is anticipated, will be within about 15 months. Specification, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by Nov. 18.

Glasgow.—The Corporation invite tenders for the construction, supply, and erection, under one contract, of the whole of the machinery and accessories required for the mechanical equipment of the machinery buildings at the Dalmuir outfall works. Amongst the more items are: four Lancashire boilers, centrifugal pumping engines, screening and elevating machinery, penstocks, valves, electrical generators for lighting and power, electric motors, auxiliary pumps, steam and water pipe connections, lime-mixers, and other sewage treatment plant, overhead water-tank, etc. Specifications, etc, may be had on application at the Office of Public Works, City Chambers, 64, Cochrane-street, Glasgow. Tenders by Oct. 28.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tientsin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

London.—The County Council invite tenders for the roadwork and platelaying required for the reconstruction on the conduit system for electrical traction of the tramways (a) from the Elephant and Castle, *via* New and Old Kent Roads, to East Greenwich, and (b) from the Elephant and Castle, *via* Walworth-road, Camberwell Green, Church-street, Peckham-road, and Queen's-road, to New Cross-gate. The contractor will be required to use the track rails and fastenings, the slot rails and conductor tees, which will be furnished by the Council under another contract; but all the remaining metal work and other materials, and all the special work at junctions, crossings, cross-overs, car-shed entrances, etc., beyond the track and slot rails and the conductor tees, will be included in this contract. Specifications, etc., can be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Nov. 18.

Madrid.—The Directorate-General of Posts and Telegraphs, Calle de Caretas 10, Madrid, as well as in the offices of the civil Governments of the provinces of Barcelona, Cordoba, Valladolid, and Zaragoza require tenders by Oct 28, which will be opened five days afterwards in the Directorate-General of Posts and Telegraphs, Madrid, for the supply of 35 tons of galvanised iron wire four millimetres in diameter, 10 tons of galvanised iron wire three millimetres in diameter, three tons of copper wire two millimetres in diameter, four tons of copper wire ⅛ of a millimetre in diameter, and four tons of copper wire ⅛ of a millimetre in diameter, for the telegraph and telephone lines of the State, at the upset prices of 570 pesetas, or about £17, per ton for iron wire, and 2,890 pesetas, or about £86, per ton for copper wire. A provisional deposit of 5 per cent. of the amount of the contract at the upset prices is required to qualify any tender. A translation of the general conditions of the contract has been received through the Foreign Office from his Majesty's Embassy in Madrid, and, together with the particulars of the requirements which the wire must fulfil, may be seen by those interested on application to the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W., on any day between the hours of 10 a.m. and 5 p.m.

RESULTS OF TENDERS.

Aylesbury.—The Urban District Council have received only one tender for electric lighting.

Gravesend.—The Town Council have accepted the tender of Gardner and Co., for the lighting of the market by electricity, at £396.

Hackney.—Additional contracts have been agreed to as follows: Marryatt and Place, wiring, £96. 8s. 9d.; Aiton and Co., pipework, £306; Johnson and Phillips, arc lamps, £418.

Southampton.—The Corporation have accepted the following tender for the supply of 110 tons of rolled-steel rails and the fishplates therefor: Walter Scott, Limited, Leeds Steelworks, rails £8 per ton, fishplates £9. 10s.

London County Council.—The County Council have accepted the tender of the Electric Construction Company for the supply and delivery at the electric meter-testing station on the Victoria-embankment of an alternator and motor, at £370. The tenders received for the supply of two electric car traversers for the Council tramways have been referred to the Highways Committee.

Swindon.—The Town Council have accepted the following tenders: British Thomson-Houston Company, Rugby, testing instruments, etc., £111; R. J. Nicholson and Co., Manchester, station lighting, £232; B. Thomas, one complete lighting switchboard, with all instruments and accessories, £929. 10s. The tenders of Howell and Co., Swindon, E. G. Goodridge, Swindon, and C. O. McCarthy, Manchester, were all accepted for wiring of consumers' premises.

BUSINESS NOTES.

TRACTION.

Huddersfield.—The proposal to extend the tramways to Newsome has fallen through.

Egham.—The scheme for a light railway from Staines to Egham is being considered by the Rural District Council.

Stockport.—The Tramways Committee have decided to issue weekly workmen's tickets on the Reddish route.

Renfrew.—The tramways to this place have been completed, but alterations to the telegraph poles have to be made before the service can be opened.

Rochdale.—Since the opening of the Corporation electric tramways the cars have run 46,311 miles, the average receipts amounting to 14¼d. per mile.

Woodbridge.—The Rural District Council are opposing some of the level crossings proposed in the Woodbridge-to-Bawdsey light railway scheme.

Sheffield.—A further revision of the fares on the tramways is recommended by the committee. It is proposed to introduce a penny fare on all sections.

Appointment.—Mr. Andrew Daggett, in the tramway department at Leeds, is recommended for the appointment of superintendent at a salary of £200 a year.

Dundee.—The Tramways Committee have decided only to run the electric cars on the Constitution-road route as far as Moncur-crescent, as originally proposed.

Paisley.—Mr. Murphy is negotiating for the purchase of the horse tramways here, and his plans are almost ready for submission to the local authority for approval.

Ossett.—A motion to rescind a resolution of the Town Council appointing a sub-committee to consider the tramway question was defeated at the last meeting.

Stockton Heath.—An agreement has been come to between the Parish Council and the Warrington Corporation with regard to the light railway scheme for this place.

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Lewisham.—The Borough Council will receive a deputation from the local committee who are pressing forward the matter of the New Cross, Brockley, and Sydenham tramways on Friday evening next.

Hampton.—The District Council have decided to enter into an agreement with the London United Tramways Company as to the construction of electric tramways in the area under their jurisdiction.

Gildersome.—The promotion of a line of light railways to this place by the British Electric Traction Company has been postponed until the company have secured running powers within the Leeds boundary.

Chatham.—The light railway company have received an influentially signed petition from Rainham asking the company to extend their system from Jezreel's temple at the top of Chatham Hill to Rainham.

Aberdeen.—Last Sunday the winter arrangements for the running of the tramway cars at Aberdeen came into operation, when there was a stoppage in the traffic between the hours of one and three o'clock in the afternoon.

Wellingborough.—The British Electric Traction Company have informed the Urban District Council that the construction of the Wellingborough tramroads is being dealt with by a committee appointed to carry out the scheme.

Personal.—Mr. C. S. Drummond has resigned his seat on the Board of the British Electric Traction Company owing, it is said, to his having accepted the chairmanship of two American companies, necessitating his frequent absence from England.

Doncaster.—The Tramways Committee have placed orders for small clocks to be fitted in the tramcars. The Wheatley Urban District Council have approved the extension of the tramways along Beckitt-road, and promised their support thereto.

Bath.—The Town Council have taken exception to the proposal to lay double lines in Broad-street and along Bladud-buildings, and have resolved not to approve it unless the company pave the whole of the tramway area in Broad-street with prismatic oak cubes.

Farsley.—As a result of an interview between the Farsley Council and the Bradford Tramways Committee, the committee have fixed the fare between Bradford and Stanningley on all cars either way before 8 a.m. at 1d., the fares during the day to remain as heretofore.

Lanarkshire.—The tramway company who are constructing electric tramways from Wishaw to Motherwell, Hamilton, and Blantyre, have intimated their intention of applying for a provisional order to construct additional lines to Larkhall and surrounding districts.

Hindley.—The question of the purchase of the tramways was fully considered at the last meeting of the Council, and it was resolved that all necessary and requisite steps be taken to complete the purchase of the tramways from the Wigan Corporation as early as convenient.

Haslingden.—The Corporation are in communication with Rawtenstall as to the proposals of the Rawtenstall Corporation with regard to running powers in the event of their purchasing the portion of the tramways within their borough from the Queen to Lockgate.

Ayr.—The extension of the car-shed is to be proceeded with. The cars are to be fitted with Messrs. Edmunston and Burton's E.P.D. earth indicator as a means of preventing accident, the cost being £2 per car. The salary of the tramway manager has been increased by £50.

Tramway Competition.—In consequence of the competition of the electric tramways in the locality, the Midland Railway Company are following the example of the Lancs. and Yorks Railway of reducing the season-ticket rates on their lines between Manchester, Withington, and Didsbury.

Jarrow.—The erection of the offices and car-sheds to be built on a site adjoining the electric power station will shortly be taken in hand, and there is every prospect that a start will be made in the near future to lay the lines for the electric tram service between Jarrow and South Shields.

Goole and Marshland Light Railway.—This railway, and also that of the Isle of Axholme line, which will terminate at Haxey, has become the joint property of the North-Eastern and Lancashire and Yorkshire Railways under an Act obtained last session. The purchase price was £73,000.

Johnstown.—Messrs. Dick, Kerr, and Co. have made splendid progress with the laying of the tramways in this district, having now reached Johnstown. The erection of the new sheds is also proceeding rapidly, and it is expected that the same will be completed in course of another month.

Bournemouth.—The Corporation are trying to come to some arrangement to take over the Poole and district electric traction undertaking. The cars on the Holdenhurst-road route of the Corporation tramways commenced running on Thursday, which allows of a through ride to Pokesdown.

Isle of Man.—The shareholders of the Isle of Man Tramways and Electric Power Company, Limited (in liquidation), are being offered a preferential allotment in the debenture stock of the Manx Electric Railway Company, Limited. In the view of the *Financial News* the offer is one of doubtful value.

Aston.—Sir Frederick Bramwell has held an arbitration in London to decide the price to be paid by the Aston District Council to the Birmingham and Aston Tramways Company for the taking over of the company's undertaking, partly under the Tramways Act and partly under agreement. The company's claim is for £80,000.

Tramways in Kent.—In connection with the proposed electric tramway lines connecting Maidstone with Chatham and Chatham with Gravesend, there is now a suggestion of linking up the Gravesend, Dartford, and Bexley systems, and if these connections are accomplished the through route to London will be practically complete.

East Preston.—The representative of the British Electric Traction Company in the district has had an interview with the Rural District Council as to the proposal for a line of tramways between Worthing and Littlehampton. Before coming to a decision the Council have referred the matter to the Highways Committee for consideration.

Cardiff.—The Parliamentary Committee have decided to apply for a provisional order, to include, in addition to the extensions already decided upon, a line from Windsor-road through Sanquhar-street to Ordell-street, and one from the Heath Hotel to Talygarn-street, the latter two to be subject to the consent of the Tramway Committee.

Brighton.—The Town Council have decided to apply for parliamentary powers to further extend the Corporation electric tramways by making a line from Seven Dials down Vernon-terrace and Montpelier-road to the sea, thereby connecting the northern part of the borough and the central railway station with the front to the west of the West Pier.

Lincoln.—The proposed purchase of the tramway undertaking by the Lincoln Corporation was discussed at the Bracebridge Urban Council meeting on Tuesday. The sub-committee are considering the advisability of giving the tramways company notice, calling upon them to sell so much of their undertaking as is in Bracebridge in the same way as in the case of Lincoln.

Flamborough-Bridlington Light Railway.—The statement is made that the Flamborough-to-Bridlington light railway scheme will not now be proceeded with, and that a further extension of the 1897 order will not be applied for, although the promoters had given notice of their intention to make such an application. The Town Council have opposed the scheme from the beginning.

Yarmouth.—An interesting report has been presented to the Tramways Committee, showing the statement of accounts for three months ending Sept. 18. The profits in this period have amounted to £2,125. The committee have considered the question of extensions, and their recommendations in the matter will be submitted to the Council at a meeting to be specially convened.

Private Bills.—In the House of Commons on Thursday last week the following Bills were considered and ordered for third reading: the Baker-street and Waterloo Railway, the Brompton and Piccadilly-circus Railway (New Lines, etc.), the Charing Cross, Euston, and Hampstead Railway, and the North-West London Railway Bills. The Edgware and Hampstead Railway Bill was read a third time.

Torquay.—The Town Council in committee on Friday had the tramway question again under consideration. The routes to be followed were agreed to, and a further discussion took place as to whether it would not be more advisable to have the advice of an expert on the whole of the proposed routes. The selection of the professional adviser was delegated to the Mayor and Mayor-elect.

Blackburn.—During the week ending Oct. 10 the passengers carried on the Corporation tramways numbered 134,326, and the receipts amounted to £760, as compared with 123,941 passengers and £690 receipts in the corresponding period last year—an increase of 10,385 passengers and £70 receipts. For the 199 days' running in each year, the receipts were £24,280 in 1902 and £20,759 in 1901, being an increase of £3,521.

Belgium.—The Belgian Government are reported to be seriously prosecuting the scheme for an electric railway between Brussels and Antwerp. A Brussels message states that all the contracts have been concluded, and work is to begin on Nov. 15. The inauguration is to take place next July. Twenty minutes is to be the time allowance for the distance of 24 miles, which at present requires 50 minutes, and there is to be a reduction of two-thirds on the present travelling rates.

Friern Barnet.—In reply to an enquiry at the last meeting of the Urban District Council regarding the proposed light railways, the Clerk said that as regards the Tottenham and Wood Green line, tenders for the construction of the line had been received by the County Council, and would be shortly dealt with. With respect to the proposed line past the Orange Tree, tenders for the work had been invited, but the time for the receiving of tenders had not yet expired.

Salford.—A provisional agreement between the Salford Corporation and the Whitefield District Council has been arrived at with regard to the tramway traffic in the Whitefield district. The Salford Corporation have already commenced the work in connection with the Prestwich tramways, and when that is completed they will turn their attention to Whitefield. It is said that Salford will then approach Radcliffe and Bury with a view to effecting a similar arrangement in those districts.

Bradford.—The extension of the Allerton branch of the city tramways has now been completed, and the first car was run over the new section of line on Friday. The extension is about threequarters of a mile in length, beginning at the point which has hitherto been the terminus, passing through the village of Allerton, and ending at a point just beyond the end of Hill Top-lane. All that is now required before the line is opened for traffic is the inspection on behalf of the Board of Trade.

Paddington.—Subject to approval of the plans, especially as to road widenings and to the exaction of no local contribution, a special committee of the Borough Council recommend the latter to assent to the London County Council's projected surface tramway from the Marble Arch along Edgware-road to Cricklewood. At the same time the committee object to the tramway being brought within 100 yards of the Marble Arch end of Edgware-road, as the traffic at this point is already very congested.

Swansea.—A special meeting of the Electric Lighting and Tramways Committee has decided to give notice to the tramway company to acquire certain portions of their undertaking. Some discussion took place upon an offer by the Dolter Surface-Contact Company to

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convey the members of the Council to Paris, and pay their hotel bill, for the purposes of an inspection of the system in operation there. It was, however, agreed that only three or four members should go to Paris, and that at the expense of the Corporation.

Cosham.—A very successful trial trip of the Cosham and Waterlooville light railway took place a few days ago, and as a result the directors of the company have ordered the immediate extension of the line to Horndean, while the section already completed will be open for traffic in about a fortnight. Further developments are already in the air, and the directors have resolved to relay the Gosport tramways for electric traction, and to promote a Bill in Parliament for the extension of the line as an electric light railway to Fareham.

Italian Electric Railways.—A dispatch from Rome dated Oct. 18 states that Signor Valenzano, the Italian Minister of Railways, has inspected the Vatellina electric railway, which was recently opened for traffic. At the end of the inspection the Minister declared that as the difficult technical problem had been perfectly solved, he would readily grant the additional permits needed to complete the line as far as Milan. The Minister further declared that the electrification of the entire Italian railway system was the programme of the near future.

Blackwall.—The London County Council have announced their intention to seek powers in the next session of Parliament for the construction of a tramway from the Council's tramways in Trafalgar-road, Greenwich, *viâ* Blackwall-lane and Blackwall Tunnel, to the Council's (Northern) tramways in East India Dock-road. The Greenwich Borough Council have been asked for their consent to the construction of so much of the tramway as would be within their jurisdiction. The matter has been referred to the General Purposes Committee.

South Lancashire.—The first completed length of the South Lancashire electrical tramways connecting Leigh with Bolton was opened for public use on Monday. The system, when finished, will include more than 100 miles of tramways linking up Manchester, Liverpool, Wigan, Accrington, Bolton, St. Helens, Leigh, and other important cities and towns. The Atherton, Tyldesley, and Hindley routes are now completed, while the Liverpool and St. Helens branch was opened a few weeks since. Excellent progress is being made with the other lengths.

Altrincham.—A scheme is being promoted by the British Electric Traction Company for providing a system of tramways for the district, comprising Altrincham, Sale, and Northenden. Public feeling in the district is distinctly favourable to it, but the urban district councils are not giving it a whole-hearted support. The Altrincham District Council, who represent the most considerable urban population, have given a pledge that before committing themselves to final action the ratepayers shall be consulted, and have approved generally a tramway scheme from Stretford to Altrincham.

Kensington.—At their last meeting the Borough Council received a letter from the London County Council stating that they had resolved to seek parliamentary powers next session for the construction of a tramway from Shepherd's Bush-road *viâ* Richmond-road, Holland-park-avenue, High-street, Notting Hill, and Bayswater, to a point near the Marble Arch, and enquiring whether the Council would be prepared to give their consent to the construction of that portion of the proposed line which would come within their jurisdiction. A reference to the Law and Works Committee was agreed to.

Additional Traffic Returns.—Anglo-Argentine, £99 decrease; Barcelona Ensanche y Gracia, £27 increase; Barcelona, £324 increase; Brisbane, £459 increase (month of September, £9,757, increase £994); Buenos Ayres and Belgrano Electric, £131 increase (month of September, £12,476, decrease £150); Calcutta, £183 increase; Cape Town (month of August), receipts £15,450, expenditure £7,801; Isle of Thanet Electric, £20 decrease; Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £127 increase; Port Elizabeth (month of August), receipts £4,014, expenditure £1,979.

Barrowford.—At the monthly meeting of the Urban District Council a lengthy report was submitted with respect to the negotiations between the sub-committee of the Nelson Corporation and the Barrowford Council as to the joint working of the light railway between Barrowford and Nelson. The Nelson Corporation desired each authority to make its own length of tramways, and asked that they should take out of the receipts from the trams a fixed price for electricity supplied, and also a fixed sum for providing the car-shed and cars. The report was adopted and the opinion expressed that some agreement should be come to with Nelson.

Lancaster.—A Lancaster correspondent states that some satisfaction has been expressed that the Lancaster Corporation withstood the offer of the British Electric Traction Company to buy out the Lancaster and District Tramway Company at par value if the consent of the Corporation could be obtained. It was reported at the meeting of the Town Council on Wednesday that valuers had been appointed to inspect the line to Morecambe, and report to the Corporation with the view of purchase. The electric trams in the borough are almost ready for running. Halfpenny stages will be adopted to Scotforth and Williamson Park. The delay in the installation of the scheme has been due to the construction of a new power station.

Camberwell.—In consequence of the inconvenience and loss which will be occasioned to shopkeepers and others in the main roads, unless the work of reconstructing the tramways for electrical traction in this district be rapidly proceeded with, the Borough Council have requested the London County Council to employ two relays of workmen in the borough during the time that the lines are under construction. In connection with the proposed tramway along Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, Grove-vale, and Lordship-lane, there are street widenings and improvements to be carried out involving a total estimated cost of £114,950, and of this amount the Borough Council are going to contribute a sum not exceeding £34,000.

Liverpool.—A special meeting of the City Council has been called for Nov. 19 to consider a proposal to lay a partly single and partly double line of tramways in continuation of the existing line in Lodge-lane north of Croxteth-road, passing along Lodge-lane as a single line, and continuing as a double line through Sefton Park gates and along the trotting track on the west side of Aigburth-drive, thence passing through the park gates at Aigburth-road, and terminating by a junction with the existing lines in Aigburth-road. The length of this line would be about 1 mile 200 yards of double and 170 yards of single line, or an equivalent of 2 miles 570 yards of single line. The Corporation have abandoned their decision to apply for powers to construct tramways between Lodge-lane and Aigburth-road.

Dewsbury. — In certain quarters the tramway proposals for establishing communication with the outlying districts are receiving a hearty welcome. The Tradesmen's Association at their last meeting adopted this resolution: "That the association is strongly in favour of electric trams running between Dewsbury and Ossett, and trusts the Town Council will use their utmost influence to obtain such object." The British Electric Traction Company are the promoters of the scheme. The lines in the town are progressing rapidly, and the first section will shortly be ready for opening. The company, however, have not yet been able to come to an agreement with the Corporation for the supply of power for the cars. The matter will be discussed at a conference between the parties, which is to be held soon.

South Shields.—A communication has been received by the South Shields Corporation from the British Electric Traction Company in relation to the tramways scheme in response to an invitation by the Council, who desire to have the company's proposals before them prior to the meeting between the two parties. The company suggest in their letter that the negotiations should be entered into upon the following basis: (1) that the Corporation lay down the lines; (2) the company to pay interest and redemption on the capital outlay; (3) the company to contribute towards the cost of such street improvement as may be found necessary; (4) the company to transfer to the Corporation that portion of the Jarrow and Shields light railway which is in the borough of South Shields, and receive in return a 27 years' lease.

Portsmouth.—The accounts of the working of the tramways during the past year show a loss of £5 203, which makes a total loss of £6,146 since the tramways were operated by the Corporation. It must be remembered, however, that the period under review includes the time when the lines were being relaid, and the electric cars were not running until the summer season was well advanced. The capital expended to date amounts to £493,198. This expenditure includes £175,000 for the tramways company, £195,000 for the new lines, £20,000 for the overhead work, £30,000 for the cars, and £35,000 for the power station. The receipts from the working of the trams were £50,643. 13s. 10d., and the expenses £29,871. 7s. 6d., which leaves a surplus of £20,772. 6s. 4d. This, of course, has been swallowed up, with more besides, by the sinking fund and allied charges.

Harrogate —At this week's meeting of the Town Council it was moved that the resolution of the Tramways Committee which was confirmed at the meeting of the Council on Aug. 11 last—viz, "That this committee deem it expedient that the Council should next session seek powers by a Bill in Parliament empowering them to provide electric tramways in and for the district of Harrogate"—be altered to read as follows: "That the Council seek powers by Bill in Parliament empowering them to provide tramways or other means of locomotion in and for the district of Harrogate." The mover contended that in passing this resolution they would be protecting themselves. He thought they were able to keep out the British Electric Traction Company. He said they did not want trams in Harrogate, which would be of no good to the town. Some discussion followed, and the resolution was carried almost unanimously.

Tramway Extensions in Surrey.—The Earl of Jersey, Colonel Boughey, and Mr. Henry Allan Steward, Light Railway Commissioners, with Viscount Emlyn as secretary, sat at Slough on Wednesday to consider the expediency of granting the application of the London United Tramways Company to extend their system from Hounslow along the Great Bath road to Colinbrook and Slough. The application was opposed by various landowners in the district and by the Great Western Railway Company. Mr. Clifton Robinson, engineer to the London United Tramways Company, and other witnesses gave evidence as to the need of the trams, but counsel for the opposition submitted that they would compete with the Great Western Railway. The Commissioners retired to consider the point, and on their return the Earl of Jersey announced they had come to the conclusion that there was competition, and that, therefore, the promoters must apply to Parliament. The application was refused.

Lancing.—The Parish Council have for some considerable time been in treaty with the British Electric Traction Company with reference to the construction of electric tramways in their district, and have practically agreed to the company's proposals. At their last meeting, however, the Council received a letter from the Corporation of Worthing stating that that body hoped shortly to be in a position to make the Parish Council acquainted with the details of their scheme for electric trams, and expressing the hope that the Council would consider it advisable not to commit themselves to any other scheme in the meantime. A member pointed out that they had already committed themselves to the proposals of the British Electric Traction Company, while another remarked that Worthing had hesitated so long that they had virtually accepted the offers of the British Electric Traction Company. Even now Worthing did not give them any details. It was decided that the letter should lie on the table.

Lowestoft.—The report of the electric traction inspection deputation, which has visited various towns in the Midlands and the North, was presented at the last meeting of the Town Council. The deputation recommended that unless the Corporation prefer to incur the

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extra expense of the surface-contact system, the overhead trolley system be adhered to at Lowestoft. The committee recommended the adoption of the report of the deputation, with the addition that 12 double-deck single-truck and six single-deck double-truck cars be ordered. The engineer was instructed to begin the construction of the tramway at Pakefield, then go to the north end of the town and afterwards to Denmark-road. The matter of obtaining the powers of the East Anglian Light Railways Company to construct a light railway to Kessingland was considered, and the committee recommended that an offer of £500 be made to Mr. Albright for the purchase of the company's powers. The report was adopted.

Halifax.—On Friday the eleventh section of the Corporation electric tramway system, that to Sowerby Bridge, was opened for traffic. The fare is 2d., compared with the railway fare of 3½d., and has the additional advantage that people are conveyed into the heart of the town both at Halifax and Sowerby Bridge. The line, which has been constructed on a private road through Pye Nest Park, with the terminus in the centre of Wharf-street, was submitted to the Board of Trade inspection five weeks ago, but Major Druitt deferred his sanction to the running of the cars until certain works were carried out. On these conditions being complied with Major Druitt made a further inspection on Thursday morning, being accompanied by various tramway officials. He sanctioned the use of the up line—the one on the right-hand side going towards Sowerby Bridge. The down line cannot yet be used because a large retaining wall which the Sowerby Bridge District Council are erecting from the Bolton-brow Board school to the borough boundary has not been completed. Until the wall mentioned is finished only a 40 minutes' service can be given.

Railway Electrification.—The directors of the Lancashire and Yorkshire Railway Company on Wednesday decided to introduce electricity as the motive power on their Liverpool and Southport line, which is about 18½ miles long, and which serves a long string of seaside residential districts, including Ainsdale, Freshfield, Formby, Hightown Hall-road, Blundell Sands, Waterloo, Seaforth, and Litherland. All the detail plans for this work have received careful consideration during the past 12 months, and various experiments which have been tried at the company's Horwich works have enabled the directors to arrive at decisions upon important points of operation. The work will be put in hand at once. It is anticipated that if the contractors, who have already been selected to manufacture such portions of the plant as the railway company will not construct at their own works, can deliver early enough, the electric trains will be running in about nine months. If this is done, the Liverpool and Southport line will be the first main-line railway to be converted to electric traction in this country. The system adopted is the third-rail, and the scheme provides for the erection of a central generating station, for the construction of which arrangements have already been made.

Rowley.—The General Purposes Committee reported to the last meeting of the District Council that in view of the application about to be made by their Council, jointly with the Quarry Bank and Brierley Hill District Councils, for the construction of light railways from Cradley Heath to Brierley Hill, they deemed it expedient for the Council to apply on their own account for powers to make tramways from Halesowen-road, Old Hill, to the Halesowen boundary, from Blackheath through Rowley to the boundary of the borough of Dudley, and from Blackheath to the boundary of Halesowen at Gorsty Hill. They recommended that application be made to the Light Railway Commissioners for the order for the joint railway from Cradley Heath to Brierley Hill, to include the above-named railways, proposed to be constructed by Rowley District Council, the latter bearing a proportion of the costs of obtaining the order. The report was adopted, and it was decided to seal the agreement with the Quarry Bank and Brierley Hill Councils with reference to the construction of the joint railway. The necessary steps are being taken in connection with the reconstruction of the tramway at Tividale by the Birmingham and Midland Tramway Company. The Midland Electric Corporation are prepared to supply electricity from their station at Old Hill.

Harrow.—An enquiry was opened by the Light Railway Commissioners at Harrow on Wednesday into an application made by the Middlesex County Council for sanction to run a line of electric trams round the base of Harrow Hill. The proposal is to construct the tramline from Willesden down the Harrow-road, and then through Harrow, Wealdstone, and Stanmore to Edgware, where it would form a connection with a similar line which has already been sanctioned to run out from Cricklewood along the Edgware-road. Evidence was given by Lord George Hamilton, who declared that such a line of trams would have a most prejudicial effect upon Harrow School. On Saturday afternoons they would get crowds of trippers down from London to watch the boys' games. That would be highly undesirable. The presence of a line of electric trams so very near the school, and running direct into London, would make it very difficult to enforce proper discipline, and it would be almost impossible to prevent the boys from travelling by it. If Harrow became a suburb of small houses, the character of the school would be most seriously affected, and the same class of boys would no longer attend it. He thought that where the interests of a great national institution were so vitally affected, a few thousands of pounds should not be given too much consideration, but that another route should be adopted. Similar evidence was given by Lord Spencer, another of the governors.

Crystal Palace Light Railway.—The Light Railway Commissioners have fixed Friday, the 31st inst., for holding the enquiry into the application of the Crystal Palace Light Railway and Tramways Company. The promoters of the scheme are anxious to obtain the support of the Camberwell Borough Council in their application, and have made the following offers to that end: that, provided they are allowed to construct the line from the Crystal Palace to Lordship-lane, they will give the London County Council running powers over such lines, at the same time taking running powers over the London County Council lines; or if the London County Council will take over the order and construct the line to the Crystal Palace they will be prepared, under the agreement they have entered into, to purchase the line of London, Camberwell, and Dulwich Tramways, and to electrify and work it with overhead traction, giving the London County Council running powers over the short piece of line in Lordship-lane. The promoters are also prepared to give the London County Council a right to run cars over their line to the Crystal Palace or to Forest Hill without any reference whatever to the remaining portion of the London, Camberwell, and Dulwich Tramways. At the instance of the Camberwell Borough Council the Board of Trade have appointed Colonel von Donop to inspect the latter tramway, and the Council are withholding their decision with regard to the proposed light railway until that inspection is made.

Colchester.—An important report was presented by the Tramways Committee at the meeting of the Town Council on Monday, in which they reviewed the present position of the tramways project. Having referred to the purchase for £2,250 of a site for the depôt in Magdalen-street, they alluded to the widening of Queen's-street and North Bridge, and declared that whilst recognising the grave responsibility they assumed, they were of opinion that the entire undertaking should be carried out by the Corporation, and that none of the powers should be delegated to a company. They had considered various systems, but they unanimously recommended the overhead trolley system. The committee had considered carefully the automobile street omnibus system, but disapproved of it mainly on the ground that the power of propulsion must be much in excess of that required for a tramcar on rails. The cost, according to the statement of experts, of rubber tyres would come to the very high figure of £144 per annum per car. The estimated cost of construction of the tramways amounted to £56,239. 14s., to which must be added the cost of properties already purchased and those required in connection with the North-street improvement. The total estimated amount required was £63,500. The committee believed that as soon as the tramways could be brought fully into work they would be able to run them without loss to the ratepayers; but they admitted that for the first few years there might be a deficit. The Council adopted the report.

London County Council.—Last July the London County Council authorised the expenditure of £22,500 for the erection of sub-stations at Clapham, Brixton, and the Elephant and Castle in connection with the approaching electrical working of the tramways on the south side of the Thames. The Clapham sub-station will form a part of a block of buildings, including workshops, in connection with the car-sheds to be erected close by, and it is proposed that the erection of the whole of this block shall be proceeded with simultaneously. The workshop buildings referred to form part of the second portion of the car-shed buildings, in respect of the first portion of which the Council approved the expenditure of £30,000 in July last. The architect's approximate estimated cost of these workshop buildings is £3,600, and at the usual weekly meeting on Tuesday the Highways Committee asked the Council to approve the proposed expenditure. They further recommended a payment of £350 as remuneration to the quantity surveyor for getting out the quantities, etc., for the three sub-stations in question. An alteration in the route of the proposed Battersea Park-road tramway was also notified by the committee at Tuesday's meeting. As originally proposed, a double line was to be constructed from Battersea Park-road (South London Tramways Company's lines), *viâ* Battersea Bridge-road, Battersea Bridge, Chelsea-embankment, Chelsea Bridge-road, and Commercial-road, to a point in Buckingham Palace-road near the Grosvenor Hotel. The Chelsea Borough Council, however, have intimated that they will dissent from any scheme for the construction of tramways along the Chelsea-embankment, but will consider favourably a proposal for tramways along Beaufort-street and King's-road. The Highways Committee are, therefore, proposing to ask Parliament in the next session for powers to construct new tramways from Battersea Park-road (South London Tramways Company's lines), *viâ* Battersea Bridge-road and Battersea Bridge, to a point in Beaufort-street near King's-road.

LIGHTING AND GENERAL.

Carlisle.—The electric light is to be installed in St. Cuthbert's Church in place of gas.

Trowbridge.—The Wilts Standing Joint Committee are having a report prepared on telephones for police purposes.

Bethnal Green.—The Borough Council have obtained what amounts to a year's extension of their electric lighting order.

Falmouth.—The agreement with Messrs. Crompton and Co. with reference to the electric lighting of the borough has been sealed.

Globe Telegraph and Trust Co.—The directors announce a quarterly interim dividend of 1s. 9d. per share on the ordinary shares.

Broadstairs and St. Peters.—A number of changes with regard to the positions of street lamps and the erection of additional lamps has been agreed to.

Carnoustie.—The electric light supply company which has obtained a provisional order for the electric lighting of the burgh, is now purchasing a site.

Strathpeffer (Dingwall).—Marked progress is being made with the installation of electric light into Strathpeffer. A considerable amount of the plant has arrived.

Bracebridge Asylum.—The Building and Sanitary Committee have recommended an installation for the supply of light and motive power by electricity for the asylum.

Yeovil.—The Corporation contemplate applying to Parliament for a provisional order authorising them to supply electricity for public and private purposes within the borough.

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Chelsea.—The Borough Council have agreed to an amended application from the London Electric Supply Corporation to lay mains in a portion of King's-road and Sydney-street.

Enquiry.—In another column will be found an enquiry with regard to the probable cost of a plant to work electric light for a colliery district with a population of 7,000.

Slough.—The Urban District Council have decided to proceed with the transfer of the electric lighting provisional order to the Datchet Electric Supply Company as soon as possible.

Harringay.—A joint standing committee of the Tottenham and Harringay Ratepayers' Associations will shortly meet for the purpose of discussing the question of electric lighting.

Cape-to-Cairo Telegraph.—The Cape-to-Cairo telegraph line has reached Ujiji, and has been transferred by the Transcontinental Telegraph Company to the Tanganyika Concession.

Walthamstow.—The District Council's electric lighting station, opened only a year ago, was described at the last Council meeting as being "already a little gold mine for the ratepayers."

Northampton.—The Town Council have to commence work on the electric station at once. The electric light company now estimate the cost of erecting generating stations at £20,000, instead of £12,000.

Caerphilly.—The District Council have decided to apply for a provisional order authorising the Council to become distributors of electricity, taking the power from the South Wales Electrical Company.

Battersea.—The Borough Council have adopted an estimate of £108. 10s. (including £57. 5s. for the cost of cable, etc., in stock) for extension of electric distributing mains from St. John's-hill to 27, Spencer-road.

Nuneaton.—The electric lighting of the town will very soon be accomplished. Several of the standards to carry the arc lamps have already been fixed, and in a few weeks the whole of the undertaking should be completed.

Aberdeen Telephones.—The Municipal Telephone Committee have agreed to delay asking for a license, but the feeling generally expressed at their last meeting was that the idea of having a municipal service should not be abandaned.

Aberdeen.—The application recently made by the trimmers in the electric lighting department for an increase of wages has been refused, the rate paid being found to be higher than that given to men in similar positions in other departments.

Newark.—A number of residents have arranged to visit the Worksop electric power station. As the town is of similar size to Newark, the undertaking which has been carried out so successfully there should afford an excellent object lesson.

Leeds.—The Lighting Committee of the Corporation have decided to extend the electric light mains from Hyde Park along Moorland-road, and also to embark upon a similar extension both for lighting and motor purposes at Meanwood.

Nottingham.—Colonel A. J. Hepper has held an enquiry into an application of the City Council for sanction to borrow £35,500 for purposes of electric lighting, including £15,500 for a station at the Eastcroft, where the Corporation are now adopting new destructors.

Oriental Telephone and Electric Co.—The directors have declared an interim dividend of 2½ per cent. on the paid-up capital of the Company, free of income tax, payable to those shareholders whose names are on the register at this date. The warrants will be posted on 31st inst.

South London Electric Supply Co.—The Company reports having sold during the first nine months of the current year 645,000 units, as against 535,000 units for the corresponding period of last year, showing a gross revenue of £13,436, as against £11,037, while the cost per unit sold has been reduced 25 per cent.

Forfar.—The Council have decided not to consent to the application of the Electric Supply Corporation, Limited, London, who intend to apply for a provisional order for the supply of electricity in Forfar. The general opinion appears to be that there is little or no room in Forfar at present for an electric lighting undertaking.

Woolwich.—The Electricity Committee have asked Mr. Spencer Hawes to examine and report upon the capital expenditure of the Woolwich Company between Oct. 4, 1901, and Sept. 30, 1902. An accountant is to be employed for the purpose of ascertaining the profit to be handed over to the Council by the company on completion.

Greenock.—For the month of September 30,443 units of electricity were generated in Greenock, and 25,980 were sold, being 7,476 more than for the same month last year. For traction 64,280 units were supplied. The applications for lighting now number 297, and the connections made and being made are equal to 38,760 8-c.p. lamps.

Hackney.—A number of applications for permission to retain lamps overhanging the public footways have been granted, subject to the usual conditions and during the pleasure of the Council; also an application by the National Electric Wiring Company, Limited, for permission to fix rail with 14 electric lights, to project over a public footway.

Dundee.—A series of explosions occurred on Tuesday in various quarters of the city at the manholes connected with the underground electric cables, probably due to foul gas accumulating in the conduits conveying the cables. As the tramways are supplied with different cables from the electric light, the running of the cars was not interfered with.

Edinburgh.—The number of lamps applied for from Sept. 26 to Oct. 16 was 5,187 of 8 c.p., as compared with 4,829 last year. These included 3,203 for lighting, against 3,044; 1,476 for motors, against 1,428; and 508 for heating, against 357. The total from May 6 to Oct. 16 was 41,107 8-c.p., as compared with 44,714 for the corresponding period last year.

Dewsbury.—There is a probability that the work of installing the electric light at the infirmary will be commenced shortly. Mr. Campion, the borough electrical engineer, is preparing an amended specification to be submitted at the earliest opportunity to the committee for their approval.

British Insulated and Helsby Cables, Limited.—The amalgamation of the British Insulated Wire Company, Limited, and the Telegraph Manufacturing Company, Limited, being now completed, it has been formally decided by special resolution of the shareholders that the title of the joint companies shall in future be British Insulated and Helsby Cables, Limited.

Bexhill-on-Sea.—The Council have adopted the engineer's scheme for lighting the new footbridge over the London, Brighton, and South Coast Railway with four electric lamps, at an estimated cost of £21. 17s. They also appointed a sub-committee to report upon the lighting of Haddocks Hill by electricity. Cables are to be continued along Woodville-road at an estimated cost of £21.

Pacific Cable.—The long section of the cable between Vancouver and Fanning Islands has been successfully laid, and the cable is now in working order between the stations on these two islands. The "Anglia" is proceeding to lay the remaining section of the cable between Fanning and Fiji. The Pacific Cable Board expect that the cable will be open to the public before the close of the year.

Yarmouth.—The Town Council have adopted a report of Messrs. Preece and Cardew on extensions of plant and mains to meet the probable future requirements of the installation. Application is to be made for sanction to borrow £16,450, made up as follows: buildings, £4,500; generating plant, £6,700; mains, £2,300; substations, etc., £1,500; engineering and contingencies, £1,450.

Teddington.—The District Council have asked Mr. Edgcome, electrical engineer, to report upon the tenders received for leasing the Council's provisional order for electric lighting. The report will deal with the tenders submitted by Messrs. Crompton and Co., Limited, and the Twickenham and Teddington Electric Supply Company, Limited, and also with the entire question of electric lighting in the district of Teddington.

Stock Exchange.—Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the British Insulated Wire Company's further issue of £250,000 4½ per cent. first mortgage debenture stock; British Thomson-Houston Company's £200,000 4½ per cent first mortgage debenture stock; Bromley (Kent) Electric Light and Power Company's £50,000 4½ per cent. first debenture stock.

Keighley.—The Electricity Committee in their last report states that the number of units of electricity sold during September, 1902, was 10,02', and that the units for the corresponding period during 1901 amounted to 3,646, the present period showing an increase of 6,374 units. The number of units sold from July 1 to Sept. 30, 1902, was 23,867, and for the corresponding period, 1901, 6,337, showing an increase of 17,530.

Colwyn Bay.—The electrical engineer in his last report states that 14,211 units have been generated during the past month, being an increase of 5,752 units on the corresponding month last year. Messrs. Lacey, Clirehugh, and Sillar have been asked to at once prepare the necessary specifications, plans, etc., of extensions of electricity plant for transmission to the Local Government Board and for the purpose of obtaining tenders.

Potash Salts.—We have received from the Lombard Press, Limited, a most comprehensive work on "The Potash Salts: their Production and Application to Agriculture, Industry, and Horticulture," by Dr. Lorentz Albert Groth, in which this competent authority deals exhaustively with the whole subject. Numerous illustrations of machinery and tables enhance the value of the work, to which Dr. Rideal has written a preface.

Hampton.—The District Council have accepted an offer of the General Post Office to provide, maintain, and renew when necessary a double-wire circuit from the public offices to the fire station, the sewage-disposal works, and the isolation hospital, at an annual rental of £29. 5s. The consideration of a further offer to provide six fire-alarm circuits radiating from these points, at an annual rental of £55. 5s. under an agreement of seven years, has been postponed.

U.S. Storage Battery Combine.—The *New York Herald* reports, according to a Reuter's telegram, that an international combination has been formed in the storage battery business which, for all practical purposes, will control the patents and the manufacture of storage batteries in the United States, England, and the Continent. It is said that the deal was effected by New York financiers, who recently visited London for the purpose of settling the tobacco war.

Hull.—The Council are anxious to commence operations in connection with the municipal telephone exchange on Jan. 1. We are obliged to a correspondent for pointing out an error which appeared in our issue of Oct. 10. It reads "which provides for the extension northward of the underground system already provided between *Hull* and Birmingham," but should be "*London* and Birmingham." We sympathise with our friend, who says: "We have no such cable; only wish we had."

Radiators.—According to a notice issued by the City of London Electric Lighting Company there is a great increase in the use of electric radiators for heating offices, etc., by means of which all the trouble connected with the use of coal fires and the unpleasant fumes of gas stoves or hot pipes are avoided, while the temperature of any room can be regulated with the utmost ease. Electricity for heating purposes is supplied by the company, by separate meter, at the special rate of 2½d. per unit.

South Wales.—The South Wales Electrical Power Distribution Company's generating stations are making progress. The Bridgend station will be at work in a month's time, and the large Pontypridd

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station in May of next year. Work has been begun at Neath, and the Pontypool station is to be started immediately. Permanent sub-stations will be at once commenced and equipped as temporary generating stations at or near Maesteg, Ebbw Vale, Risca, Llwynpia, and most probably Barry.

Swansea.—The electric lighting accounts from December, 1900, were brought into last year's accounts, showing a loss on the whole period of £349. 9s 10d., including the sum of £143. 15s. 4d. for sinking fund for March, 1901. No provision for sinking fund has been made for the present period. The Local Government Board have declined to grant the application of the Corporation for a loan of £328 towards defraying the cost of works at Parc Gwyllt. The workhouse infirmary will shortly be lighted by electricity.

Camberwell.—An agreement is proposed between the Borough Council and the South London Electric Supply Corporation, Limited, granting a wayleave to supply property in the district with electricity on the terms, including a nominal wayleave of 1d. per yard per annum. The London County Council have informed the Council that clauses have been inserted in the Council's General Powers Bill to enable the councils of metropolitan boroughs to wire and fit consumers' premises for electric lighting, and to obtain loans for so doing.

Bann Water Power.—At the last quarterly meeting of the Londonderry County Council a preliminary report of the results of the committee's inspection of the water power of the River Bann was received. From this it appears that after the inspection Sir Wm. Preece pronounced most favourably on the engineering aspects of the scheme, and the comparative ease of carrying it out. Before going further, the committee recommend that the Council's solicitor should examine into the various Acts of Parliament bearing on the navigation works, etc.

Gaywood.—The Parish Council will at their next meeting discuss an offer from the Lynn Corporation to lay down a cable and maintain eight electric lights, containing two 16-c.p. lamps each, for £3. 10s. each, which would mean about £28. Each lamp would be lit about 3,000 hours per annum. The Corporation offer to reduce this amount to £3 per lamp if 8-c p. lamps are used, or to supply Nernst lamps of 50 c.p. at £3. 10s. In any event the main cable would be of sufficient capacity to supply all private consumers, and the Corporation would afford such supply at 5d. per unit.

Bath.—Two reports will be presented from the Electric Lighting Committee at this week's meeting of the urban sanitary authority. These narrate the abortive attempt of the electric traction company to come to terms with the committee for the supply of electric energy for a power station proposed to be erected in Dorchester-street. The final item is the notification of the receipt of a letter from the electric tramways company declining to negotiate for the lease of a portion of the land in Dorchester-street. Formal sanction has been obtained to the borrowing of £11,196 for 25 years and £13,704 for 22 years.

Presentation.—Mr. F. R. Markham, who for over 11 years has been head of the test department at Messrs. Crompton's Arc Works, was last week presented with a testimonial on his leaving to start in the new business of Bray, Markham, and Priess, of Walthamstow. Mr. S. L. Brunton, the manager, made the presentation, which consisted of a silver inkstand, field glasses, and an illuminated address, which also contained photographs of Colonel R. E. B. Crompton, C.B., and Mr. Brunton, and a view of the works. The test-room staff contributed a photograph of its members. The testimonial had been contributed to by about 80 members of the works staff, most of whom attended the presentation.

South Shields.—An application by the United Enginemen's Association for an increase of 3s. per week in the wages of the enginemen, firemen, and greasers employed at the South Shields electric light station was recently laid before the Electrical Committee. The town clerk has been instructed to reply that, having obtained accurate information from a large number of towns and companies with similar undertakings, and taking an average of 34 stations where men of the same class are employed (excluding certificated mechanics), the committee find that the rate of wages paid by them is in excess of the average rate, and that, therefore, they cannot recommend any increase.

Wellington (N.Z.).—We have received an interesting report upon the working of the city engineer and surveyor's department for the three years ending March 31, 1902, by Mr. R. S. Rounthwaite, A.M.I.C.E. This city will become very interesting to electrical engineers by reason of the proposed extension of the boundaries, and the proposed acquisition of the electric lighting undertaking and the electrification of the tramways. Our readers may remember that in the spring of this year an English electrical engineer was appointed electrical engineer to the Corporation. The present electric lighting includes 22 arc lamps of 2,000 c.p. each and a number of 20-c.p. lamps, supplied by the New Zealand Electrical Syndicate.

Personal.—Mr. W. M. Furniss has joined the technical staff of the Pearson Fire-Alarm System, Limited, of 23, Nichol-square, E.C., and that in future he and Mr. G. B. Bowell will act as joint electrical engineers to the company. We are informed that this addition to the managing electrical staff has been necessitated by the rapid extension of the Pearson fire-alarm system, both in London and in the provinces. After completing nearly 50 years' service with the North-Eastern Railway Company, Mr. Alfred Graves, the electric telegraph superintendent, has resigned, and will be succeeded by Mr. C. H. Ellison, of the office of the superintendent of the line, York. We are informed that Mr. E. T. Oubridge has left the employ of the Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C.

Hebburn.—At the last meeting of the District Council, the Electricity Committee reported the receipt of a letter from the Board of Trade, stating that before they could consider the proposals to use an extra high-pressure system they would require the undertakers to show that the commercial importance of the project justified the risks involved by the use of such a supply. A copy of the letter was sent to the Northern Counties Electricity Supply Company. The surveyor was instructed to inspect the electric mains, and to draw the attention of the company to the fact that they were being laid in private land in several streets, and that the company would be held responsible. It was agreed that the managers of the Northern Counties Company be requested to meet the Council to discuss the question of trams for the district.

Leyton.—The Urban District Council have made a profit on the electric light supply station during the past six months of £700. The Council's electrical engineer, Mr. F. H. Lewis, A.I.E.E., states that whereas in 1897, the year in which the station was inaugurated, there were only 2,982 lamps connected with the system, and 28,591 units sold in the twelvemonth, at present there are 40,000 lamps connected, and the financial year now closed saw a total of 811,141 units sold. To provide for this enormous increase in the output of electricity an extensive plant of steam-engines is now being laid down. The Council had to discard the use of gas-engines upon an injunction of the High Court. There are already five steam-engines of 360 h.p. each in position, and a sixth engine is being erected, which will generate 700 h.p., and work an extra large dynamo.

London Bridge.—The temporary footbridge just being erected at a cost of £30,000 will be opened on Nov. 10. It really consists of two footways placed just clear of the proposed widening. Each is 1,006ft. long and 11ft. 2in. wide, and will carry two electric cranes to assist in the work of reconstructing the main structure. These ways are covered with a galvanised iron roof, in the apex of which wires are laid in a small tube, and incandescent lamps are connected 50ft. apart. The architect for the work is Mr. Andrew Murray, F.R.I.B.A. Mr. Cruttwell, M.I.C.E., is the engineer, and Mr. W. B. Cole A.M.I.C.E., the resident engineer. The contractors are Messrs. Pethick and Co., of Plymouth, and with the Patent Shaft and Axle-Tree Company, of Wednesbury, as sub-contractors. By permission of the Bridge House Estate Committee, the members of the Institution of Junior Engineers were enabled to visit the work on Tuesday.

Cardiff.—The Corporation have arranged to supply current to the Mountstuart Dry Dock Company's premises for lighting and power purposes. This is one of the first important initial installations undertaken by the electrical department of the borough. The engineer (Mr. Arthur Ellis) in his last report states that during the month 116,639 units had been generated at the works, an increase of 28 per cent. on the corresponding period of last year. A total equivalent to 2,329 8-c.p. new lamps was connected during the month, and the number of new consumers was 130. The revenue was £161. 18s. from street-lighting, and £1,366. 10s. from private supply. The engineer presented a revised scale of charges for meter rents. The charges ranged from 6s. (instead of 10s.) per annum for meters of the capacity of 35 8-c.p. lamps to 20s. (instead of 35s.) for meters of 500 8-c.p. capacity. The reduction was possible because the cost of meters had gone down considerably.

"Magazine of Commerce."—Under this title a new magazine has been started, and as far as get-up and printing is concerned it is by far the best production of its kind, if not of any kind we have yet seen published in the United Kingdom. If its mission is to instil more artistic feeling into our manufacturers and their wares—a thing that is sadly wanted—its managers have chosen the right way to do it. The literary part is also well looked after, and contains an article on "Foreign Competition," by Lord Charles Beresford; "The New Ministry," by H. C. Richards, K.C., M.P.; "Commerce and the Law," by W. N. Hibbert, LL.D.; "Art and Commerce," by C. E. Dawson; "Recent Decisions Affecting Commercial Law," by S. J. R. Merlin; "International Wireless Telegraphy," by J. Tarbotton Armstrong; and various other interesting articles, amongst which some pertinent remarks on the consular service by J. H. Yoxhall, M.P., might be read with profit at the red-tape and circumlocution office.

November "Smart Set."—Carolyn Wells has the following story to tell in the November *Smart Set:* "Once on a Time there were Two Young Men, each of whom Bought an Automobile. One Young Man, being of a Bold and Audacious nature, said: 'I will make my Machine go so Fast that I will break all Previous Records.' Accordingly, he did so, and he Flew through the Small Towns like a Red Dragon Pursuing his Prey. Unheeding all Obstacles in his Mad Career, his Automobile ran into a Wall of Rock and was dashed to Pieces. Also, the Young Man was killed. The Other Young Man, being of a Timorous and Careful Disposition, started off with great Caution, and Rode at a Slow Pace, pausing now and then Lest he might Run into Something. The Result was that Two Automobiles and an Ice Wagon ran into him from behind, spoiling his Car, and Killing the Cautious Young Man. *Morals:* This Fable teaches Us, The More Haste The Less Speed, and Delays Are Dangerous." There are a variety of other charming tales—both long and short. Americanisms do not abound so much as formerly; still they crop up sometimes, and when a lady says "I am well furred," we guess we smile.

Glasgow Exhibition Machinery Hall.—The Parks Committee of Glasgow Corporation have had before them various reports with reference to the exhibition machinery hall, Dumbarton-road. Mr. A. B. M'Donald, city engineer, and Mr. James Whitton, parks superintendent, estimated that the breaking up of concrete and preparing the whole surface of the interior for a uniform floorage and other repairs would cost £1,500 This would place the building in a secure condition for the next two or three years. Mr. W. A. Chamen, the electrical engineer, estimates that to wire the hall with 35 arc lamps of 1,000 c p. each would cost £250, the hire of new lamps £78. 15s. per annum, or if purchased outright the lamps would cost £140, these lamps to realise at the end of three years between £30 and £40. The cost of the light he estimates at 8s. 9d. for the first hour per day for 365 days, and 1s. 5d. for every further hour, with 3d. per hour for

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carbons, and about £2. 10s. per month for labour. It has now been decided that the flooring be sold, the ground levelled, and enquiries made as to the likelihood of a revenue being derived from the building by letting.

Cheltenham.—The proposed Corporation Bill contains the following clauses: "To empower the Corporation to purchase, provide, sell, let for hire, and fix, set up, alter, and remove lamps, meters, electric lines, fittings, motors, apparatus, and things for lighting and motive power, etc.; to exempt the same from distress; to empower the Corporation to refuse to supply electrical energy when payments due to them for supply of energy or fittings are in arrear; to exempt the Corporation from obligation to supply electrical energy to premises having a separate supply; to empower the Corporation to make regulations with respect to the wiring of premises, and the electric apparatus and fittings therein, for the safety of the innabitants, and for the prevention of fire; to postpone repayment of money borrowed under the Electric Lighting Acts, 1882 and 1888, until the completion of the works for which the money is borrowed, or until the expiration of two years from the borrowing, whichever period shall be the earlier; moneys borrowed for electric lighting undertaking not to be taken into account under the Public Health Act as regards limitation of Council's borrowing powers."

Harrogate.—Major C. E. Norton has held an enquiry at the Council-chamber relative to the application of the Town Council to borrow £46,000 for the purposes of electric lighting extensions and additions to plant and buildings. Mr. G. Wilkinson (electrical engineer) explained in detail the particulars of the undertaking, and Councillor Chippindale (chairman of the Electric Lighting Committee) said that it was a paying concern rather than a charge upon the rates. When the electric works were opened in 1897 they supplied an equivalent of 8,700 c.p.; in the following years, 18,925, 26,350, 33,940; and last year 41,800. The demand had been gradually increasing. The work during the first two years involved a loss of £1,997; the third year there was a profit of £777, after repaying interest and sinking fund; the following year there was a profit of £1,046; and last year, ending March, 1902, a profit of £1,758. There was a prospect of a further increase, and to meet the demand it would be necessary to have additional plant and accommodation. Out of the above profits about £600 had been placed to reserve fund, and they had contributed £730. 16s. 2d. to the relief of the local rates.

Bradford.—The ceremony of laying the corner and memorial stones in connection with an extension of the Corporation electricity works in Valley-road took place last week. The first stone was laid by Mr. J. B. Moorhouse, chairman of the Electricity Committee, who referred to the progress of the electric installation in Bradford. In 1891 there were 240,000 incandescent lamps, as against 1,655,000 to-day, and the total capital expended then was £40,000, against £339,000 now. The deputy-chairman (Mr. C. Dowson) laid the second stone, and both he and Mr. Moorhouse were presented with silver trowels. We regret to note that the electrical engineer, Mr. R. A. Chattock, M.I.E.E., could not attend owing to illness. The Markets and Fairs Committee having considered reports by the electrical engineer and the engineer and superintendent of baths with reference to the proposed alteration to the steam generating plant and electric lighting arrangements at St. James's abattoirs, decided to recommend against the erection of a plant for generating their own electricity, and the Electricity Committee have been asked to supply the necessary current. It has also been decided that for the more economical working of the steam-raising plant certain alterations be made at an estimated cost of £1,820.

Sudbury.—The Town Council have accepted the offer of Mr. Adrian Collins, of 61, Old Broad-street, London, for the transfer of their lighting order. On completing the contract with the Corporation, Mr. Collins agrees to repay the costs and charges (not to exceed £1,000) incidental to obtaining the provisional order), such sum to be considered as capital expenditure. As an alternative, he offers in lieu of £1,000 cash payment to pay the Corporation £300 by way of premium, £30 per annum for the first period of 10 years, and £100 per annum for the second period of 10 years by way of lease. Such sums are not to be repaid by the Corporation. The company will take a lease of the proposed site for a period to run concurrently with the lease of the undertaking. The Corporation will grant a concession for public lighting as soon as the existing contract with the gas company ceases for a period of five years at a charge of £2 per lamp per annum, the burning hours being set out as 1,500 each lamp per annum. Mr. Collins agrees to use ½-ampere Nernst lamps. The Corporation also to agree to take a supply of current for all public rooms and offices. The charges for current are not to exceed 7d. per unit for lighting purposes, and 3d. per unit for motive purposes. It is the intention to form a local company to carry out the work, and preference will be given to the residents of Sudbury.

Brighton.—Trial bores are to be made for the proposed tunnel under Shoreham harbour in which to lay the electricity cables in connection with the new power-house at Southwick, and through which the employés could go to and from the works. In his last report Mr. Galbraith stated that it was proposed to sink a 10ft. internal diameter cast-iron shaft on each side of the harbour, each shaft to be sunk about 16ft. into the blue clay, and to have a total depth of about 42ft. Within each shaft there would be a spiral staircase 3ft. 9in. wide, and the cables could be carried down the well at the centre of the staircase. The staircases would be connected by a low-level cast-iron footway tunnel of 7ft. internal diameter to be driven into the London clay, the top of the tunnel to be 14ft. below the bed of the river, and 7ft. below the assumed level of the clay, thus giving an ample cover of that material. He estimated the cost of the work at £6,000, this including 10 per cent. for contingencies and the usual percentage for engineering superintendence. The Town Council have approved a report of Mr. John Christie, resident electrical engineer, with reference to the improvement of the lighting of the aquarium entrance at an estimated cost of about £375. The scheme provides for outlining the structure in electric lights, preferably white, with various points sharpened up by arc lamps or more powerful lights.

Hammersmith.—The last report of the Electricity and Lighting Committee states that since the last Council meeting 16 additional consumers have been connected, representing a maximum of 1,431 8-c.p. lamps, and that the total number of consumers now taking current from the mains is 1,104. The following report of the electrical engineer has been received: "After running several trials with the Hydroleum system of burning oil fuel, I have come to the conclusion that if we can obtain fuel oil at anything less than 30s. per ton delivered, it will not cost us more than coal at present prices. No. 7 boiler is still fitted with the Hydroleum Company's system, and the boiler is urgently required in order that the other boilers may be taken off to be cleaned. In order to work this furnace as at present fitted, it will be necessary to obtain some more storage tanks for the oil, or else dismantle this furnace and revert to coal. This will mean the complete loss of the cost of fitting-up this boiler. As the Shell Transport Company have quoted 28s. 6d. per ton for oil delivered into our tanks, I think it will be wise to buy some tanks at a cost not exceeding £30 and get this boiler under steam again. These tanks will not be wasted, as No. 1 boiler is not of much use in its present state, the chimney stack being now about loaded up, with the result that we get such a very poor draught on this boiler that it is practically useless. Under these circumstances I think it will be advisable to have it fitted up with an oil-burning apparatus which is independent of the chimney draught. These tanks will then be of use for this purpose. It will be necessary to get out a specification and obtain price and guarantees from manufacturers before deciding the best make of apparatus to be fitted to this boiler." The committee recommended that additional storage tanks be provided at a cost of £30. The Council have consented to the application of the Metropolitan Electric Supply Company, Limited, who intend to lay extra high-tension trunk mains from their works in Acton-lane, Willesden, into the borough of Paddington, including a portion of the Harrow-road situate within the borough.

Worcester.—The Corporation's new electricity station is now nearing completion under the skilled direction of the city electrical engineer (Mr. C. J. Sutherland). It comprises a substantial and carefully planned building of brick and stone, including engine-room, boiler-house, pump-room, battery-room, and workshop, chief engineer's office, assistants' office, general office, drawing office, and test-room, and messroom, bathroom, and lavatories for the staff. The engine-room, 52ft. by 32ft., contains four engines—*i.e.*, one of 120 h.p., coupled by a friction clutch to an alternator and a dynamo mounted on one shaft, and three engines, each of 450 h.p., capable of developing 500 h.p. should circumstances require it. One of these engines is connected to two dynamos, which will supply current for the lighting mains, and the other two are each connected to a dynamo, which can be used either for tramway or lighting purposes. Except on Bank Holidays, one engine will be sufficient for tramway purposes, so that there will be a spare engine and dynamo in case of a breakdown either in the lighting or the tramway system. By a clever mechanical device it has been so arranged that when there is a surplus of water power at Powick the alternator will be used as a motor, using power received from the Powick station to generate by means of the dynamo continuous current for supplying the town mains or charging the batteries, while when the water supply at Powick is short the dynamo can be used in turn as a motor to drive the alternator, thus supplying the alternating current to the town mains for lighting purposes, and obviating the necessity for running one of the large engines at Powick. In addition, either machine can be run by the steam-engine to which it is coupled, and which runs at 500 revolutions to the minute. The engines are supplied with steam at a pressure of 175lb. to the square inch and at a temperature of 500deg. There is a switchboard of the Ferranti type, and a storage battery, capable of supplying 2,000 lamps for six hours. An overhead travelling crane capable of lifting 12 tons weight has also been provided. The boiler-house is 52ft. square, and contains three boilers, each capable of developing 500 h.p. Superheaters raise the temperature of the steam to 500deg. Mechanical stokers worked by an electric motor will be used. In the pump-room are two steam pumps for feeding the boilers, and two centrifugal pumps driven by electric motors for pumping the condenser water from the river into an overhead tank. The boiler pumps are so arranged that they can pump either direct from the river or from the tank, and the tank also has the town supply laid on.

Wigan.—A mining and technical college bazaar and exhibition is being held. It includes, according to the *Wigan Examiner*, a very interesting collection of electrical specialities, furnished by the electrical department of the Corporation and the Corlett Electrical Engineering Company. The latter show an assortment of electric mining machinery, amongst the most interesting items of which may be mentioned an electric haulage gear. This consists of a cast-iron bed-plate, fitted with drum and gearing, and driven by a 25-h.p motor, the pinion on the motor shaft being of raw hide and gauging with a machine-cut spur wheel. The motor can run in either direction, the starting, stopping, and reversing are all controlled by a special liquid pattern starting switch. At the close of the exhibition the plant will be used for a subsidiary haulage at a colliery. The gearing was made by Messrs. Tickle Bros., Wigan, and it has been generally admitted to be a creditable piece of workmanship. Messrs. Corlett have also working a complete set of Grant's patent electric drilling plant, such as is now largely used for tunnelling work underground. The drill is of the rotary type, and is specially strongly built, the thrust collars being capable of taking as a working load a strain of seven tons. This drill can drill into the rock or stone usually met with in the coal measures. In this particular case the supporting column is placed horizontally for convenience of fixing, but in colliery work it is usually placed in the vertical position, supported between the floor

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and the ceiling. Wherever Messrs. Corlett have used this drill underground the colliery people find their tunnels can be advanced much more rapidly and much more cheaply than by hand labour. The machine is shown in actual work. Messrs. Corlett also have a small electric pump all self-contained, the pump being of the three-throw vertical type, having rams 4in. diameter by 6in. stroke, and capable of delivering 50 gallons per minute. The motor is mounted on an extension bed-plate and is of the three-phase type. This plant is one of two sets which will be installed in a colliery at the close of the exhibition. A duplicate of the motor is also shown taken to pieces, and it is worth noticing that there are no wearing parts to be renewed, the revolving part of the motor touching nothing but its two bearings. There is also shown a three-phase motor of 35 h.p., which will be used for driving an electric winding gear at a Durham colliery. There is also shown a main reversing controller for operating this motor, and also a safety switch for preventing overwinding. The motor will be fixed at the top of a staple, about 1½ miles from its generator. There is also a similar motor, but of 10 h.p. size, for driving a three-throw pump at the same colliery. On the stand there is a considerable collection of smaller articles, such as Messrs. Corlett's electric light fittings, specially designed for use in mines, also electric bells, telephones, and many other articles of interest, but too numerous to mention in detail.

Hastings.—The Town Council at their meeting on Friday last had before them a report from the Lighting Committee respecting communications received from Dr. Kennedy and Mr. Leonard Andrews, the borough electrical engineer. Dr. Kennedy had written some months ago to the committee pointing out that there had been scarcely any occasion during recent years to refer matters to him, and suggesting that it might be thought unnecessary to burden the undertaking with his retaining fee. The borough electrical engineer had also written resigning his appointment in order that he may devote his time to private practice, but intimating that he would be willing, should the Council desire it, to continue to advise them upon matters of importance in connection with the electrical undertaking. The committee recommended that both Dr. Kennedy's and Mr. Andrews's resignations be accepted; that a resident electrical engineer, who shall devote the whole of his time to the duties of the office, be appointed at a salary of £300 per annum, to advance by yearly increments of £25 to a maximum salary of £500 per annum, and that Mr. Andrews's services be retained as consulting engineer at a retaining fee of £100 per annum. It is proposed that all plans, specifications, and estimates, etc., shall be prepared by the new electrical engineer, and that these shall be submitted to Mr. Andrews to report upon. It is hoped by these means to ensure continuity of the present practice. The chairman of the Lighting Committee (Dr. C. H. Allfrey), in moving the adoption of the report, expressed regret that the private work Mr. Andrews had in hand rendered it necessary for him to resign his present appointment. Reference was also made to the progress that had been made since Mr. Andrews went to Hastings nine years ago. At that time there were only 108 consumers on the books of the undertaking, and the gross profit on the year's working was less than £250. This state of affairs was the result of 12 years' working. At the present time the undertaking can number 663 consumers, and it is estimated that the gross profit on the current year's working will be considerably over £7,000. The recommendation to retain Mr. Andrews's services was strongly supported by several members of the Lighting Committee, but was opposed by other members of the Council on the ground that it would be impossible to get a really good man to undertake the work if he realised he would be required to submit his schemes to his predecessor. Many of the members of the Electric Lighting Committee were in favour of appointing Mr. Dudding as the new resident electrical engineer. Mr. Dudding is at present the chief assistant engineer, and reference was made to the satisfactory manner in which he had managed the undertaking during the borough electrical engineer's absence in the States. The general feeling was, however, that the salary offered would be sufficient to induce a number of good men to apply who have had previous experience in the design, management, and control of a similar undertaking. After considerable discussion, the recommendations of the Lighting Committee, as set forth above, were carried.

Bermondsey.—The meeting of the Bermondsey Borough Council on Tuesday evening, the 21st inst., was chiefly occupied by the discussion of matters connected with the lighting of the district. Upon the recommendation of the Electric Lighting Committee it was resolved to apply to the Board of Trade for a provisional order authorising the Council to supply electricity for public and private purposes in the parishes of St. Olave and St. Thomas and St. John. These parishes have been added to Bermondsey under the London Local Government Act. The Finance Committee reported having had under consideration an estimate of £4,185 for the extension of arc lighting to nine streets. The annual charge for each arc lamp will be £20, and as the number of lamps to be erected will be 55, 1,200 c.p. each, and two incandescent lights of 32 c.p. each, the total annual charge will be £1,100. The number of gas lamps displaced will be 82 ordinary flat-flame burners, 13 c.p. to 14 c.p. each; 10 incandescent burners, 60 c.p. each; and six No. 4 Kern burners, 80 c.p. to 100 c.p. each, the annual charge for which is £267. 19s. The committee recommended that the estimate of £4,185 be made a charge on capital works account. Mr. Layman said the annual charge of arc lighting and the repayment of loan and interest would bring the cost to £1,237. 8s. 10d. a year, which was five times as much as they were paying now for gas. What would the ratepayers say to this? When the fact became known—and the local papers and the powerful trade organs of the gas industry would see to that—there would be meetings of protest, and the Council would have to face an agitation from ratepayers' associations and labour organisations. The recommendation was adopted. The same committee reported having had under consideration an estimate of £1,190 for the substitution of electric light for gas in 13 side streets. The number of gas standards proposed to be converted is 96, of which 81 are the ordinary flat-flame burners with a candle-power of 13 to 14 each, 12 No. 4 Kern burners with a candle-power of 80 to 100 each, and three No. 2 Kern burners with a candle-power of 40 to 50 each. It is proposed to substitute for each gas lamp two electric lamps of nominal 16 c.p. each, but in consequence of the silver backing it is proposed to use the power is intensified, the committee state, to the extent of 140 candles. The cost of the new lighting will be £384 a year (96 incandescent electric lamps at £4). The present cost of gas is £263. 2s. 10½d., made up as follows: 81 ordinary flat-flame burners, at £2. 15s.; 12 No. 4 Kern burners, at £2. 15s. 10½d.; three No. 2 Kern burners, at £2. 5s. 9½d. The committee recommended that the estimate of £1,190 be made a charge on capital works account. This was agreed to. Upon the recommendation of the same committee an estimate of £405 for extending distributing mains in 11 streets was made a charge on the same account. It was reported that the number of equivalent 8-c.p. lamps applied for by private persons during the past fortnight was 1,175, making a total of 9,500 8-c.p. lamps applied for to date. A letter was received from the secretary of the County of London and Brush Provincial Electric Lighting Company, Limited, stating that the directors are not disposed to make an offer to sell the Council their undertaking under the St. Olave Electric Lighting Order, 1896.

Launceston (Tas.).—From the annual report of Mr. W. Corbin, M.I C E., M.I.E.E., the city electrical engineer, we note that during the last 12 months (the fifth year of working) the output from the Corporation's station exceeded 1,000 000 units, being 95,000 in excess of the previous year, of which 44,000 were due to increased use of motors and heating apparatus. The number of motors has increased by 30 per cent., and the aggregate horse-power more than doubled, this increase including a 50-h.p. motor used for running the quarry stone-crushing plant. This was only started in December last, so that the average horse-power in use for the year has not increased in the same proportion as the total horse-power on Dec. 31. The receipts have, however, increased by over 50 per cent. The average price per brake horse-power per annum is an item worth noting, being the low figure of £5. 2s. 11d. The number of factories each using one or more small motors and employing a number of hands has increased, and the industries carried on are more varied than before—cabinet-making, wood-cutting, chaff cutting and bagging, oat-crushing, boot-making, flock-milling, coffee-grinding, hoisting, pumping, the manufacture of bicycles, poisoned wheat, soda-water, and picture frames, also printing, sausage-making, sewing machines for clothing, harness, etc., and more lately brush-making, are all represented. As regards heating, the flatiron is the most popular article in use. During the year the number of consumers using heating appliances increased fourfold, the total power in use for this purpose was trebled, and receipts increased by 80 per cent. Mr. Corbin's recommendations as regards providing for the rapidly increased demand on the plant received the careful consideration of the committee for many months. Finally it was decided that a second opinion should be obtained as to the class of plant, etc., with a view to confirming his views or otherwise. After some difficulty in finding an engineer qualified to give an opinion who was ready to come, Mr. A. C. F. Webb was chosen from several whose names were submitted, and he visited Launceston early in October, and reported to the Council shortly after confirming Mr. Corbin's recommendations in every particular. In November the Council instructed Mr. Corbin to draw up the necessary plans and specifications, and at the same time decided to send him on a tour of investigation to the other states with a view to comprising in the specifications any points that the latest Australian experience could furnish. He was further instructed to take particular note of the tramway systems of Sydney and Brisbane, and report on them in connection with the possible introduction of electric tramways in Launceston. The Council subsequently decided to adopt his recommendation to instal plant on the polyphase system, and specifications have been drawn so that each manufacturer may offer that solution of the problem which he thinks best. Briefly, the work contemplated includes new polyphase plant at the power station; a new transmission line; the removal of the present distributing station to the centre of the city (which will get over a difficulty now experienced in keeping the pressure at the lamp terminals constant over the whole system); and machinery for enabling the existing single-phase alternators to work in with the new plant where practicable. The cost per unit in 1901 was 1·254d. The financial result for 1901 works out as follows: gross profit on year's working, £5,657; less interest on loans, less interest receivable, £3,465; sinking fund contribution, £991—£4,456. Surplus for the year, £1,201.

PROVISIONAL PATENTS, 1902.

OCT. 13.

22198. Improvements in electrically-lit signboards and the like. George Smith, 57, Barton-arcade, Manchester.

22233. Electrothermic diffusers. Frederic de Mare, 56, Ludgate-hill, London. (Complete specification.)

22249. An improved method of and apparatus for the production of high-frequency electric currents. Robert Scharf, 1, Queen Victoria-street, London. (Complete specification.)

22255. Improvements in electric ignition devices for explosion engines. Karl von Dreger and Robert Friedlander, 4, South-street, Finsbury, London. (Complete specification.)

22262. Improvements in electrical conducting systems. Ignace Hippolyte Hegner, 18, Buckingham-street, Strand, London.

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22261. Improvements relating to the method of and apparatus for armouring electric cables and the like. Edwin Truman Greenfield, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

Oct. 14.

22280. Improvements in and relating to the electrification of long-distance ways generally known as railways, and also to the electrification of street and road tramways. Joseph Frank Smith, 67A, Corporation-street, Birmingham.

22286. An improvement in or relating to trolley-wire ears employed in connection with the overhead system of electric traction. Joseph Wilkinson, Gough-chambers, Savile-street, Hull.

22296. Improved method of and means for cooling armatures and other parts of motors or dynamos. Martin Kuhl, 9, Tempest Hey, Liverpool.

22313. The "Massey automatic electric signal" for tramways or railways. Izmay Massey, 7, Windsor-crescent, Mannamead, Plymouth.

22334. Improvements relating to sparking plugs for the electrical ignition apparatus of explosion engines; particularly applicable for use in conection with motor road vehicles. Archibald Ford, 34, Castle-street, Liverpool.

22336. Improvements in electrical signalling apparatus for transmitting orders or signals from one remote point to another. Albert Frederick Hauss, 52, Chancery-lane, London. (Complete specification.)

22344. Improvements in coin-freed electricity vending machines. Frank Harvey Urry and William Haydon, 22, Church-street, Islington, London.

22346. An improved apparatus for indicating the presence of leaks on electric circuits. Reuben James Bott, 11, Southampton-buildings, Chancery-lane, London.

22352. Improvements relating to apparatus for locating breaks and grounds in electric circuits, or for comparing the resistance of one circuit with that of another. Matthew Jervis Myers, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22356. Improvements in retarding devices for use in connection with electrical measuring and like instruments. Adelbert Oswald Benecke, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

Oct. 15.

22400. An improved electric lamp for use on cycles, motorcars, and other vehicles. Robert Sinclair, 100, Wellington-street, Glasgow.

22421. Improvements in electrical switches. Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford. (Complete specification.)

22426. Galvanic double battery. Herman Bley, 101, Chausseestrasse, Berlin.

Oct. 16.

22503. Improvement in electric and other tramcars. Joaquim Antonio de Macedo, Leventhorpe Hall, near Leeds.

22505. Improvements relating to electrical interrupters or make-and-break devices for induction coils, and for producing electrical discharges. Edward Ernest Bartlett, 10, St. George's-crescent, Liverpool.

22532. Improvements in incandescent electric lamps. John Joseph Rooney, 321, High Holborn, London. (Complete specification.)

22551. Improved electric signalling system. Charles Willard Mills and William Walter Piddington, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22555. Improvements relating to electric insulating material. Isaac Shimwell McDougall, 18, Southampton-buildings, Chancery-lane, London.

22556. Improvements relating to electric insulating fabrics. Isaac Shimwell McDougall, 18, Southampton-buildings, Chancery-lane, London.

Oct. 17.

22580. Improved method of protecting electric cables. Drake and Gorham, Limited, 66, Victoria-street, London.

22615. Improvements in insulated connections for electric cables. Lancelot Walter de Grave, 9, Irongate, Derby. (Complete specification.)

22635. Antiseptic telephone mouthpieces. William M. English and George A. Burns, 36, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 28, 1901, being date of application in United States.) (Complete specification.)

22649. Improved method of and appliances for operating trolley line and other switches. Philip Henry Dawe, 173, Fleet-street, London.

Oct. 18.

22657. Improved means for applying electricity to the human body. John Wilson Gibbs, Fife House, Kingston-on-Thames.

22675. An improvement in electric trolley heads with a wire-finding apparatus attached. John Thomas Cherry and Edward Henry Clive, 2, Bedford-park, Plymouth.

22676. An improved house fuse-box. Charles Henry Naylor, 96, Elliscombe-road, Old Charlton, Kent.

22705. Improved electric motorcar. Heinrich Wilhelm Hellman, 7, Zinzendorfstrasse, Berlin.

22712. Improvements in and connected with alternate-current motors. Valere Alfred Fynn, 70, Chancery-lane, London.

22724. An improvement in electromagnets. George Hollingworth, 110, High-road, Willesden, London.

22732. Improvements in and relating to electric switches. Arnaldo Paolo Zani, 18, Southampton-buildings, Chancery-lane, London.

22750. Improvements relating to electric illuminating devices, chiefly designed for use in connection with signs or the like on tramway and other vehicles. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Reversible Electric Car Sign Company. United States. (Complete specification.)

22751. Improvements relating to electric illuminating devices, chiefly designed for use in connection with signs or the like on tramway and other vehicles. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Reversible Electric Car Sign Company, United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov 6.

1901.

14219. Means and apparatus for operating and controlling telegraphic and other apparatus or mechanism from a distance without wire or other like connections. Armstrong and Orling.

18105. Coherers or detectors for electrical waves. Marconi. (Solari.)

21205. Electricity meters. Lorrain. (Macdonald.)

22033. Alternating electric current motors. Hobart.

22808. Means for working signal and points on railways electrically. Timmis.

22888. Electric railways. Wise. (Maschinenfabrik Oerlikon.)

23214. Manufacture of a material for incandescent electric lamp filaments. Siemens Bros. and Co., Limited. (Siemens und Halske, Actiengesellschaft.)

23423. Means for supporting and insulating the trolley wires of electric tramways on the overhead trolley wire system. Ullman and Barber.

28934. Automatic electric switches and like apparatus. Charlton and Barton.

26237. Accumulators or secondary batteries. Blanc.

1902.

2058. Rail bonds or connecting strips for the rails of electric railways. Blanchard.

12780. Telephone installations. Hardegen.

14297. Electric time switches. Heath.

14947. Electric systems. Baudry. (Date applied for under International Convention, Dec. 14, 1901.)

15124. Wearing apparel for protecting from electric currents under high voltages. Artemieff.

16394. Electric resistances and method of using same for electrical measurements. Addenbrooke and Robinson.

16837. Framing of dynamo-electric machines and electrometers. Siemens Bros. and Co., Limited. (Siemens und Halske, Actiengesellschaft.)

18341. Telephone installations having a central microphone battery. Siemens Bros. and Co., Limited. Siemens und Halske, Actiengesellschaft.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7¾-8¼
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	101-103
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	½-1
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1½
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16¼
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2¼-2¾
—— 5 per cent. Debentures	100 ..	101-106 p.e
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10½
—— 4 per cent, 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16-17
—— 4½ per cent. Preference	5	5½-5⅝
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	98-102
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	12½-13
Brisbane Tramways Invest., Lim., Ord., 1-75,000	5	3½-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9½-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c xd
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13-14
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12½-13
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅜-1½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5½
—— 5 per cent. Deb. Stock, Red.	100	104-107
—— Prov. Cert., all paid	100	98 101
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4⅞-5⅛ xd
—— 4 per cent. 1st Mortgage Debentures	100	101-104 xd
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95 98
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4⅛-4⅜
—— 4 per cent. Debenture Stock	100	95-98
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	11½-12
—— " " " "	5	8¾-9⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	107-109
—— " " Prov. Crts.	50	81-83
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8½-9⅝
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	16s.	3 16
—— £50,000 " "	1	1
—— £500,000 4½ per cent Debenture Stock	80 p.c.	80 p.c

Electric Railways.—

Central London, Ordinary	100	104-107
—— 4 per cent. Pref.	100	107-110
—— " " deferred	100	105-108
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	71-73
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	91 94

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	105-108
Bournemouth and Poole, Ordinary	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	9½-10⅛
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	10½-10⅝
—— 7 per cent. Preference	5	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7½-8½
—— Nos. 20,001-30,000	5	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " £10 Ord.	6	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	105-109
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4⅞-5⅛
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5½-6
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104-107
County of London and Brush Provincial, Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6½-6⅝
—— 6 per cent. Cum. Pref.	5	6-6½
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3½-4⅛
—— 5 per cent. Debenture Stock, Red.	100	98-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5⅜-6⅛
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8 xd
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10⅛
London Electric, Ordinary	3	1⅜-2⅛
—— 6 per cent. Pref.	5	4⅛-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15⅛-16⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	110-113
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9⅛
—— Preference	4	6½-6⅝
Notting Hill Electric Lighting	10	13½-14⅛
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oriental, 1879	1	—
—— £5 Shares	5	—
—— £4½ Shares, New	4½	—
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1⅜-2⅛
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2⅜-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	15-16
—— 7 per cent. Pref.	5	8½-9½
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3½-4⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3½-4⅛
Westminster, Ordinary	5	11½-12½
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	6-6½

Telephones.—

National Telephone, Preferred	100	93-95
—— Deferred Stock	100	56-58
—— 6 per cent. Cum. First Pref.	10	12½-13½
—— 6 per cent. Cum. Second Pref.	10	11½-12½
—— 5 per cent. Non. Cum. Third Pref.	5	4⅝-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	96 99
—— 4 per cent. Deb. Stock. Red.	100	102-106
Oriental Telephone and Electric Company	1	⅛-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1902.	1901.	Week	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 18	925	685	+ 239	+ 5,377	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	,, 18	5,229	4,834	+ 395	+13,680	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	,, 10	760	690	+ 70	+ 3,521	24	—		26,064		738,557	—	11·86	1,085	—
Blackpool Corporation	,, 16	507	489	+ 18	—	16½	—	Mar. 31	41,818	5,809,190	753,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	,, 18	306	300	+ 6	— 308	16½	—	Dec. 31	31,331	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	,, 19	1,572	1,533	+ 39	+ 2,967	32	—		77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	,, 19	3,363	1,187	+2,176	—	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57ᵃ
Bristol Tramways Company	,, 17	4,805	4,040	+ 765	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	Sept. 20	195	180	+ 15	+ 450	—	—	,, 31	8,675	2,010,873	323,044*b*	1·03	6·46	—	4·65
Central London Railway	Oct. 18	6,971	6,326	+ 645	+ 8,906*b*	12	12	,, 31	335,086	41,188,389	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	,, 19	3,273	2,071	+1,202	+15,527	12½	9½	,, 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	,, 16	682	454	+ 228	+ 5,128	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	,, 18	204	218	— 14	+ 57	4½	—	,, 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	,, 18	102	102	— 6	+ 13*b*	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	,, 17	4,093	3,514	+ 549	} + 1,236	46	46	,, 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	,, 17	836	781	+ 55				May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Dundee City Tramways	,, 15	831	704	+ 177	—	22	—	,, 31	532,146*c*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Glasgow Corporation	,, 18	12,630	13,657	— 917	—	104	95	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,950	9·67
Halifax Corporation	,, 8	1,105	1,019	+ 86	+ 2,105	27½	18½	Sept. 30	29,061*b*	4,649,813	626,031	1·5	11·14	600	11·29
Huddersfield Corporation	,, 18	1,100	904	+ 196	—	48	48	,, 30	72,331*b*	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Hull Corporation, E. S.	,, 18	2,495	2,210	+ 284	+ 2,134	19	9½	Dec. 31	87,707	21,065,939	2,218,696	1·11	9·49	5,004	5·07
Liverpool Corporation	,, 11	9,873	9,260	+ 613	+31,157	93	78	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Liverpool Overhead Railway	,, 19	1,520	1,461	+ 59	- 1,146	15½	15½								
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Sept. 20	1,831	1,003	+ 828	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Oct. 19	4,117	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	,, 16	991	892	+ 98	—	11	—	,, 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	,, 19	1,080	1,073	+ 7	—	19	17	,, 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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NOTES.

Institution of Electrical Engineers.—The opening meeting of the new session of the Institution is fixed for Thursday, Nov. 13, at eight o'clock, when the premiums awarded for papers during the session 1901-02 will be presented, and Mr. James Swinburne, the president, will deliver his inaugural address. The students' section opens its winter meetings on Wednesday, Nov. 5, with a paper by Messrs. H. A. Pickett and A. B. Scorer, on "Steam and Electrical Exhibits at the Wolverhampton Exhibition."

Institution of Junior Engineers.—By permission of the Bridge House Estates Committee the members of the above institution recently paid a visit to the London Bridge widening works, and had the opportunity of witnessing the erection of the last girder of the temporary footbridge. The resident engineer, Mr. W. B. Cole, A.M.I.C.E., showed the party over the works, which are being carried out with the object of widening the footways of London Bridge from the present width of 9ft. 6in. to a width of 14ft.

Liquid Air.—Dr. Carl Linde, the well-known scientist, of Münich, will read a paper on "The Technical Application of Liquid Air" on Wednesday evening, Nov. 5, before the Cold Storage and Ice Association at the Institution of Mechanical Engineers, the hall of which has been kindly lent for the occasion. In the absence of the Hon. Alan de Tatton Egerton, M.P. (president of the association), Mr. T. B. Lightfoot will preside. Communications respecting the meeting should be addressed to the hon. secretary, 19, Ludgate-hill, London, E.C.

"Proceedings of the American Institute."—The American Institute of Electrical Engineers has issued its *Transactions* for June and July last. A large number of papers and the discussions of papers are embodied in this issue, which is unusually bulky. Chief among the former are the following: "The Electro-Chemical Industries," by Mr. S. Sheldon; "The Electric Furnace in Industrial Chemistry," by Mr. Chas. B. Jacobs; "Electrolytic Conduction without Electrodes" and "Liquid Potentiometer, by Mr. C. Hering; "Electrolytic Recovery of Copper from Low-Grade Ores," by Mr. N. S. Keith; and "Some Common Faults in Exterior Illumination," by Mr. S. Everett Doane.

A Tidal Waters Power Scheme.—We understand that a proposal is on foot at Hikuraki, in New Zealand, for the utilisation of the tidal waters of the place in the generation of electricity. The plan is to build a tunnel through a narrow neck of land at Pelorus Sound 88ft. in length. The rise and fall of the tide at this place varies from 6ft. and 7ft. to 10ft. and 11ft., and the tunnel would, it is said, command 50,000 acres of tidal water. It is not stated how the power would be generated, but presumably the tunnel would be made below the level of the lowest ebb tide, and turbines would be installed at either end of the tunnel. The scheme has been taken up by a local company, which has a capital of £75,000.

International Fire Exhibition.—The electrical section will be a distinctive feature of the forthcoming fire exhibition at Earl's Court. It will comprise primarily fire-calls and fire-alarms, but at the same time will include exhibits of systems of insulation, cut-out apparatus, and other protective devices. Mr. James Swinburne (president of the Institution of Electrical Engineers) has accepted the chairmanship of this group, of which the deputy-chairman is Mr. Lionel Langridge, whose name has long been associated with the question of electrical risks in insurance. Among the members of the advisory council there are also to be found the names of two notable electricians in Sir W. H. Preece and Prof. Ayrton.

Electricity in Mines.—A committee has been appointed by the Home Secretary to enquire into the use of electricity in mines and the dangers attending it, and to report what measures should be adopted in the interests of safety by the establishment of special rules or otherwise. The committee consists of Mr. H. H. S. Cunynghame, C.B. (legal assistant, Under-Secretary of State for the Home Department) (chairman), Mr. Charles Fenwick, M.P., Mr. Archibald Hood (past president of the Mining Association of Great Britain), Mr. James Swinburne (president of the Institution of Electrical Engineers), and Mr. W. N. Atkinson and Mr. A. H. Stokes (his Majesty's inspectors of mines). The secretary of the committee is Captain A. Desbrough, one of his Majesty's inspectors of explosives, Home Office.

Diffusion of Hydrogen through Platinum.—In describing some experiments in this direction, Mr. A. Winkelmann states that the rate of diffusion of the hydrogen increases after the platinum has been treated for some time. It is proved that this is not due to expulsion of occluded air, but to the crystalline structure assumed by the metal. When the platinum has passed into this state, it persists therein. The diffusion of hydrogen through red-hot platinum is not proportional to the pressure of the gas, but it is probable that the diffusion is accompanied by a dissociation of the molecules, and only the atoms of hydrogen pass through metal. The results agree with the formula obtained in previous experiments. The present experiments were made with a platinum tube 19cm. long, 1mm. in diameter, and 0·1mm. thick in the walls. The metal was heated electrically.

Berlin High-Speed Trials.—The electric high-speed trials on the Berlin-Zossen military railway have been resumed with a new type of motor designed by Messrs. Siemens and Halske, of Berlin The forward end of the motorcar has been made parabolic in shape, in order to lessen the wind resistance, and the heavy transformers previously used to reduce the pressure of the current from 10,000 volts to 2,000 volts are now dispensed with entirely. Current is thus delivered to the motors at the line voltage. This and a reduction in the size of the motors will have the important effect of lessening the deadweight of the car. The experimental track has been relaid with heavier rails, and it is anticipated that these and other alterations in the conditions of the previous trials will allow of a higher rate of speed being attained, approaching 125 miles an hour. Up to the present the maximum speed on the preliminary trials has been 85 miles per hour.

Telegraphs to the Far East.—Replying to Sir Edward Sassoon in the House of Commons on Tuesday, the Postmaster-General said he was aware that cable rates from Hong Kong to England *vid* the Great Northern line are practically double those charged from Hong Kong to Russia. Mr. Chamberlain added that it was in accordance with a well-established principle of the Telegraph Convention that adjoining countries like Russia and China or China and British India may make arrangements between themselves for lower rates than those which are generally applicable; and Hong Kong, as forming geographically part of China, has been brought within the terms of the special agreements regulating telegraphic rates between China and Russia on the one hand and China and British India on the other. These and other charges had been under the consideration of the Colonial Office and the Post Office, and he hoped that it might be possible to reduce the rate

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between this country and Hong Kong. The Great Northern Company did not possess a monopoly of landing rights in any British territory.

High Osmotic Pressures.—Some twelve months ago a method was described for the electrolytic deposition of an osmotic membrane in the wall of a porous cell. The highest pressure which had then been reached with such a cell was 4·5 atmospheres, the inability to withstand higher pressures being due, not to the weakness of the membrane, but to the difficulty of securing the manometer in the cell. Mr. H. N. Morse, in conjunction with Mr. J. C. W. Frazer, has now published an account of improved arrangements for securing the manometer, and of certain modifications in the construction of the cell. By means of the improved apparatus, with a normal solution of sugar, a pressure of 31·5 atmospheres has been attained. The osmotic pressure of a semi-normal solution of sugar at 20deg. was found to lie between 13 and 14 atmospheres.

Calculation of a Transmission Line.—In a paper read before the Pacific Coast Transmission Association, Messrs. Hutton and Crawell remark that since the discovery of great oil fields the use of fuel oil has begun to compete seriously with electric power in the West. They proceed to consider the design of a 50,000-h.p., 80,000-volt, 200 mile transmission line, and recommend using a pressure in thousands of volts equal to one third of the number of miles of the transmission line. Aluminium is assumed for the transmission wire, and four cases are analytically treated: First, two three-wire three phase circuits, operated at 60 cycles per second; second, two three-wire three-phase circuits, operated at 30 cycles per second; third, four three-wire three-phase circuits, operated at 60 cycles; and fourth, four three-wire three-phase circuits, operated at 30 cycles. The last system is the most suitable. For a plant of this size, where the bulk of its capacity would be used for driving motors, a frequency of 30 cycles, or even less, should be adopted, using motor-generator sets when lighting is required, thereby getting a much better voltage regulation for lighting than is shown in the average transmission plant of to-day.

The Dunedin Power Scheme.—Latest advices from Dunedin, New Zealand, fail to show any change in the deadlock which has arisen with regard to the water-power schemes for supplying electric light and power to the city. The trouble has its origin in the fact that the Corporation are unable to make up their mind as to which scheme to accept, although the matter has been under consideration for considerably more than a year now. In the meantime the construction of the electric tramways in the city is proceeding, and the Corporation have to make arrangements for a supply of current by the time the trams are ready for running. It has, therefore, become necessary to erect a temporary steam plant to work the electric system, although the hope was cherished originally that the water-power scheme would have made sufficient headway to enable a supply of energy to be obtained from this source for the tramways. Mr. Goodman, the engineer to the Corporation, is now in America, and he has been cabled to to secure the necessary machinery. We are sorry to see that the Corporation will obtain the temporary plant from the States, as it is desirable, for more reasons than one, that the British Colonies should place their orders with home manufacturers as far as possible.

New Wireless Telegraph System.—The interesting announcement was made in the early part of this week that the Eastern Telegraph Company has entered into an agreement with Mr. Nevil Maskelyne, son of the veteran Egyptian Hall entertainer, for a trial of a system of wireless telegraphy which Mr. Maskelyne claims to have invented. It was stated that the arrangement provides for the equipment of all the cable ships owned by the Eastern Telegraph Company with the new system. Enquiries at the offices of the company, however, have elicited the fact that the agreement has been arrived at merely from an experimental standpoint, and that an installation is to be set up at a point near Land's End. Two of the company's cable ships now lying in the Thames are also to be fitted with Mr. Maskelyne's apparatus, and the experiments are to take place as soon as weather conditions permit. In spite of Mr. Maskelyne's assertion that his system is superior to that which Mr. Marconi is now engaged in perfecting, the former assigns 50 miles as the practical limit for communication by wireless telegraphy. The principal improvements claimed to have been effected in the new system consist, according to the inventor, in the removal of the necessity for the vertical wire in the Marconi system and in the greater sensitiveness of the coherer.

An Interesting "Wireless" Installation.—It will probably not be generally known that at the present time there is in actual operation a wireless telegraph installation within the metropolitan area. It is to be found in the suburban seclusiveness of Streatham, and is used by the London County Council as a means of communication between the street fire station at Streatham green and the temporary sub-station in Mitcham-lane. For rather more than two years now the apparatus have been at work, but few of those, even residents in the neighbourhood, who read in the papers of the great achievements of wireless telegraphy abroad, knew of the installation which was operating in their midst. To the uninitiated, the "clicking" sounds which emanated from the street station when messages were being transmitted or received were of little or no consequence and excited no interest. The distance covered by this installation is very short—perhaps 100 yards or so—but in the two years it has been up it has done yeoman service, resulting in the saving of time in the turning out of appliances at the temporary sub-station. The instruments are supplied by Marconi's Wireless Telegraph Company, under an agreement with the London County Council, and the arrangement has just been extended for another year—until September next—when it is expected the permanent fire station in Mitcham-lane will be completed.

Electrolysis by Return Current.—Writing in a German contemporary recently, Mr. Larsen gave a good account of some experiments in which he investigated the question of how far the electrolysis of gas and water pipes by return currents of tramways can be diminished by changing the direction of the current at regular intervals. Two sets of tests were made; in one, the direction of the current was reversed once every hour, in the other once every day. The results seem very promising, for by reversing once a day the electrolytic action is reduced to one-fourth, and by reversing once an hour it is reduced to one-thirtieth. Moreover, if the direction of the current is always the same, the result of electrolytic action is that holes are eaten into the pipes, while with the current reversals the reduced electrolytic action which is still left is distributed more uniformly with considerably less bad effects. In some further experimental investigations by the author a piece of steel tube, 2in. in diameter, was placed vertically in the centre of an iron cylinder 10in. in diameter. There were nine cylinders, each one of which had its tube resting in an upright position on an insulating clay plate The space between the cylinders and tubes was filled with earth. Direct current was sent from the tubes to the outside cylinders, all these different "cells'

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being connected in series. The results show that the loss of weight per ampere-hour was practically the same under the different conditions of the experiments, and was independent of the current density, the voltage, the kind of iron, the percentage of sodium chloride, and of whether the circuit was continuously closed or periodically interrupted.

The Steam-Turbine.—The American Street Railway Association held its annual convention at Detroit on the 8th of the present month, and it speaks well for the growth of electric traction in the States that the attendance was the largest in the history of the association. The list of papers read was of a high order of merit, although a number of them were of quite local interest, having reference to the methods and practices followed in street railway operations in the States. There was, however, one very interesting paper of outside interest, which was contributed by Mr. E. H. Sniffin, on "Steam-Turbines." In this paper the author considered the general character of the turbine as a type of motor contrasted with the piston engine. He detailed a number of interesting installations of the steam-turbine, and gave data relative to its efficiency and the advantages of small floor space and its tendency to vary but little over wide ranges of load. From an abstract of the paper in the *Electrical Review* of New York, it was shown that with a unit as small as 400 kw., a result of 14·47lb. of steam per brake horse-power per hour may be obtained, corresponding to less than 13¾lb. per indicated horse-power. As the units become larger, the turbine is brought into comparison with the best engine practice. Here it still preserves its uniform efficiency, and its practical advantages are no less evident. The difficulties in the way of successful parallel running, he thought, cease with the turbine. There is no fluctuation of angular velocity. There is but one direction of motion, with no element to detract from even turning moment, and due to its speed there is stored up more flywheel effect than is present in the piston engine. As will have been gathered from the above remarks, the author was entirely in favour of the steam-turbine as the prime mover in electricity generating plants.

Electrolytic Manufacture of Chlorates.—In the current number of the *Electrical Review* of New York, Mr. J. B. C. Kershaw presents the first of a series of articles he is contributing to that journal on the electrolytic manufacture of chlorates. Mr. Kershaw is an eminent authority on electro-chemical matters, and his literary contributions are always interesting. In the present article he briefly describes the electrolytic method which is covered by the Gall and Mortlaur patents, and which is employed at the Valorbes Chlorate Works in Switzerland, and the St. Michel Chlorate Works in Savoy, France. Water power is employed in both instances, the horse-power available for the manufacture at both centres being between 3,000 and 4,000. The Société d'Electrochimie, of Paris, the company owning the Gall and Montlaur patents, having proved that the process operated successfully at Valorbes, built a second factory at St. Michel in 1894. At these works a head of 230ft. is obtained at the turbine-house. The water is taken from the River Arc at a point 1½ miles above the factory, and this water is conveyed by a tunnel 1¼ miles in length to the forebay at the head of the pipe lines. The turbine-house contains twelve 200-h.p. and four 400-h.p. turbines, direct-coupled to Thury dynamos of equivalent power. Since 1894 the company, it is believed, has adopted new methods of working the cell, laboratory investigations having shown that the presence of chromates and of hydrochloric acid in the electrolyte increases the yield of chlorate in a remarkable manner. The combined output of the two factories is probably now over 3,000 tons, but official confirmation of this figure is not forthcoming. Another patented procedure for the electrolytic manufacture of chlorates, known as the Carlsen process, has been operated at Manshoe, in Sweden, since 1894. At these works some 20 turbines are installed, the capacity of the plant being somewhere in the neighbourhood of 4,500 h.p. An annual output of 1,300 tons is maintained. A second chlorate factory has been started at Alby, in Sweden, where 1,200 h.p. is available, but no details of the process used have yet been published.

New Method of Starting Induction Motors.—An article recently appeared in *Elektrotechnische Zeitschrift* from the pen of Mr. A. Schwartz in which he described a new method of starting small induction motors, which is claimed to be a great improvement on those at present employed. The method in question makes use of the property of the alternating field to repel a conductor if placed unsymmetrically in this field. In its normal position the rotor of an induction motor is placed symmetrically, so that this repelling force is not evident. By shifting it a little axially and connecting the stator winding to the supply a strong repulsion becomes evident. With the rotor in this position it can be started by hand, a slight effort only being necessary. It will then come up to speed, the repelling forces of the alternating field being greater at this time, due to the heavy current flowing in the short-circuiting ring, than the attraction of the magnetic field for the iron core of the rotor. When, however, the rotor has reached it normal speed, the current flowing in its windings is considerably less than at starting, and the attraction of the magnetic field for the core of the rotor is greater than the repelling force acting upon the rotor windings. The rotor is then drawn strongly back into its normal position. This motion is made to effect the coupling of the motor to the driving shaft. The coupling is attached to the end of the rotor shaft, which must be extended for this purpose, and sufficient end play allowed between the bearings for this motion of the rotor. When the rotor is drawn into its normal running position, the coupling engages in the under surface of the driving pulley, and the machine then picks up its load. The action of this arrangement is claimed to be very sure, since the act of coupling does not depend so much upon the motion of the rotor as upon the relative forces acting upon this. The rotor is not drawn back into its running position until the current in its windings has diminished sufficiently to allow the attraction of the field to overcome the repulsion exerted on the windings. In starting the motor, the rotor is pushed axially a short distance, the main switch is closed, and the rotor given a slight motion by hand. The motor at once runs up to speed, automatically throws its coupling into gear, and picks up the load.

Tube Railways in London. — The failure this session of the capitalists to obtain parliamentary powers for a system of tubular railways to run through the heart of London from West to East, has emboldened the London County Council to take up the matter in a way which we think is to be strongly deprecated. In a lengthy report, which was submitted to the Council at their Tuesday meeting this week, the Parliamentary Committee sketched the history of the two Bills whose fate was decided by Sir Lewis McIver's Committee of the House of Commons in the early part of last week. We agree with the committee in the regret they expressed at the end of their report that the session of Parliament should have passed without any addition to the means of locomotion in London in the

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direction indicated by the Joint Committee of 1901, but we refuse to be convinced that "the question has become of such urgent importance that the Council should at once address itself to the problem of seeking for London some means by which to secure that the needs of the travelling public shall be adequately met." In our opinion, the Council is going quite outside its province in taking upon itself such work as this, which, in its early developments at least, should be left entirely to private enterprise. Further, it introduces a form of competition which would have most injurious effects, as we have time after time pointed out in this journal. We trust, therefore, that the Council will most seriously consider its position before taking steps to introduce a Bill on the subject in the next session of Parliament. But, in any case, we are confident that Parliament would not fail to hesitate before accepting an entirely new scheme promoted by the London County Council in opposition to the promoters of the older schemes, who have promised to amend and revive their proposals next year, and whose experience in these matters has been dearly bought by costly proceedings in the committee-rooms of the House of Commons. Lastly, a decision in favour of the London County Council would enable that body to compete with the existing railways, which are burdened with pioneering charges. This kind of competition has always been condemned by Parliament.

Long-Distance Transmission for Electric Traction.—Long-distance transmission from a steam station for electric traction is the exception and not the rule in the States, where in nearly all cases of the transmission of energy to long distances the station is worked by water power. There is, however, described in the issue of the *Electrical World* for the 11th inst. a very interesting case of long-distance transmission from a steam station, the main purpose of which is to operate electric car lines between a number of cities in New Hampshire, of which Portsmouth is the principal and the only seaport. Portsmouth, indeed, is the site of the generating station that operates electric cars in Nashna and Rochester, which two places are over 75 miles apart. The most distant end of the system is 50 miles away from the power-house, and accordingly the energy is transmitted at the high voltage of 13,200 volts. The total length of the line operated at this voltage is 65 miles, and branch lines raise this total to over 80 miles of high-tension transmission. Throughout the greater part of its course this 13,200-volt line does not follow the tracks of the tramways it is designed to feed, but takes, as a rule, the shortest course across country from one sub-station to another. A result of this plan is that a great part of the line is run over private land. As many as nine sub-stations are supplied by the high-tension lines, and the general plan of their arrangement is to decrease the number or size of conductors at each sub-station as the distance from the generating plant increases. At each sub-station the received energy after passing through the oil switches goes to transformers, that reduce the voltage from 13,200 to 380 for the rotary converters. These three-phase rotary converters, of which there are 15 distributed over the nine sub-stations, work at 25 cycles and deliver direct current at 600 volts to the trolley wires. All the sub-stations are devoted exclusively to the operation of the electric railway of the New Hampshire Traction Company, which has a total length of about 132 miles. A minor purpose of the transmission system is the general distribution of light and power to Portsmouth, Exeter, and Hampton, and other points where it may be desired.

Researches on Elements.—The current number of the *Journal* of the Chemical Society prints a long abstract of an account of the researches recently made by Mr. P. E. Berthelot on elements founded on the reciprocal action of two liquids. The first experiments are thus described: The amount of hydrogen evolved per minute in a voltameter when a current was passed through it was measured. In the circuit of the current, a known metallic resistance was interposed. Using two Daniell cells, and with the voltameter under the ordinary atmospheric pressure, there is no visible evolution of gas when there is a resistance of 5,000 ohms in the circuit. If the resistance is reduced to 2,000 ohms, the gas evolution commences, and 0·000187 mg. of hydrogen is evolved per minute. At 1,000 ohms, the quantity of hydrogen is 0·00037 mg. The pressure in the voltameter was reduced to 5mm., and the gas evolution then becomes apparent when the resistance is 25,000 ohms At 20,000 ohms, the hydrogen evolved per minute amounts to 0·000018 mg. The evolution of gas is produced with a smaller E.M.F. if the voltameter contains a substance, such as pyrogallol, capable of absorbing oxygen—a fact which is probably due to the diminution of polarisation. Using two Daniell cells and with pyrogallol in the voltameter, the evolution of gas is apparent when there is a resistance of 20,000 ohms in the circuit, and 0·000044 mg. of hydrogen is evolved per minute. With 10,000 ohms, the quantity of hydrogen amounts to 0·000087 mg. Employing a single Daniell cell, and with the pressure in the voltameter (containing pyrogallol) reduced to 5mm., the evolution becomes apparent when the circuit contains a resistance of 90,000 ohms. From these numbers it is evident that the presence of pyrogallol exercises a profound influence on the evolution of gas in the voltameter. After describing further experiments the author concludes that the number of elements required to give a visible evolution of gas in the voltameter can be ascertained from the formula $i = (N - 1{\cdot}6)/(2{\cdot}10\,N\epsilon/n - R)$, where i is the intensity expressed in amperes, ϵ the E.M.F. of one element, $N\epsilon$ that of N elements in series, n the number of scale divisions over which the galvanometer needle moves, and R the external residence. The values calculated from this formula agree well with the results previously found.

An Engineering Address.—The presidential address of Mr. John Tweedy to the opening meeting of the new session of the North-East Coast Institution of Engineers and Shipbuilders which was held at Newcastle-on-Tyne last Friday, has a considerable interest for engineers outside the membership of the society. In some prefatory remarks Mr. Tweedy referred to the great work achieved by the Hon. C. Parsons in his connection with the steam-turbine, which, he asserted, was now firmly established as a rival to the reciprocating engine. It is interesting to learn that the total of all compound parallel-flow turbines at work and on order for generating electricity reaches the large aggregate of about 300,000 h.p. Mr. Tweedy also referred to the application of the turbine to the steamship, and prophesied that we should see in the not far-distant future our largest vessels fitted with turbines. He next dwelt at considerable length on the organisation and training of the engineering *personnel* of the navy, and urged the necessity for reform in this direction. At present the engineer officer was not an officer of the military branch of the navy; he was not endowed with the necessary executive powers in his own department, which experience pointed out as being absolutely necessary for efficiency. He therefore expressed the hope that the Admiralty Board would strengthen itself in regard to this question by appointing a strong commission, composed of experts from the inside and a few competent persons from the outside,

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to consider and report upon the whole question. The president then took up the question of education in technical science. The intrusion of electricity into the various branches of industry made still higher demands on technical scientific acquirements; electricity had introduced new conditions; it had compelled engineers to introduce an exactness in design and construction of engines and machinery of all kinds hitherto unknown. If we were to maintain our position in the affairs of the world we should have to discard all prejudices and antiquated methods, and apply ourselves with diligence to the improvement of our educational machinery. We should have to prepare a foundation of sound, sensible, general culture on which to build a superstructure of technical scientific education higher and broader than exists at present in this country. Mr. Tweedy concluded his address by a brief reference to the shipping question. The report of the council, which was presented at the same meeting, showed that the roll of members of the institution lengthens yearly, while its finances continue in a healthy condition. The total membership at the present time comprises 1,163 names. Among the awards which have been made to the authors of papers read before the graduate section is one of the value of £2. 10s. to Mr. R. Robson, for his paper on "The Wiring of Ships for Electrical Installation."

Electrical Work in the Tropics.—Mr. Chas. H. Hines in the *Electrical World* gives some valuable hints to electrical engineers who are thinking of taking up the work of installing lighting and power plants in countries lying within the tropics. Mr. Hines is especially capable of speaking on this subject, since he was one of the pioneers in this particular line at a time when the field was new and untried. The first and most important thing to be considered in taking up this class of work is a thorough knowledge of the foreign language, for without that the engineer, no matter how great his ability, will find himself greatly handicapped. Before sailing, the engi neer should always go carefully over the list of materials sent, checking off all articles, and being sure that he has everything required to the very nails and screws. Arriving at his destination he will find that his machinery is generally handled in any way. He must personally supervise the unloading of the same if he wishes to preserve it unbroken. Then another important point is the question of health. If the place where he is located is unhealthy—and most tropical towns are more or less so—too much care cannot be taken until well acclimatised. Assuming the engineer on the ground where the plant is to be erected and ready to begin operations, then begins the test of his fitness for this class of work, as he finds that he must be in turn surveyor, mason, blacksmith, machinist, boilermaker, engineman, lineman, and a few other things, besides being an electrical engineer. Practically the greatest trouble to be encountered, however, is labour, and this varies greatly in different countries. In handling and erecting the heavy pieces the engineer is advised to see every hitch and tie made on all work, as otherwise disaster is sure to follow. In the matter of stringing wires, the fact of the great expansion during the intense heat of the day and contraction in the almost always cool nights must be taken into consideration, or trouble will ensue from the start, and, above all, the matter of protection from the heavy thunderstorms of the tropics must be given the most careful study, the very best arrester being employed. If the prime movers of the plant are wheels or turbines, another factor of trouble must be considered in planning the hydraulic part of the station, and that is the rapid rise that takes place in the streams after a heavy rainfall. But the troubles of the engineer are not over even with the completion of the power station. The difficulty mostly arises in connection with the native assistants, who, it seems, resent the authority of their chief after a few months' work. After starting up and getting the plant to run in more or less smooth shape, other troubles may arise out of the ignorance or superstition of the natives. Lamps are stoned and broken, lines cut, or poles uprooted, and for these troubles drastic remedies are needed. Truly, the lot of electrical engineer in the tropics is a hard one.

Electric Power Transmission.—Within the last year or two the physical limits of electric power transmission have been greatly extended, and in California, where much of the pioneer work was undertaken, there is to-day in actual operation a transmission line delivering energy 173 miles distant from the generating station. At present this is about the longest distance over which it has been found practicable to transmit electrical energy, but there are several schemes now in course of fulfilment in America which aim at breaking this record by the addition of many more miles. There is also one notable power transmission scheme in South Africa, the ultimate aim of which is to distribute power within a radius of 500 miles from the Victoria Falls. In view of these possibilities it is interesting to refer to a discussion of the physical limits of electric power transmission which is contributed by Mr. A. W. Adams to the columns of our American contemporary, the *Engineering Magazine*. It is admitted that power can be transmitted to any distance with constant efficiency and affixed weight of conductors, provided the voltage is increased directly with the distance. But the physical limits of transmission are those fixed by the practical voltage that may be employed. At the present time the highest voltage employed in the transmission of continuous currents is 22,000, and a system at this high voltage has been used in Europe. A practical voltage for alternating-current transmission, however, is 50,000 volts, which is in actual use on present transmission lines in the States. Large transformers are now being worked regularly at from 40,000 to 60,000 volts. Experimental transformers have, however, been designed and built giving voltages from 100,000 to 150,000, and the author sees no reason, so far as the transformer is concerned, why such voltages should not be used on transmission systems. To-day there are many transmission lines in the States employing 60,000 volts, but at this point leakage through the air between the conducting wires becomes very appreciable, and increases rapidly with an increase in voltage. This leakage can only be reduced by increasing the distance between the conductors. Results of some tests made on a Colorado transmission line show that at 40,000 volts the loss between two wires 15in. apart was about 150 watts per mile. At 47,300 volts, the loss between the two wires 15in. apart was 1,215 watts per mile, while an equal voltage on two wires 52in. apart caused a leakage of only 152 watts per mile. Three methods of line construction are suggested to reduce this leakage loss. First, by using heavy poles, the length of the cross-arms may be increased to 12ft. or 14ft. This would permit the three wires to be placed 10½ft. or more apart. The second suggestion is that two light poles be used with a cross-piece between them. In this way, with a 30ft. cross-piece, three wires could be kept 14ft. apart. The third suggestion is that each wire be carried on an independent toll line By this arrangement the distance between the wires might be anything desirable, according to the ground space available, and the physical limit of electrical trans mission would then be dependent upon the highest pressure at which transformers can be operated.

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THE CAUVERY POWER TRANSMISSION.

This interesting undertaking, belonging to the Mysore Government, is the first of its kind in India, and power is transmitted regularly by it over distances which have not been exceeded or even approached elsewhere within the British Empire. The undertaking was formally opened on June 30 last, when for the first time electric power was transmitted from the falls to the Kolar goldfields. Since then the Viceroy of India, Lord Curzon, has visited the works, and we, fortunately, have been able to obtain some photographs taken at the time of his visit. These, with the following description, will give our readers some idea of the magnitude of the work and of the difficulties which have been successfully overcome by the engineers connected with the same. The Cauvery power transmission undertaking differs essentially from any other that we know of, in that the whole of the output of the generating plant installed was taken up under a 10-year contract previous to any orders being given for the machinery. The Mysore Government was first advised as to the possibilities of transmitting power from the Cauvery Falls to the Kolar goldfields by Captain Lotbiniere in 1899. The distance over which the power has to be transmitted before any motors are attached to the lines is 92 miles. After reaching the goldfields the length of the distributing systems places the farthest motor considerably over 100 miles from the source of power. Captain A. C. Joly de Lotbiniere, the deputy chief engineer of the Government of Mysore, was authorised in 1890 to make a tour through the United States, England, and the Continent of Europe in order to investigate what had been done in a similar way elsewhere. Although he could not at the time see any power transmission scheme at work over the distance contemplated, what he did see was quite sufficient to warrant the work being undertaken soon after his return. The next step taken was the negotiation between the Government and the various gold mines on the Kolar fields. It was found from actual experience that the cost per horse-power per annum on these goldfields with steam as the motive power was about £31. After considerable negotiations an agreement was entered into by which no less than 10 of the companies agreed, under the advice of

FIG. 1.—One of the Cauvery Falls, "Gangan Chakki."

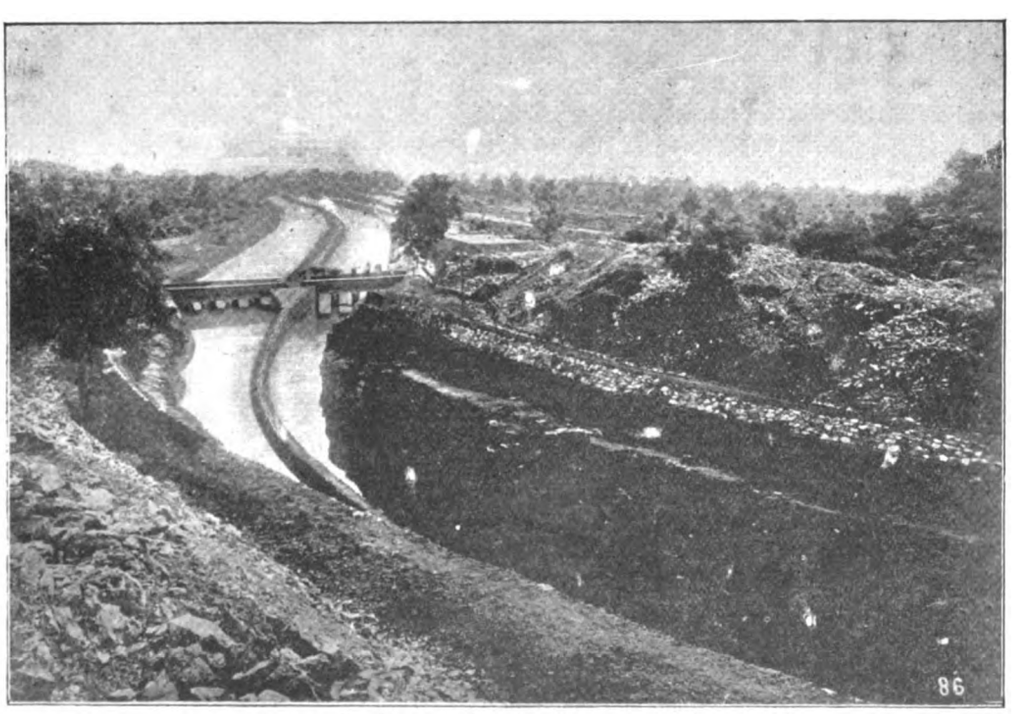

FIG. 2.—Typical View of the Twin Canals.

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their consulting engineers, to take power for 10 years from the Mysore Government at the following rates per horse-power per annum: £29 for the first year, £18 for the three succeeding years, and £24 for the fifth year. After the first five years the charge will fall to a uniform rate of £10 per horse-power per annum. It is estimated by the engineers that the higher charges during the first five years, besides making full provision for the working expenses and repairs, will enable the Government to recoup themselves for their capital outlay. At the end of the sixth year, at least, this will be the case, so that after that time the Government will have a large income entirely free of capital charges. Now that the plant is in working order it has been proved that the estimated saving to the gold-mining companies is more than realised. This is so because, apart from the saving in the cost per horse-power per annum, they find that they get considerably greater outputs from the plant in consequence of the steady and regular driving they obtain with electric motors. This increase in output is in certain cases as high as 15 per cent.

The power when delivered on the goldfields is used for two main purposes—*i.e.*, crushing gold quartz and the driving of the air-compressors, which work the compressed-air mining tools below the surface. In each case the labour arrangements are such that there is continuous load for practically the whole of the 24 hours. The only variable loads supplied are the motors for driving five lifts, and these form a small proportion of the total. The good load factor does not in this case bring in an increased revenue, owing to the system of charging a fixed rate per horse-power per annum, but it greatly facilitates the smooth working in the generating station. The Government not only provides the whole of the generating plant and civil engineering work at the falls and the transmission lines, but also the whole of the electrical gear on the goldfields. In consequence of this, the mining companies were not put to any appreciable outlay in making the change over from steam to electric driving. The motors now installed vary in horse-power from 5 to 400, and the average output is over 130 h.p. per motor. As a rule, induction-type motors are used, but some of the larger ones are of the synchronous type, which enables the lag of the current in the line to be adjusted. The capital outlay of the whole of the undertaking approaches very nearly £350,000, and under the agreement with the mining companies 4,000 h.p. has been contracted for for the next 10 years. This is practically the output of the present plant after making allowance for the loss in transmission. We understand that in exceptionally dry seasons more

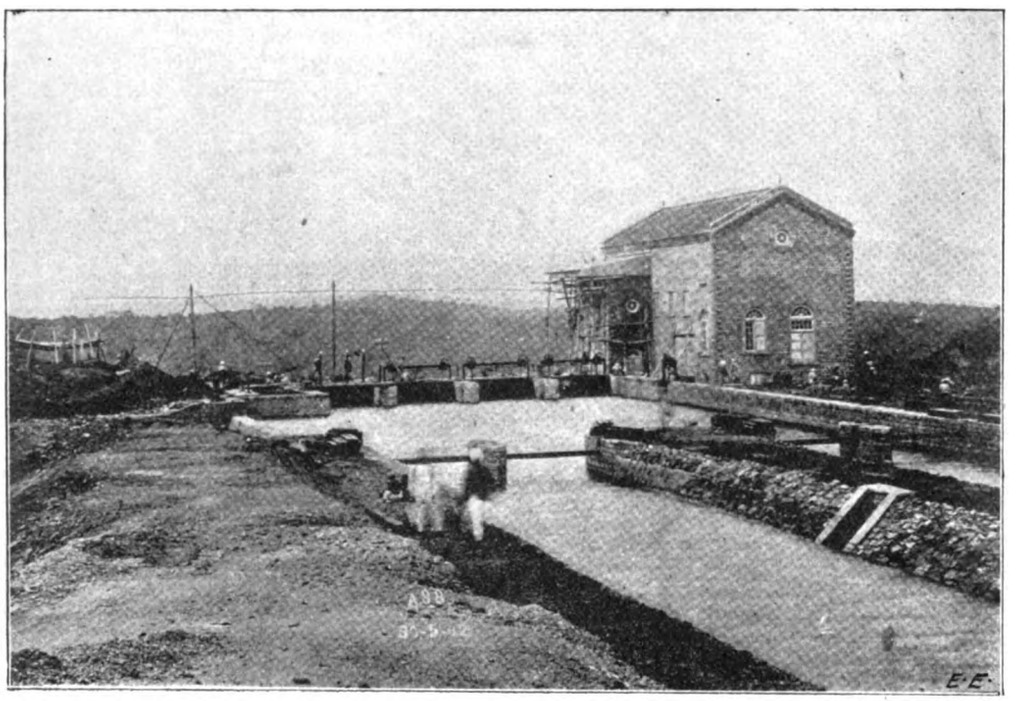

FIG. 3.—The End of the Canals, showing the Penstock Chamber.

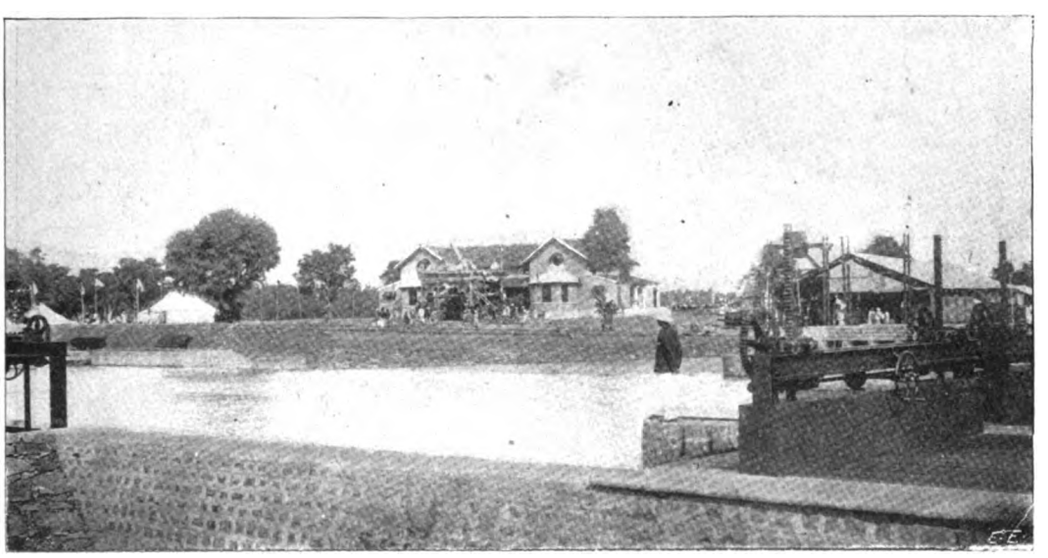

FIG. 4. View of the Canal from the Penstocks.

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power than this cannot be relied upon from the falls. It is likely, however, that considerable extension of plant will be made in the near future under agreements which permit of the supply being discontinued for short intervals during exceptionally dry years, when shortage of water occurs. It is interesting to note that the capital cost only averages £87·5 per horse-power available at the mines, or £118 per kilowatt.

The payment will not commence until five years from the date the works were started. In the river above the falls two low-level diverting dams have been constructed. The actual intake for the canal to the power-house is situated on the western branch of the stream, but the higher dam placed above the point where the river branches diverts the whole of the water into this western branch in dry seasons. In making this canal, which is 3½ miles in

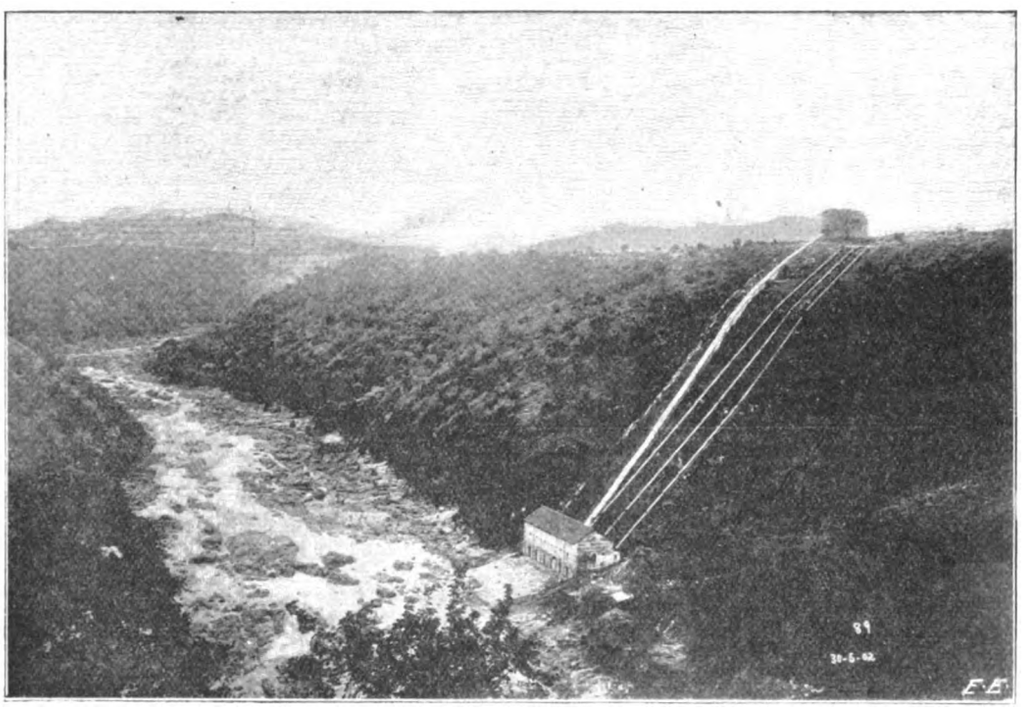

Fig. 5.—General View of the Cauvery River, showing Power House, Transformer House, Penstocks, and Pipe Lines.

Coming now to the power works at Sivasamudram, the Cauvery River is one of the largest in the southern part of India. It drains over 6,000 square miles before it reaches the falls which are utilised in this scheme. Just above the falls it divides into two branches, one of which goes on each side of the island of Sivasamudram. The illustration (Fig. 1) shows one fall situated in

length, the engineers responsible for the scheme have constructed a dividing wall, or an embankment, right along its centre, so that two separate intake channels are obtained, each of which is capable of taking enough water to supply the present plant. The object of the two independent channels so formed is that either one can be emptied for cleaning without interrupting the works. The

Fig. 6. The Pipe Lines, Cableway, and Tramway.

the west branch of the river. The intake works are so arranged that the whole of the water is available in times of drought. An interesting point arose in the earlier stages of the undertaking owing to the river forming the boundary line between the Madras State and the State of Mysore. An agreement was, however, come to by which all friction is avoided, by payment from the undertaking of an annual sum to the Madras Government.

widths of the beds of the channel are 18ft. in places where constructed in earth, and 12ft. where the channels are made through rocky formation. The sides of the channels have a slope of 45deg. in the earth cuttings, and are vertical in the rockwork. The normal depth of the water is 5ft. in each case, and with the sides as arranged the discharge per channel was calculated to be 250 cubic feet per second. The grade in the earthwork channels is only one-third of

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that in the rock cuttings. From trials made, however, since the works have been in operation, it has been proved that the channels are capable of discharging quite 50 per cent. more than the above.

In Fig. 2 we give an illustration of these twin canals taken from a point at which they are passing through rock formation. In this case the division wall is built up of masonry. In the section seen beyond the bridge the canals run through excavations in earth. In Fig. 3 is seen the end of this twin canal looking toward the penstock chamber, while Fig. 4 is a view taken the opposite way from the penstocks. In this the staff quarters can be seen. On the edge of the forebay (Fig. 3) is the transformer chamber, in which are placed the step-up transformers, which are to be described later. Means are provided at the intakes to these penstocks to prevent any floating materials from getting carried into the wheels. Fig. 5 gives a general view of the works, showing the pipe lines laid down the hillside. The length of these pipes down the side of the cliff is about 930ft, while the vertical drop is about 400ft. This gives an idea of the grade of these pipes which it is difficult to obtain from a photograph. Three steel pipes, each of which supplies two Pelton wheels, have now been fixed. They are 45in. diameter at the upper end and 36in. at the bottom, while the thickness of the steel varies from $\frac{1}{4}$in. up to $\frac{1}{2}$in. In consequence of their length three expansion joints are provided in each pipe, and anchorage is effected at three points as well. In Fig. 6 will be seen the system of supporting these pipes on masonry piers built up on the rock forming the hillside. The main valves at the head of each pipe are balanced and so arranged that they shut off the water in the event of a pipe breaking. The principle of this automatic action depends on the fact that if a serious fracture takes place in the pipe the water column will be interrupted, causing a partial vacuum at the top of the pipe. This operates on the valve and shuts off the water. There has been up to the present no trouble whatever with the pipework, which has been subjected in course of preliminary work to some considerable strain. By the side of these pipe lines will be seen two railway tracks, which are used for transport of staff and light materials up and down the side of the river gorge. The trucks on these are worked on the

FIG. 7.—Lord Curzon on his way to the Power House.

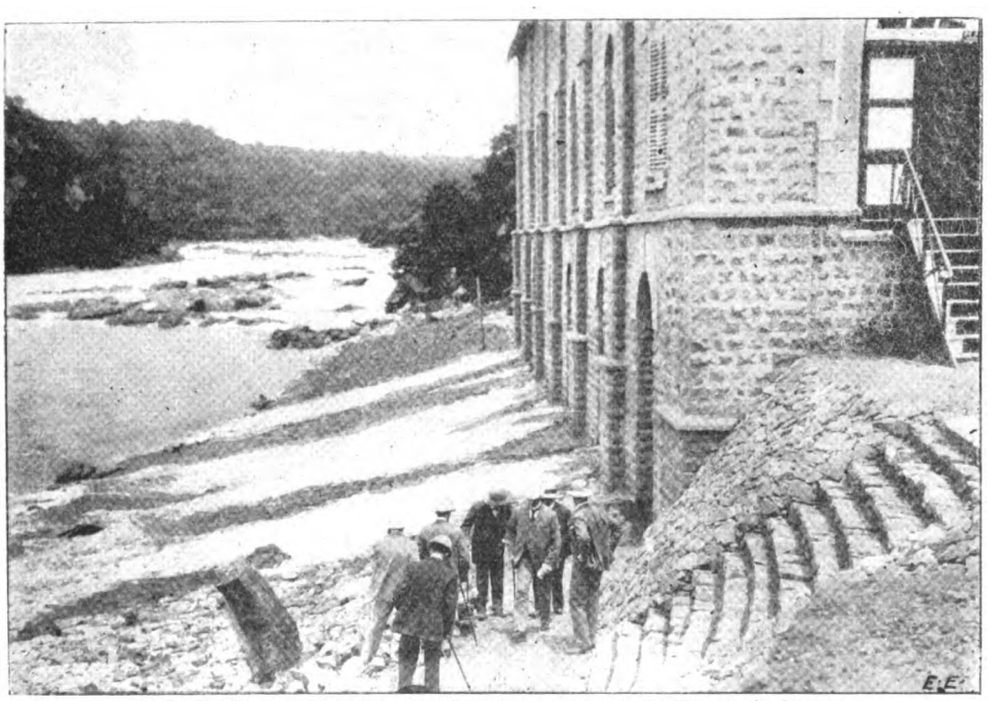

FIG. 8.—The Viceregal Party inspecting the Tail Race Returning the Water to the Cauvery.

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balanced principle, and are connected by a wire rope passing round a drum at the top. A tank under the car at the top is filled with water to give it the necessary weight to haul up the ascending car, and to overcome frictional resistances. In Fig. 7 we show the vice-regal party leaving the car in order to inspect the generating works. Lord Curzon is the second Englishman counting from the right

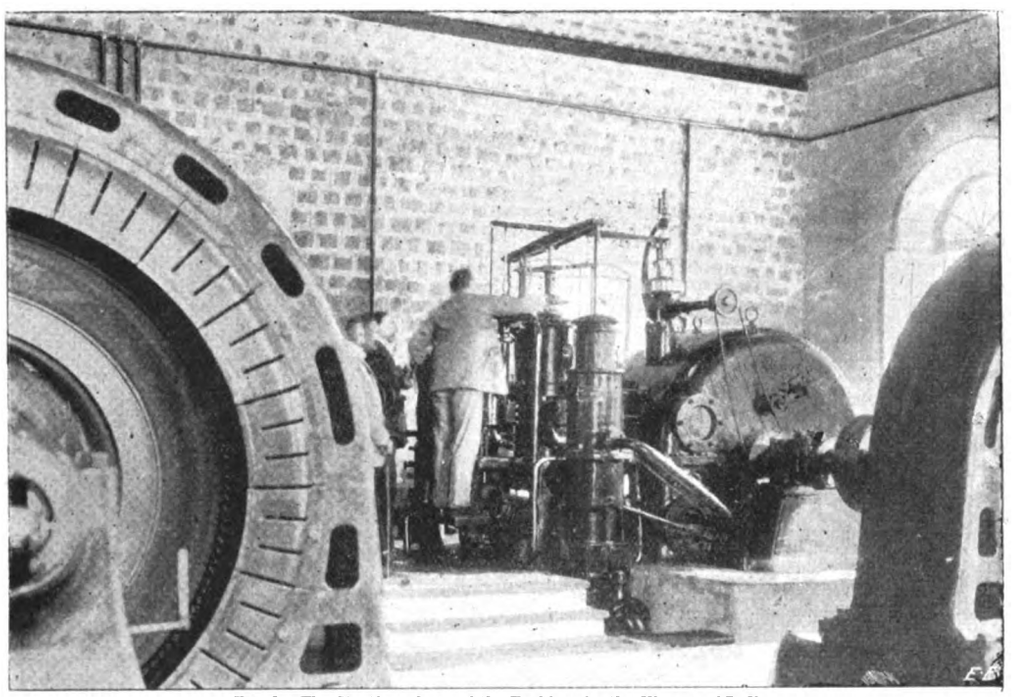

FIG. 9.—The Starting of one of the Turbines by the Viceroy of India.

in the group of five. In Fig. 8 the same party are to be seen inspecting the tail race.

The power-house equipment consists of six Pelton wheels, supplied by the well-known firm of Messrs. Escher, Wyss, and Co., of Zürich, while the electrical plant was all supplied and erected by the General Electric Company of America. Each of the six turbines is guaranteed to give 1,250 b.h.p. at the coupling, working with an effective head of 382½ft. The efficiency of these Pelton wheels, which are 60in in diameter, is guaranteed to be 75 per cent. at full load and 70 per cent. at half load. In governing this class of wheel working under high heads, it is of great importance that while the speed should be kept approximately constant, the governing shall not increase appreciably the water pressure in the pipe. We understand that the governors supplied by the Zürich firm provide that while the speed shall not vary more than 8 per cent. when half the load is suddenly thrown on or off, the pressure in the pipe shall not vary more than 5 per cent. up or down from the normal. Instead of deflecting the jets of water impinging on the revolving wheel, we understand that with these governors the size of the orifice through which the jet of water passes is varied. This is, of course, a much more economical way of governing than by keeping the volume of water constant and simply deflecting it in order to reduce the power, as is often done in the States. The fact that the makers can get 70 per cent. efficiency at half-gate is a proof of this. One of these turbines with its governor can be seen in Fig. 9. This photograph was taken at the instant when Lord Curzon was starting up the No. 6 set at the time of his visit to the works.

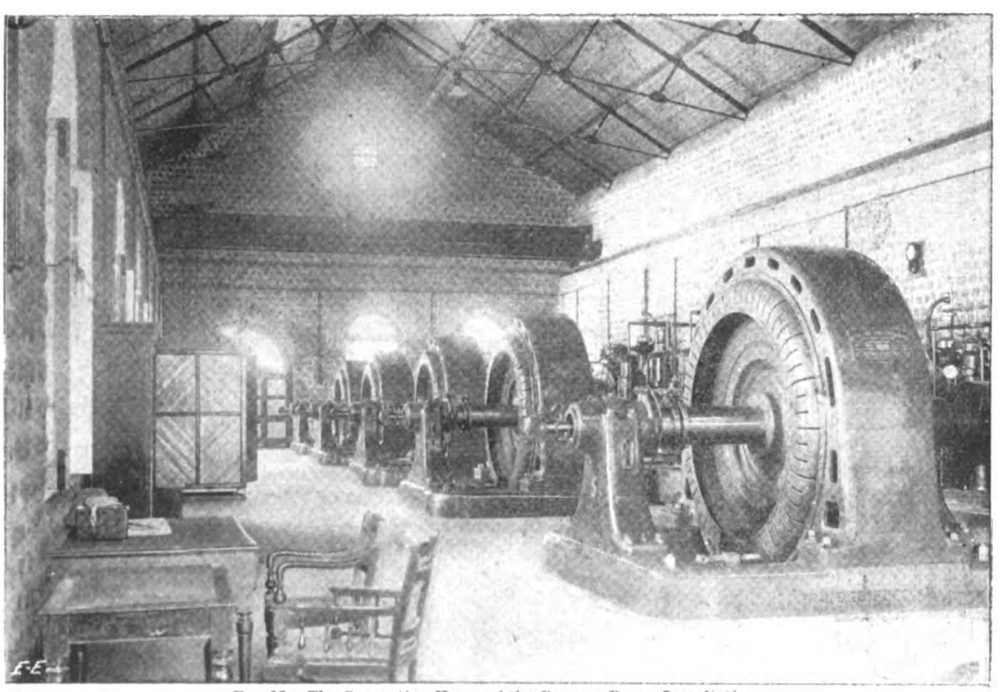

FIG. 10.—The Generating House of the Cauvery Power Installation.

The alternators (Fig. 10) are of the General Electric three-phase type with revolving fields. The output of each machine is 720 kw. at 2,200 volts. At the normal speed of 300 revolutions the frequency is 25 complete

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cycles per second. The excitation for the alternator fields is obtained from two 75-kw. direct-current dynamos, independently driven by two smaller Pelton wheels which run at a speed of 465 revolutions. The maximum output of the station can be supplied by five of the three-phase alternators, excited in parallel from one of the continuous-current machines. The other alternator and exciter will hence form the reserve in case of accidents. As will be seen from Fig. 5, the power-house is situated at a low level in the river gorge, and, unfortunately, malaria fever is prevalent in the district. In consequence the engineers who designed the scheme determined to so arrange it that as small a staff as possible should have to work at the low level. The transforming-up station is accordingly placed on the high ground, as are also the staff quarters. The current, generated at 2,200 volts, is carried by insulated cables up the masonry duct seen beyond the pipe lines in Fig. 6 to this transformer house. The inside of the duct is provided with a number of stone shelves, on which these cables rest. In the transformer house (Fig. 11) the voltage is raised from 2,200 to 30,000 for transmission to the goldfields. Twelve transformers, each of 400 kw. capacity, are provided for this purpose, and are arranged in groups of threes. In this case there is even more ample spare than in the power-house, as three of the transformers are not required at full load. These transformers are air cooled. The air-compressors for this purpose are electrically driven.

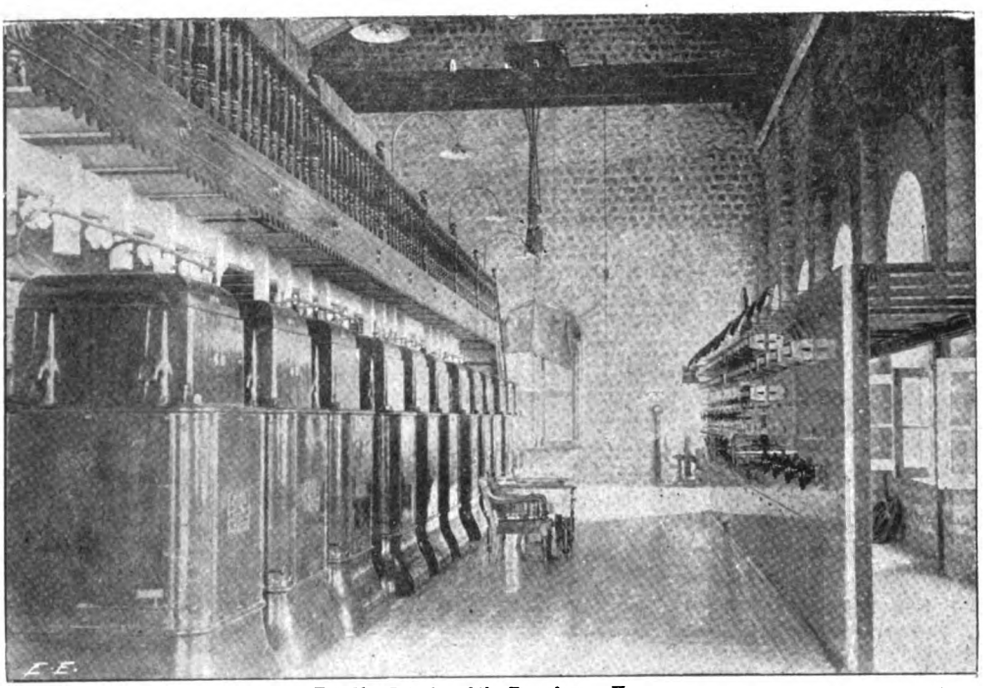

FIG. 11.—Interior of the Transformer House.

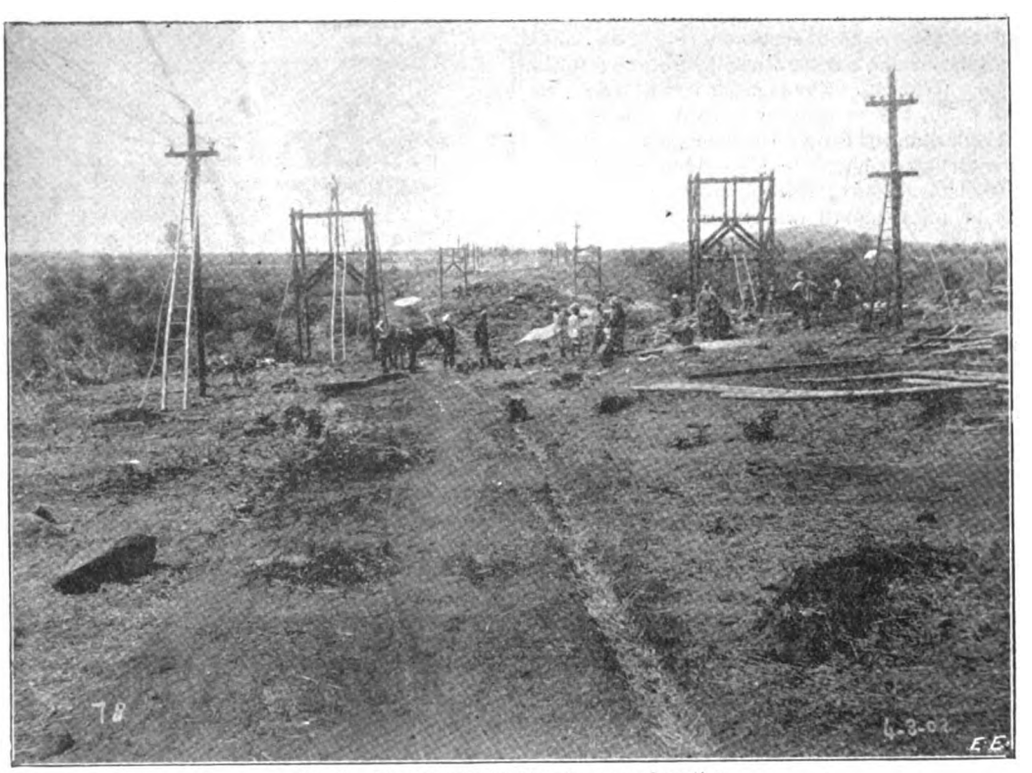

FIG. 12.—The Transmission Lines in course of erection.

Coming now to the line by which the current is conveyed to the goldfields, it will be seen that equal care is taken over this as over the generating works to guard against an accident to any part causing an interruption to the supply for any considerable length of time. Two totally distinct lines are provided, carried on separate poles placed 60ft. apart. These lines in course of construction can be seen in Fig. 12, which shows a part of the route

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where a river had to be crossed. In the general way the three line wires, each of No. 0 Brown and Sharp gauge, are supported on each pole on three insulators 3ft. 4in. apart from each other. The poles are made in two sections, the lower half being of steel, 13ft. in length. The upper part is of wood, 17ft. long and about 7in. in diameter. The placing of these poles was no easy task in many parts, as they frequently had to be sunk into solid rock. The wires at any point are never less than 20ft. from the ground level. The other structures seen in the illustration are for supporting the conductors crossing a river. In this case silicon-bronze wires are used instead of copper, and the supports each side of the river provide a horizontal distance of 10ft. between each conductor. The longest span which had to be erected was 525ft. On the one pole line additional cross-arms are provided on which telephone wires are carried In the first instance it was suggested that there should be stations along the line at which they could be interrupted for testing purposes and for linking up round faulty sections in the event of breakdowns. It was ultimately decided, however, that with this high voltage the additional switchgear at 30,000 volts would be a source of danger to the constancy of the supply. The lines as constructed, therefore, are not interrupted at all between the transforming up station by the Cauvery River until they reach the transforming-down station on the goldfields. Either of the lines will carry the whole of the power, but this involves, of course, a higher voltage at the generating works. Under normal conditions the lines are connected up in parallel, and the switchgear enables one faulty line to be quickly disconnected.

The transforming station on the goldfields is also equipped with 12 transformers, which reduce the received voltage to 2,300, which is the distributing pressure employed. A further reduction to 220 volts is made wherever small motors have to be supplied, but every motor taking 100 h.p. or more is wound for 2,300 volts. In the distribution system some 25 miles of line have been erected. As there are no Board of Trade regulations to the contrary in Mysore, overhead wires have been used throughout, the largest section being No. 0000. Extensive trials have shown that the loss between the generating station and the motors is approximately 20 per cent. This loss is quite permissible with transmission over practically 100 miles, and the whole scheme, which is now working satisfactorily, is a remarkable instance of what can be done by electricity in taking power from a point at which it is of no value to one where it is urgently needed.

It remains now to give credit to those who have been intimately connected with the undertaking from the start to the finish. Colonel D. McNeil Campbell, R.E., is the chief engineer to the State of Mysore. Captain Lotbiniere undoubtedly did the bulk of the pioneering work connected with the inauguration of the scheme, and he was strongly supported by the late Sir K Sheshadri Iyer, who was Dewan of Mysore. The resident engineer for the work was Lieutenant J. C. Hunter, under whom came a considerable staff of assistant engineers. Mr. Axel Ekstrom acted as chief electrical engineer on the works for the General Electrical Company of America, while Mr. W. Muller had charge of the water-power plant for Messrs. Escher, Wyss, and Co., of Zürich. The handling of the heavy machinery required over most difficult and ragged country was no slight task, but with the aid of elephants and oxen the transport was successfully carried out. The worst difficulties which the engineers had to face were epidemics of cholera and plague amongst the coolies, who had to be imported. Nearly 5,000 men were employed on the works in the early part of last year. The undertaking was officially inaugurated on June 30 last by Colonel Donald Robertson, C.S.I., the Hon. British Resident in Mysore. The current was then switched on by Mrs. Robertson, when power was transmitted for the first time to the Kolar goldfields. The value of the scheme to these goldfields is likely to be very great, and it is expected that during the next 10 years it will save them over half a million in working expenses. In spite of this saving, the rates charged for power are estimated to be sufficient to return to the State the whole of the capital expenditure in five years. Allowing ample margin for contingencies, this should induce other undertakings of a similar nature to be started in India and elsewhere

LEAVES FROM A TESTING ENGINEER'S NOTEBOOK.

BY FRED. W. DAVIES.

(Concluded from page 593.)

Field-Magnet Cores, Yokes, and Pole-Pieces.—It is not often that any defect is discovered in the core, yoke, or pole-piece of a field magnet; but even this occurs sometimes. Several machines—notably multipolars—have come under the writer's notice at different times, in which the permissible movement of the brushes, consistent with sparklessness, was very small indeed; so much so, in fact, that it was difficult to find a really sparkless position for the brushes at all. This was on account of the space between the tips of adjacent magnet poles (of opposite polarity) being too small. The defect was remedied in each case by cutting away the tips of the poles, as shown in Fig. 3.

A certain bipolar dynamo, having its field magnet made of soft Swedish iron stampings, was found to be very sluggish in the way it picked up and lost its magnetism. The voltage did not respond readily to changes in speed. This was due to the great remanence of the magnetic circuit, which, in turn, was caused by the low reluctance of the magnet cores and yoke, and of the air-gaps, which, it

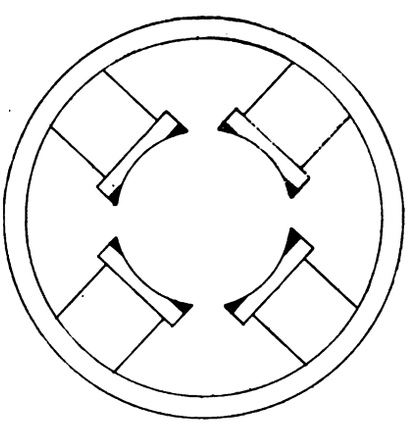

FIG. 3.—Showing, by the Shaded Portions, the Parts of the Poles that were Machined off.

should be stated, were rather short. The armature tunnel was bored out larger, thus increasing the length of the air gaps, which not only resulted in the voltage responding more readily to changes in speed, but also improved the commutation as well.

With a design of machine having a toothed armature core, it will sometimes happen that a shrill whistling sound, more or less loud, is emitted whilst running. This phenomenon usually accompanies a short air-gap, in which the magnetic induction is fairly high. It can usually be remedied by boring out the armature tunnel so as to increase the length of the air-gap. This will, inevitably, be accompanied by a slight increase in the speed. If it is desired to keep the speed the same, then it is necessary to make an alteration in the magnet winding, so as to compensate for the increased length of air-gap by a corresponding increase in the number of ampere-turns on the magnet.

Field-Magnet Windings.—The winding of a field magnet is more often the cause of trouble than are the cores, yokes, or pole-pieces, but the possible complications that may arise in connection with the magnet winding, although sometimes baffling to the uninitiated are few in number. A few typical instances illustrating some of the faults that may occur in a field-magnet winding are given below.

The shunt coil of a 400-volt, four-pole, enclosed motor became partially burnt out—that is to say, some of the insulation was charred. The cause of its burning out was that the leading-in wire was not sufficiently insulated from the rest of the coil. It was led to the inside of the coil down the side of the bobbin flange. It appeared that the current had arced across from this leading-in wire to some of the

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outer layers of wire in the first instance, and, having once been started, it is easy to understand how the arc would go on from bad to worse until a large portion of the coil was completely spoiled. This is no isolated instance. Such accidents are of comparatively frequent occurrence. The obvious and the only way to avoid them is to thoroughly insulate the leading-in wire, and also to place a layer of light insulation between each layer of wire on the coil.

Perhaps one of the most common mishaps in a shunt motor is for the shunt circuit to get broken. Especially is this so in small machines wound for 200 volts and over. The effect of a break in the shunt circuit of a motor is that the motor will run in either direction, according to the lead given to the brushes, the direction of rotation being the same as the direction of the lead given to the brushes. The torque is always very feeble. If working on a load, the motor will run at a very slow speed, but if running light, it will run at an abnormally high speed. Whether it is working on a load or not, the brushes invariably spark badly. A motor which is working under normal conditions and with the usual slight backward lead given to the brushes, will usually, on the shunt circuit being broken, commence to run backwards. When the shunt coils of a motor are intact, but connected up so as to make the magnet poles neutralise one another, it behaves as if there were a break in the shunt circuit. This contingency, however, is only likely to arise in a new machine or a motor which has been repaired.

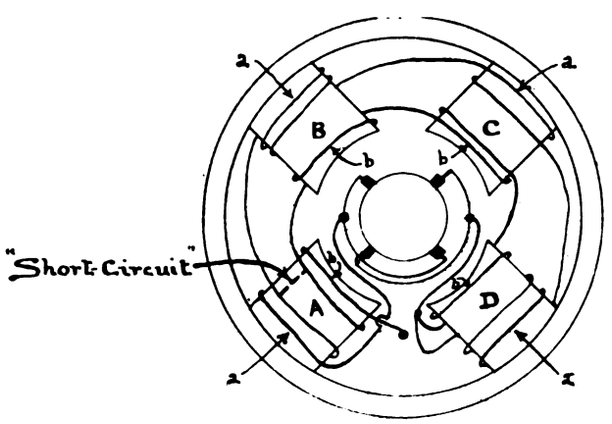

FIG. 4.—Diagrammatic Sketch of Field-Magnet, showing where "Short-Circuit" occurred (*a*, shunt coils; *b*, series coils.

One of the shunt coils of a compound-wound, four-pole generator (output 500 volts, 100 amperes, 550 revolutions per minute) suddenly began to get hot during the testing of the machine, and the brushes began to spark. It heated so much that it became necessary to shut down the machine. It appeared at first that this was due to the leading-in wire arcing to some of the outer layers of wire, or to internal arcing of the coil in some way—a point which has already been dealt with. With this idea in view, the warm coil was removed from the machine and partially unwound, but no trace of burning could be found, and, on its being tested, the coil appeared to be perfect in every respect. Ultimately, it was discovered that there was a "short" between the series and the shunt winding on one of the coils A reference to Fig. 4 will assist in making it clear where this occurred. The series coils, it should be mentioned, were wound on the top of the shunt coils, and both ends of the shunt coils passed between the series winding (which consisted of copper tape) and the bobbin flange. The "short" occurred between the series winding and the outside end of the shunt coil on the magnet core, marked A. The immediate result of this was to cut out the three shunt coils marked B, C, and D, and to throw the whole pressure of the machine (500 volts) upon the coil A, thus causing it to heat. Besides this, the distribution of magnetism in the magnet was altered, which was the cause of the brushes sparking. All of which shows how imperative it is that the insulation between the series and shunt coils should be good.

Generalities.—If the various parts of a machine are made to templet, and interchangeable, the centre of the armature will coincide with the centre of the magnet, and it will project to an equal distance beyond the magnet at each end. If, however, it is out of centre so as to project beyond the magnet more at one end than at the other, then it will be continually subjected to a longitudinal drag, tending to draw it to the centre. In one particular instance of this kind, due to faulty workmanship, the longitudinal pull caused the shoulder on one end of the shaft to grind into the bearing bush to such an extent as to necessitate its early renewal.

The method adopted for coupling a motor to its work is of importance, and influences very largely the performance of the motor. In one instance where spur wheels and pinions were used to transmit the power from some motors to countershafts, a great deal of trouble was experienced from the motors sparking badly at the brushes. The cause of this sparking was found to be that the countershafts (which carried the spur wheels) were not fixed securely, and owing to their not being rigid the teeth did not always engage to the same depth with the teeth of the pinions. This resulted in the load on the motors being in a state of continual change, and it was impossible to find a sparkless position for the brushes, for this position was not permanent. The remedy was to fix the countershafts rigidly.

A compound-wound dynamo, which was used for driving a motor of similar design, situated some little distance away, for some unaccountable reason failed to excite on one occasion. Although the field magnet was of cast steel, it seemed to have completely lost its magnetism. No fault could be discovered anywhere on the machine, and on imparting an initial magnetism to the field magnet from an independent source, it resumed its normal condition and gave its specified output without sparking, overheating, or any other defect manifesting itself. The reason why it lost its residual magnetism, and consequently failed to excite, was this: At the time of shutting down the motor was running light—that is, with its load thrown off—and instead of switching off the motor preparatory to stopping the dynamo, the engineer simply stopped the dynamo engine. The engine and dynamo soon came to rest, but the armature of the motor, having no load on at the time, kept on revolving for a little time after this. The motor, being shunt-wound (with only a few turns of series winding to assist it in starting), naturally operated as a dynamo whilst running thus, and sent a current back through the series coils of the compound-wound dynamo in the wrong direction. By this means the dynamo magnet was robbed of its residual magnetism, and had the motor kept on running longer, it is possible that the dynamo magnet would have been remagnetised with opposite polarity.

It is a bad plan to suddenly switch off a heavy load from a dynamo, as the sudden rise in voltage which invariably follows is liable to damage the machine. There are several factors which tend to cause a rise in the voltage on switching off the load. The first is that there will probably be a slight increase in the speed of the engine. The second is that the magnetic field in which the armature revolves will be more or less distorted whilst the load is on, owing to the reaction of the armature, and on switching off the load the lines of force constituting the field will instantly spring back to their normal position, snapping across the armature conductors in doing so, and thereby setting up an extra E.M.F. in the armature. Thirdly, and lastly, owing to their self-induction, an E.M.F., acting in the same direction as the original E.M.F., is set up in the armature winding and series winding (if there is one) on the main circuit being broken by the act of switching off the load.

Conclusion.—It remains now to offer a few suggestions as to the general testing and management of dynamos and motors. Before beginning a test, a point should always be made of seeing that everything works freely, that the brushes are all down on the commutator and pressing properly, and that all screws and nuts are properly tightened up. Commutators running with copper gauze brushes may be lubricated, if necessary, with a very little vaseline. For commutators running with carbon brushes a good lubricant, if any is needed, is a little paraffin wax. Finally, it may not be out of place to offer the suggestion that it is well to make a note of any peculiarity which may be noticed in a machine, together with the cause

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of the same. Such notes will be found to be of use in diagnosing any faults which may be met with afterwards.

AUTOMATIC PUMPING AT CARDIFF.

In connection with the introduction of electric tramways at the town of Cardiff, it was found necessary to have more headroom under the railway bridge crossing Bute-street. The lowering of the surface of the roadway interfered with the surface-water drainage, and special pumping arrangements were therefore necessary. Mr. W. Harpur, the borough engineer, decided to put in an automatic electric pumping plant, and made arrangements to take the current from the tramway power plant, which has been erected by Mr. Arthur Ellis. The pumps (Fig. 1), which are in duplicate, consist of centrifugal pumps coupled direct to electric motors. As space was very limited and no site could be found by the side of the road for a pumping-house, it was decided to construct a motor-chamber and sump beneath the road surface at its lowest point. The chamber is about 10ft. by 7ft. by about 12ft. deep. The lower part to a depth of 5ft. is used for a sump, and the upper part

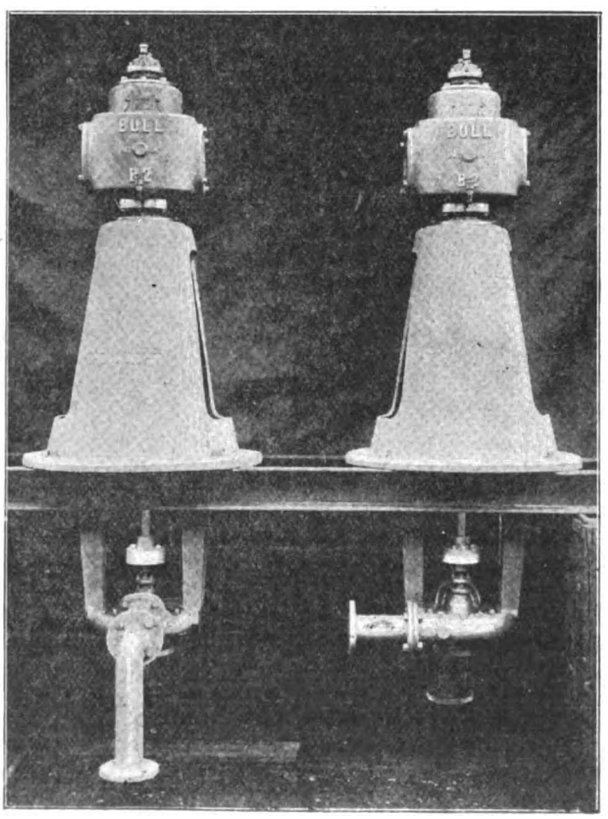

FIG. 1.—Electric Pumps for Cardiff, designed by Mr. Napier Prentice.

above the floor level contains the motors and automatic switching gear (Fig. 2). The motors are arranged to work with a vertical spindle, the weight of armature, shaft, and pump disc being taken by adjustable ball-thrust bearings on the top of the motors. The motor spindle is fitted with two deep oil-cups, which surround the upper and lower bearings (which in this case act as guides only), and so keep them perpetually flooded with oil. The armature is slotted and fitted with former-wound coils. The magnet cores are hollow, and can be removed together with the coils without interfering with the armature or armature connections. The centrifugal pumps are fitted with 3in. suction and separate deliveries, and raise 150 gallons per minute against a head and friction equal to about 20ft

The switching gear, shown diagrammatically in Fig. 3, consists of a multiple-contact switch thrown on and off by a tumbling weight controlled by the level in the sump The movement of the switch when being put on is retarded by an oil dash-pot, to prevent a sudden rush of current. The switches, as well as the motors and pumps, are in duplicate, and a simple contrivance enables either one or the other switch to take the lead, so that the pumps may be arranged to work alternately for certain periods, the idea being that one pump will start up when the sump is filled to a certain extent; but if one set is unable to cope with a sudden rush of water, or fails to work from any reason, then the increased depth of water in the sump automatically starts the second set.

The installation was designed and installed by Mr. Napier Prentice, of Stowmarket.

KING'S LYNN ELECTRICITY WORKS.*

BY JOHN PILLING, M.I.E.E., BOROUGH ELECTRICAL ENGINEER.

This short paper is in response to the request of the borough engineer of King's Lynn that a description of the electricity works of the King's Lynn Corporation

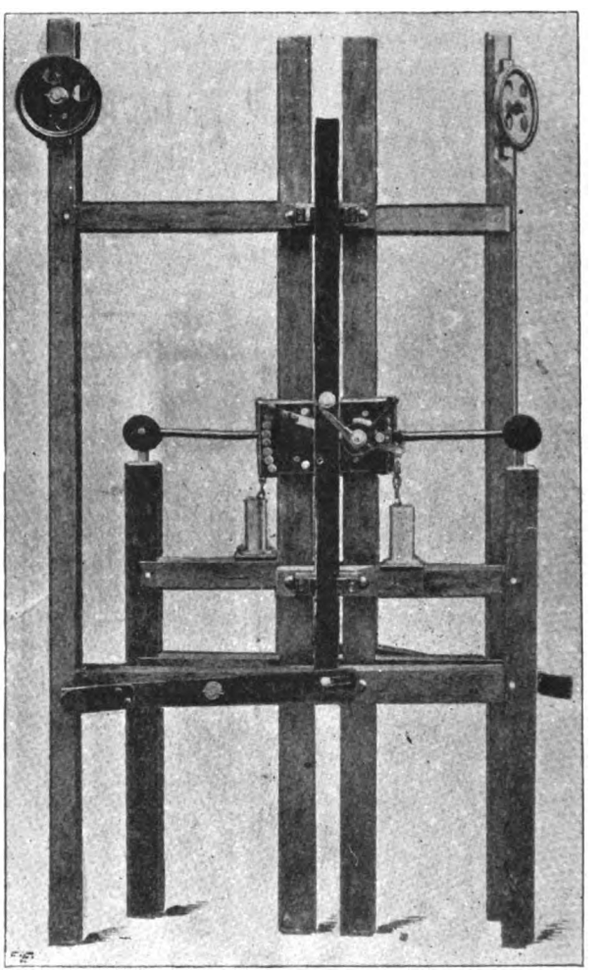

FIG. 2.—Details of Controlling Gear.

should be read to the Municipal and County Engineers on their visit to the town. Perhaps the most interesting feature of the works is the fact that the plant consists of both gas and steam generators. The Corporation obtained its provisional order in 1896, and in 1898 obtained the advice of Prof. Henry Robinson, who designed and laid down the initial gas-driven scheme, which commenced to supply current in August, 1899. Prof. Robinson first proposed a steam-driven scheme, but owing to the intended site for the generating station being substituted by another one, he altered his designs to a gas-driven plant, believing at the same time that there would be very little demand from private users, and that small gas generators would be capable of meeting the requirements. The amount of the loan sanctioned for the initial scheme was £27,000, and the total expenditure has now increased by extensions to about £45,000. As the area supplied is a compact one, the three-wire direct-current system of supply was adopted, with 400 volts across the outer conductors. The generating station

* Paper read before the Association of Municipal and County Engineers at King's Lynn.

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is on the site of the old waterworks, where there is an abundant supply of water, suitable for condensing and boiler feed purposes, and a railway siding for the delivery of fuel to the works.

The gas-producer house is situated at some 50 yards distance from the engine-room, and contains four Fielding and Platt's gas-producers working on the Dowson principle, each designed to give off 13,000 cubic feet of gas per hour of a calorific value of 145 British thermal units per cubic foot. They are fitted with steam-jet air injectors, the cast-iron pipe being laid in its passage to the underside of the firebars, between the firebrick lining and the outer iron shell of the producer. The producers are fed through hoppers from the top in the usual way, and are provided with cleaning-out doors at the bottom. Two vertical boilers provide the steam for the air injectors. Anthracite peas costing 24s. 6d. per ton delivered are used in the producers, and coke with screened ashes from the generators in the vertical boilers. The gas on leaving the producer passes through a series of vertical cooling pipes, on the top of which there is fitted a water spray. The gas then passes through an hydraulic box, which prevents the gas returning to the producer, also two scrubbers, the first being filled with coke and sprayed with water, and the other consisting of two or three trays of sawdust. The gas can then be sent to a holder and on to the engines or direct through an auxiliary main to the engines. The main gasholder is of wrought iron 20ft. in diameter with a 10ft. lift, and is supported on four cast-iron columns with wheels, chains, and an adjustable balance weight.

There are five gas-engines working on the Otto principle with "hit-and-miss" governing. The engines run at 185 revolutions per minute and drive by belts 40-kw. dynamos. They are designed to give 65 b.h.p. when the number of explosions in the combustion chamber of the engine does not exceed two-thirds of the possible number. The engines are therefore large and massive for the required output, being capable of giving out about 100 b.h.p. for short periods. They have cast-iron single flywheels, cast in one piece, weighing over eight tons, running between the engine and an outer bearing, the flywheel also serving as belt pulley. The cylinder, combustion chamber, and exhaust-valve seating are water jacketed, and the water for the jackets is supplied by a 2in. centrifugal pump driven by a 2-h.p. electric motor. The ignition is on the hot-tube method, the tubes and ignition valves being in duplicate to prevent stoppage of the engine in the event of a tube bursting. The further precaution is taken to heat one of the tubes by the producer gas and the other by town gas to avoid stoppage should the quality of the producer gas fall too low to heat the tubes sufficiently. For starting the engines, Fielding's patent starter is used, which operates as follows—viz., the crank is first set into position by hand gear and a charge of gas admitted to the combustion chamber, then compressed air is admitted from a storage cylinder, which causes the charge in the engine to ignite at the ignition tube. The compressed-air cylinder is pumped up by the gas-engines themselves when slowing down after the gas has been shut off. Each engine exhausts separately through three silencing boxes placed in series, into a brick pit filled with granite cubes. The dynamos driven by the gas-engines are of the ordinary two-pole type giving 88 amperes at 450 volts. Soon after the works commenced to supply, the Corporation was obliged to consider the question of extensions owing to the great demand on the existing plant. Having found it impossible to prevent vibration and noise due to the working of the gas-engines, it was decided to carry out all extensions by means of steam plant. The subsoil of the site on which the station stands is of a very spongy character, and unsuitable for horizontal engines with heavy reciprocating parts, it being impossible to prevent vibration, or, rather, oscillation of the ground The author advised the Corporation on the scheme of extensions, and the borough engineer has been responsible for the architectural work of the extension. The cost of the extensions at the generating station has been about £10,000.

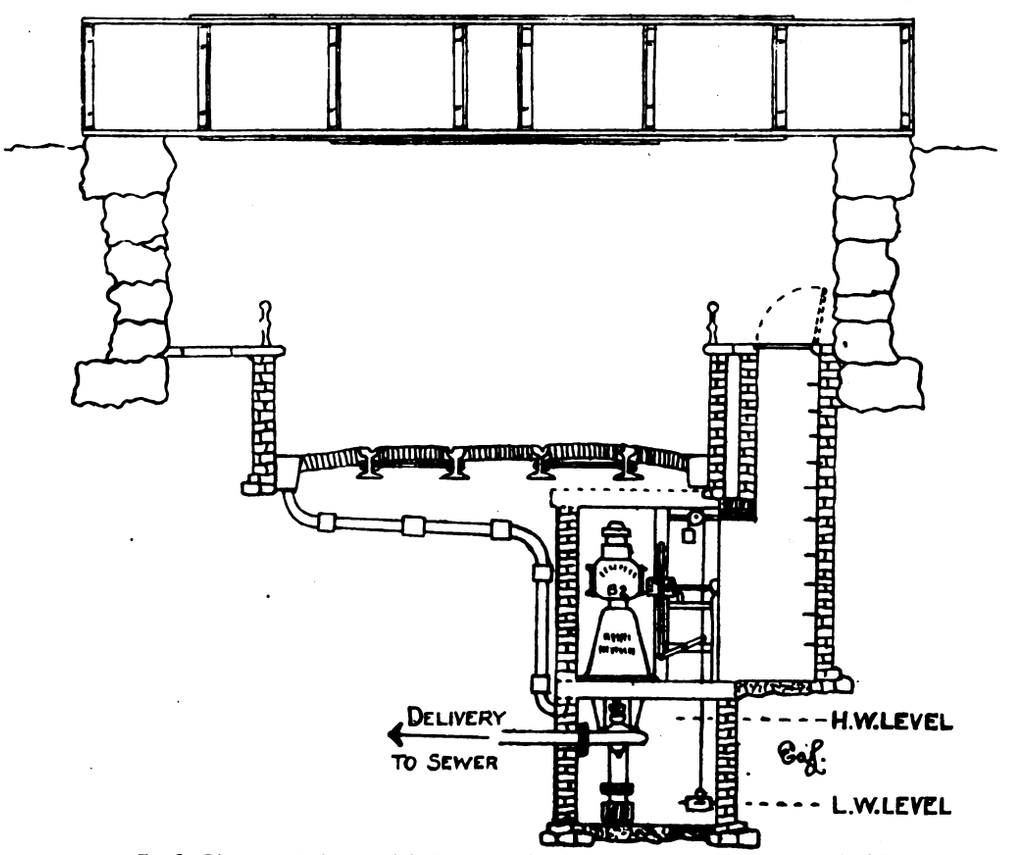

FIG. 3.—Diagrammatic Section of the Sump, showing the Pump and Controlling Gear, at Cardiff.

The boiler-house plant consists of two Lancashire boilers 30ft. by 8ft. for a working pressure of 150lb. per square inch. They are each fitted with Meldrum's forced-draught furnaces for burning small coal. Slack coal is used at about 10s. per ton delivered. In each boiler flue tube five cross tubes are welded. One 96-tube Green's economiser is installed, the scrapers being driven by a 1-h.p. electric motor through worm gearing. There is also a Weir's feed pump capable of discharging 2,400 gallons per hour against 150lb. per square inch at 12 double strokes per minutes. Provision is made for the fixing of a second pump when required. In addition to these there is a Gresham's injector capable of discharging

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1,200 gallons per hour against the boiler pressure. The feed pipes are arranged so that the water may be sent either through the economiser, or direct to the boiler, each boiler being provided with two feed valves. The feed water is drawn either from an iron tank in the boiler-house, or from a well in the engine-room which communicates with the pond outside, the water in the well being at the same level as that in the pond. The storage tank is kept full by a portion of the discharge water from the condenser, the town water being also connected for emergency. Two Belliss-Laurence-Scott steam dynamos are installed, one of 200 kw. and the other of 120 kw. running at 350 and 400 revolutions respectively. The engines are worked condensing, and both exhaust into one Worthington jet condenser capable of condensing 10,000lb. of steam per hour.

The author receives many enquiries from engineers in various parts of the country with respects to the merits and demerits of gas and steam driving, and the paper would perhaps be considered incomplete if some reference to the actual results obtained from the two systems were not made. During the 12 months ending March 31, 1901, gas plant only was in use, but during the year ending March 31, 1902, the current was almost wholly generated by steam plant. The sale of current during the former year was 245,009 and in the latter year 286,679 units, and the generating costs were as follows:

Gas—Year ending 1901.	£	s.	d.		Pence per unit.
Coal*	1,004	15	3	...	·98
Oil, waste, water, and stores	119	9	9	...	·12
Wages	636	10	11	...	·60
Repairs of works and plant	233	5	0	...	·26
	£1,994	0	11	...	1·96
Steam—Year ending 1902.					
Coal*	703	11	0	...	·59
Oil, waste, water, and stores	113	0	1	...	·09
Wages	521	6	5	...	·44
Repairs of works and plant	170	19	5	...	·14
	£1,508	16	11	...	1·26

*The cost of coal in 1901 was increased by £100, owing to the enhanced prices ruling.

For Dowson gas plants anthracite fuel (or coke, though it is, as a rule, not so suitable) must be used, and the comparative cost of anthracite and suitable steam coal at any particular locality where the power is required will determine whether the fuel costs would be lower if the power were produced by Dowson gas plant or by steam plant. Generally, if the price of anthracite peas in any district were over £1 per ton and steam coal could be secured at about 12s., it would be more economical to generate by steam. There are many other points, however, that tell against the gas-engine in its present form which must not be overlooked when considering the *pros* and *cons*. The author believes that there is a great future for gas driving in electric generating stations, but it ought to be realised that before much headway can be made in this direction the gas must be produced from ordinary bituminous slack coal. The engines must be of large size, corresponding to the powers of the large steam-engines now existing in power stations, as the period of the multiplication of small generating sets has passed by. The engines will be direct coupled to the generators; they will not be governed on the "hit-and-miss" principle, but rather by varying the quality of the charge at each admission, and the ignition will probably have to be done by the electric spark owing to its greater certainty of action and greater ease of control. Makers of gas-engines are, of course, fully alive to the destructive action of the intense internal heat on the valves and other parts and its interference with the perfect internal performance of the engine, and are making strenuous efforts to overcome the difficulty. It will be necessary for gas-engine makers to consider the question of lubrication and the collection of the waste oil in order to bring the engines up to the perfection obtained in steam sets.

A storage battery is installed consisting of 225 Chloride R-type cells in glass boxes, having a capacity of about 400 ampere-hours when discharging in 10 hours. The accumulator room is of two floors, and the cells are arranged in four rows on each floor, mounted on the usual wooden bearers. An unusual method of regulation on the battery is adopted, the pressure being altered by "cutting" cells out or in on the negative side of the battery only, and altering the position of the middle-wire connection to the battery from one well to another. The regulating cells on the negative end of the battery are arranged five cells per stop, and the middle-wire cells three cells per stop. The battery is charged across the feeders, and the end regulating cells are charged by a motor-generator, which takes current at 400 volts and gives out current at 10 to 100 volts. There is one disadvantage in this method of regulation—viz., when the discharge on the two sides of the battery is unequal it is impossible to adjust the middle-wire regulator, so that the middle-wire regulating cells each receive their proper amount of charge, which leads to rapid deterioration of those cells. The balancing of the load on the three-wire mains is done by the battery at the station end of the distributing system, in addition to which there are two motor-transformers fixed in the basement of the town hall on the opposite side of the town.

Five concentric two-wire feeders leave the station laid in Doulton conduits. The feeders, as well as the distributors, are insulated with impregnated jute and lead sheathed. The distributors are triple concentric, and armoured with two layers of steel tape, and chiefly laid direct in the ground with a covering of creosoted boards to serve as a protection. The polarity of the outside conductor of the main is reversed at intervals in order to make the connection of services easy, and the neutral wire of the cable is always the middle conductor, thus obviating the need of cutting down to the innermost conductor of the cable, except for three-wire services. The balancing of the consumers on the two sides of the system needs very little attention, as by this reversal of polarity it is brought about almost automatically. The street-lighting of the town is done entirely by electricity. At present there are eight Siemens open-type arc lamps, 14 Davy enclosed arc lamps, 10 Nernst lamps, and 450 lamps, each containing a pair of 16-c.p. incandescents.

The open-type arc lamps are arranged four in series and the enclosed type two in series between the neutral and "outside" wires of the distributors. The two incandescent lamps in each lantern are wired in parallel, and usually each lantern is connected separately to the distributing mains, but in some cases as many as four or five are on one connection and controlled by one switch. In the wider streets the lamps are fixed on posts, but in the narrow streets they are fitted on wall brackets or suspended across the streets by means of steel wire or wrought-iron arches. The Electricity Committee supply, erect, and maintain the lamps at the following inclusive charges per annum—viz.: each arc lamp, £16; each lamp containing a pair of 16-c.p. incandescents, or each Nernst lamp, £3. 10s. The department carries out wiring work and the supply and fixing of motors for its consumers for cash, but has not instituted any scheme for hiring out of motors or free wiring. There are now some 360 consumers connected to the mains, or about 17,000 lamps of 8 c.p. (or equivalent), including over 100 h.p. in electric motors.

ON THE PREVENTION OF SMOKE.*

BY JOHN S. RAWORTH, M.I.C.E.

I have not hesitated to bring this subject before the association, for no one will deny that though

> "Coal has made England,
> Smoke has marred it."

No one who has not travelled knows how to appraise the natural beauty of England nor the artistic ugliness of her manufacturing towns. In such towns smoke spoils everything, and were it not for the natural antagonism of the Englishwoman to Satan and all his works, we should soon be lost in dirt. If the Metropolitan Railway were managed by women, they would scour it or die; they would not consent to live in such an environment of filth. Happily we have hope that the modern Hercules will soon clean out this Augean stable and substitute sweetness and light for

* Paper read before the Belfast meeting of the British Association.

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dirt and darkness. At one time I harboured a great hope that electricity would cure the smoke evil, or at least take it right away outside our towns, but that was before the days of the municipal craze, and I did not foresee that corporations would necessarily plant their works within their own area, and thereby increase the density of the pall that reduces summer to a mere warm variety of winter and makes winter more miserable than a place we have read of but not seen.

I have endeavoured, in co-operation with my friends, to mitigate the smoke nuisance by promoting Electric Power Bills, whereby the undertakers would be, and in some cases are, authorised to generate electrical energy in the country and supply it in bulk to municipalities. It is common knowledge, however, that these Bills were opposed with the greatest possible vigour (not to say acrimony) by the municipalities. It became obvious, therefore, that our local rulers have made up their minds that we shall still continue to live amongst chimneys; therefore, as we cannot convert our rulers, the only way of salvation is to convert the chimneys. To come to the point: I think I have found a cure for smoking chimneys; or, to be more precise, I have found a man who knows the inventor of a new process for this purpose—viz., the Wilson smokeless process. It did not take me long to get an introduction to the process itself, which I discovered consisted in squirting a mixture of air and nitrate of soda solution on the fire. I fitted up a Babcock boiler at Kidderminster and gave the system a trial. The original installation was both crude and expensive, but it cured the smoke. It had plenty to cure, for the coal in that district is both soft and dirty, consequently the numerous chimney tops emit dense clouds of smoke. The action of the solution of nitrate of soda appears to be somewhat obscure—my theory is that it creates nuclei of intense heat, which fire the gases and enable the injected air to combine with them. I have had experience with nearly all known methods of smoke prevention. Many of them are good, but usually a good stoker can give equally good results without them; the defect of both of them and the good stoker is that they diminish the output of the boiler and its thermal efficiency owing to the fact that they let into the furnace a larger amount of air than is necessary for perfect combustion. My first desire, therefore, after the success of the Wilson process in preventing smoke had been demonstrated, was to ascertain how it affected the output of the boiler and its evaporative efficiency.

For this purpose I instructed Mr. H. Wall Wilkinson, A.M.I.C.E., to conduct a series of tests to ascertain (*a*) the output and efficiency under existing conditions; (*b*) the output and efficiency under existing conditions with air blast only; (*c*) the output and efficiency under existing conditions with the complete Wilson process. The results are given in the appended report, from which it will be seen that, assuming existing conditions as 100, (*a*) equals 100 plain furnaces; (*b*) equals 108 air injected; (*c*) equals 122 Wilson process.

It is necessary to state that Mr. Wilkinson was entirely sceptical as to the value of the process, and made numerous other tests to satisfy himself that the results obtained were correct. The engineer of the power-house was equally sceptical, but when he found that the coal bill was actually reduced he asked to have all his boilers fitted with the process—which was done. Other instances of the successful application of the process have come under my notice—one at Durham, where the chimney of the power station in the valley disgorged smoke under the windows of houses on the hill side, and another at Windermere, where the electric lighting company was subjected to proceedings in Chancery for nuisance. In this case the smoke was smoke in name only: there was no black smoke; but the process removed the last vestige, and the Chancery suit has been withdrawn.

The Wilson smokeless process is extremely simple. It consists in the injection of a very minute quantity of nitrate of soda in solution into the furnace in combination with sufficient air to produce perfect combustion of the gases The cost of the nitrate of soda used is from 3d. to 4d. per ton of coal burnt. The system has been installed at the works of Messrs. Gallagher, Belfast. The owners have graciously expressed their desire that all members of the association interested in the subject should personally inspect the operation of the process.

REPORT BY MR. H. WALL WILKINSON, A.M.I.C.E.

I visited the works of the Electric Traction Company at Kidderminster on May 22, 1901, for the purpose of making a series of tests on the Wilson smoke-consuming process, the apparatus having been fixed to one of the boilers at those works. The boiler is a Babcock and Wilcox water-tube boiler having 27 square feet of grate area, 1,218 square feet of water-heating surface, and 142 square feet of steam superheating surface. It is fitted with the so-called Scotch furnace, and works at a pressure of 120lb. per square inch. It was fitted with Meldrum's forced-draught apparatus, but this was not used during the tests. The feed water was passed through a Green's economiser on its way to the boiler. The tests were made on the boiler while performing the ordinary work supplying steam to the traction engines, and the load varied therefore from time to time, and was not the same on all the four days over which the tests continued. The process consists in forcing jets of air over the surface of the fire, the air carrying with it in the form of spray a solution of the "chemical" supplied by the inventor. The air is introduced through cast-iron blocks built into the furnace walls at the four corners, the "chemical" being sprayed in at the two front corners only. Steam jets were used for inducing the supply of air to the blocks. The "chemical" was made into a strong solution and supplied by pipes from an overhead tank. The coal was "thick slack" from the Hawkins Colliery, Cannock.

On the first day I confined myself entirely to observations of the top of the chimney stack, carefully noting the difference in the amount and quality of smoke after each firing, both with and without the "process." When working under the usual conditions a good deal of dark-brown smoke was visible, lasting for about two minutes after each firing. I may here mention that the firing on the "spread" system was well and carefully done, about three to four shovelfuls being put on about every four minutes. With the process in full operation a very slight coloured haze was produced, which lasted about 15 seconds after each firing. With the air jets in operation, but with the "chemical" cut off, there was a very light-brown smoke, lasting for about 30 to 40 seconds. On the second and following days I made a series of evaporative tests both with and without the process, and also a test with air-jets only without the "chemical." The results of these tests are appended hereto.

After the test on the first day had commenced, an intermittent leak from the relief valve of the economiser was discovered, so this test was repeated again on May 30. Every care was used to get as accurate results as possible. The coal was weighed in boxes of 56lb. each. The contents of five of these were emptied on the floor at one time, and no more was weighed out till this was all used, the time being noted. The feed water was measured in two barrels which had been carefully calibrated, and which were emptied alternately into the tank from which the feed pump drew. The fire was cleaned about one hour before commencing the test, and then burnt low. It was cleaned again in three hours after the test was started, and again about one hour before it ended. At the end of the test the fire was burnt low again so as to bring it to the same condition as at the beginning. The firing was done by the regular stoker employed by the traction company. All tests lasted over seven hours.

March 15, 1902. (Signed) H. WALL WILKINSON.

SUMMARY OF RESULTS OF EVAPORATION TEST ON BOILER AT KIDDERMINSTER FITTED WITH THE WILSON APPARATUS.

—	May 23, with air chemical	May 24, with air only.	May 25, ordinary conditions.	May 30, with air and chemical
Duration of test	7·08 hrs.	7 hrs.	7·42 hrs.	7 hrs.
Average pressure of steam	113·3lb.	115lb.	117·7lb.	115·3lb.
,, temperature of steam (superheated)	469° F.	473° F.	459° F.	466° F.
Average temperature of steam feed	143° F.	140° F.	146° F.	150° F.
Factor of evaporation	1·228	1·235	1·22	1·219
Total coal	2,856lb.	3,416lb.	3,248lb.	2,744lb.
,, per hour	403lb.	488lb.	438lb.	392lb.
,, ,, per square foot of grate	15lb.	18lb.	16·2lb.	14·5lb.
Total water	19,520lb	19,485lb	17,680lb	17,886lb
,, per hour	2,755lb.	2.784lb.	2,334lb.	2,555lb.
Water evaporation per pound of coal (actual conditions)	6·83	5·7	5·32	6·52lb.
Water evaporation per pound of coal from and at 212deg. F.	8 38	7·01	6·5	7·95lb.

NOTE.—An intermittent leak from relief valve of economiser was discovered after the first test was started. It was therefore repeated on May 30. H. W. W.

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CONTENTS.

Notes	613	Professional Etiquette	634
The Cauvery Power Transmission	618	Forthcoming Events	634
Leaves from a Testing Engineer's Notebook	624	Questions and Answers	634
Automatic Pumping at Cardiff	626	Tube Bills in Parliament	638
King's Lynn Electricity Works	626	Legal Intelligence	639
On the Prevention of Smoke	628	Companies' Meetings and Reports	639
"Where Ignorance is Bliss 'tis Folly to be Wise"	630	New Companies Registered	640
Correspondence	631	Contracts for Electrical Supplies	640
Obituary	632	Lighting Notes	641
Appointments Vacant	632	Traction Notes	644
Trade Notices and Novelties	633	Provisional Patents, 1902	646
Edinburgh Accounts	633	Companies' Stock and Share List	647
		Traffic Returns	648

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"WHERE IGNORANCE IS BLISS 'TIS FOLLY TO BE WISE."

In its issue for Oct. 24 the *Electrical Review* criticises our remarks of Oct. 17 relating to "Electric Lighting Returns—Company *v.* Municipal." Although the title of this paper is carefully suppressed, still we must be thankful for small mercies, and accept with due humility the rôle of "an esteemed contemporary." It is not often we take any notice of criticisms in contemporary papers, but we respect the *Review* too highly to rest silent under what we shall term audacious—if they do not approach something worse—statements, for they really are not criticisms. But the sting of the article is in its tail, which reads:

> "(1) The whole matter must be dealt with on the broad principles of socialism *versus* private enterprise.
>
> "(2) Municipal *enterprise* and municipal *trading* are entirely different things—the former may enrich the town, whereas the latter may involve it in ruin."

We are not at present interested with an academic discussion on socialism, or the distinction between municipal enterprise and municipal trading, and wish to bear in mind Carlyle's dictum:

> "A head too dull to discriminate the true from the false, a heart too dull to love the one at all risks and to hate the other in spite of all temptations, are alike fatal to a writer."

Our attempt was an honest attempt to get at the truth, and in our articles we deprecated solely conclusions founded upon figures—especially selected figures. Now, up to the time of our writing municipal authorities had been condemned (1) for extravagance, (2) incapacity, (3) trading at a loss, (4) competing with private enterprise, and in a dozen other ways. Figures were quoted to prove all this; figures selected by the controversialists. Company management has been belauded for its expert knowledge of the subject, its cheapness, its business instinct, and it has been praised as having every good property, while the municipal committeeman was elected, and that was all. The latter we were often told has no knowledge of electrical matters, but the guinea-pig director of a company put into that position for the use of his name or his money is in some way a heaven-born genius in matters electrical. Perhaps we shall be told that directors of companies do not pose as experts, but employ experts. Well, be it so; and oh, sapient critics, do the members of electric committees pose as electrical experts, or do they employ experts to advise? To say the truth, the later-day system of bringing in this personal question and suggestions that this or that man (be he company director or committeeman) is incompetent because he is what he is, lordling or sweep, is to us a sign of decadence, a great sign of a weak case, and a disgrace to an argument. The *Times* in its articles on "Municipal Socialism" has been one of the greatest offenders; and as the *Review* drags in the "broad principle of socialism," we take the earliest opportunity of complaining against the question, "What does such a man know about the electrical business?" The *Times* and the *Electrical Review* both row in one boat, and we contend both are carefully avoiding any direct attempt to get at valuable facts, and trying all they can to cloud the true issue by putting forward something of little importance. That we should be driven to explain municipal figures is strange, because this office is the only one that has endeavoured to find out any principle or law to guide as to what should and what should not be a municipal undertaking. Perhaps we shall be told that Mr. Garcke's "no profit" manifesto was before us, but as a

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matter of fact the "no profit" theory had been discussed by us long before it was put forward by Mr. Garcke. The "no profit" theory is a good war cry, but a useless obstacle to prevent what is generally known as municipal trading. We are compelled to write this introduction, because upon no other assumption than having thrown in its lot with anti-municipalists can we understand the *Electrical Review's* attitude, or its admission and editorial sanction of the article discussing our figures. The writer of that article must have been in hard straits for something to say, and has thus been led to any amount of discrepancies, which he will have hard work to explain away. Let us take his paragraphs *seriatim*. There are eighteen of them, and of the whole we may say with Fontenelle, "I might have my hand full of truth, and would only open my little finger." Paragraph 1 refers to comparisons. Paragraph 2 to the comparisons between accounts not kept uniformly. Our reviewer generalises with a vengeance. Will he kindly explain why "total capital outlay" cannot be compared? He may keep his accounts as he pleases, and yet there is no difficulty in the comparison; or for the total revenue, or total cost (excluding capital charges), or units sold, or capacity of plant, etc. To say that such comparisons are not easy, to suggest inferentially or otherwise that the comparisons are untrue and misleading, is simply idiotic nonsense. Paragraph 3, unless we misread it, states what is not true, or it may be its words are misplaced, or our contemporary may contend that repayment of capital is not depreciation. If it is not, we should like to know what it is. Paragraph 4 states our conclusions are valueless because comparisons cannot be made from the accounts as they exist. Now, the capital expended in the provinces is either £2,963,000 for the companies concerned and £13,404,570 for the authorities concerned (*Electrical Engineer*, Oct. 17, page 551), or it is some other amount. Either the respective revenues are as stated or are not, and so on. The method of keeping the accounts does not alter the figures we took for our averages one iota. Paragraphs 5 and 6 really hint that local authorities are liars, and deliberately falsify their accounts so that the true position shall not be known. This we repudiate with the strongest indignation. All local authorities have their accounts audited, and while there may be a few debatable cases where charges have been debited to a different account to that which opponents would debit them, we do not believe there exists in the kingdom an authority that would wilfully tamper with the accounts in order to misrepresent their position. Paragraphs 7, 8, 9, 10, 11, and 13 deal with the crux of the whole matter—*i.e.*, that of management. Our conclusions are condemned as unjustifiable, and it is said that our comparisons will not bear investigation. Individual reasons for discrepancies are then pointed out, just as they were in our article, but the main contention that a general average includes the figures from all the badly managed concerns, whether company or municipal, will give a fair conclusion, is not disproved. In fact, our contemporary accepts our reasoning at the end of paragraph 13, which reads: "It by no means follows that the lowest price charged indicates the best management, if the companies' rate of 4·72d. leaves a fair profit, and the local authorities' 3·58d., a considerable loss. The credit of good management is due to the companies." Quite so. An elementary calculation from the figures quoted for the metropolitan area shows that if the municipalities obtain 3·9d. per unit, they will earn the same percentage gross profit on their capital outlay as the companies do charging 4·72d. We, however, deprecated too close comparison for the London undertakers. In the provinces, where the conditions are more uniform, the local authorities earn a larger gross profit than the companies, who charge 41·4 per cent. more for their electrical energy. This is not due to book-keeping, as the figures of capital spent, units sold, revenue, and cost are not disputed. All the statements against the accounts of the corporations deal with depreciation and net profit questions. It is a matter of surprise that our contemporary had not something to say on the average cost of production per unit sold as being evidence of efficiency of management. This is the direction in which we should look for the effects a good engineer can make in the undertaking under his management, rather than to the borough accountant's system of stating the results of a year's trading. From the internal evidence of the whole article we surmise that in a moment of generous impulse the *Electrical Review* delivered over its columns to some writer whom it deemed discreet, but who has led it into the wilderness. The remaining paragraphs have as little to do with our articles as with Mexico. Throughout our columns we pointed out the worthlessness of figures without discriminating knowledge, and the total unreliability of figures without capacity for interpretation. What we did prove, and proved up to the hilt, was that the figures given—interpret them as you please—show that the total capital employed by municipalities in electricity supply is more usefully employed than the total capital employed by companies. When the anti-municipalists realise that half truths will not prevail, their efforts will be on the road to success.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BOLTON TRAMWAY DEPRECIATION.

SIR,—If "P. T." had waited a week he would hardly have needed to have asked his query what I do with the $4\frac{2}{3}$ per cent. depreciation after paying the $3\frac{1}{3}$ per cent. loan repayments, for you show on p. 593 what I do with the money. We write the 8 per cent. off the capital yearly, as shown in the account. The $3\frac{1}{3}$ per cent. is repaid to the mortgagee and *cannot be reborrowed*, but the $4\frac{2}{3}$ per cent. is put into our bankers' hands and can be used for fresh capital outlay in lieu of borrowing to that extent, leaving the borrowing power intact to be used for replacements as they may occur. I am afraid "P. T." is not as good an accountant as he may be an electrician. What good is there in putting the $4\frac{2}{3}$ per cent. into consols and accumulating it? As a practical man I prefer to use the money, and thus save the revenue account the interest which would otherwise have to be paid. My chief reason, however, in Bolton for adhering to our method of depreciation is the fact that we have already had to spend £49,279. 1s. 4d. in relaying the old track. Now, I think the whole of this ought to be paid for out of depreciation, and not out of new borrowed money. With respect to his preferring the Glasgow system, I beg to hand you the opinion of the *Accountant* newspaper on this very matter, which has come to hand this week, and which, I think, entirely endorses the view I am defending.—Yours, etc.,

GEO. SWAINSON, F.S.A.A.

Town Hall, Bolton, Oct. 27, 1902.

Copy from the "ACCOUNTANT" *of Oct. 25, 1902, p. 1,077.*

DEPRECIATION AND SINKING FUNDS.

From the comments that have appeared in some of our contemporaries, it would appear that there is still a considerable amount of misapprehension on the subject of sinking fund instalments and depreciation, even among those who might be supposed to have devoted special attention to the subject. As we have repeatedly pointed out, no Act of Parliament or Government department can decree anything which will have the effect of altering the fundamental principles upon which only true accounts can be constructed. The payments made by an undertaking in redemption of its liabilities

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cannot ever be a revenue charge, even although it may be provided by statute that they shall be charged against revenue account. If all items properly chargeable against revenue have been included, then the addition of the sinking fund instalments has the effect of understating the profits actually earned. *Per contra*, the omission to provide for depreciation has the effect of overstating these profits. The proper provision for depreciation may in almost every case be said to be in excess of the necessary provision for sinking fund. Consequently, if sinking fund be charged against revenue and depreciation is not, the profits will be overstated by the difference between the proper provision for depreciation and the sinking fund instalments. As a matter of fact, the charging of sinking fund instalments against revenue has, however, a more practical objection than theoretical inaccuracy. Reducing as it does the amount which it is necessary to charge for depreciation in order to arrive at true profits, it has at the same time the effect of reducing the amount which the local authority can claim as an allowance in respect of wear and tear from the income tax authorities. It is also very largely responsible for the fallacy that so long as sinking fund instalments are charged against revenue, depreciation need not be.

OBITUARY.

THE LATE PROF. SIDNEY H. SHORT, M.I.E.E.

It is with much regret we have to chronicle the death of Prof. Sidney Howe Short, technical director of the English Electric Manufacturing Company, at his London residence last week from appendicitis. Prof. Short was born in Columbus, O., in 1858, the second son of Mr. John Short, a manufacturer of that town. Like most inventors, he showed mechanical ingenuity in his very childhood. Before he was 14 he was an expert telegraph operator, and had equipped his father's house with a burglar alarm system and other electrical devices. Visiting the Centennial Exhibition at Philadelphia in 1876, he made a close examination of the Bell telephone apparatus, and discovered that the principle of articulate transmission there shown was practically the same as that which he had already put into operation in the laboratory of the State University. Upon his return he perfected a long-distance telephone transmitter, which he patented and afterwards sold to the Gold and Stock Telegraph Company (now a part of the Bell Telephone Company).

In 1878 the late Prof. Short was elected assistant professor of physics and director of the laboratory, and graduated two years later with the degree of B.S., and immediately accepted the position of professor of physics and chemistry and vice-president of the University of Denver, Colorado. While in Denver Prof. Short invented a double-reduction motor for street railways, and, resigning his professorship and concentrating his entire attention upon electric railway work, he soon had several lines working in western cities. He used first the conduit system, then the overhead trolley. In June of 1899 he removed to Cleveland, O., where he interested his old friend, the eminent electrician, Charles Francis Brush, in his inventions, and the Short Electric Railway Company, of which the Brush Electric Company was a large shareholder, was formed to manufacture his railway machinery. In 1892 the Thomson-Houston Company bought out the Brush Electric Company, the Short Electric Railway, and later the Edison companies, thus forming the existing General Electric Company. In 1893, Mr. Short became connected with the Walker Manufacturing Company, of Cleveland, Ohio, a firm which rapidly became a formidable competitor of the General Electric and Westinghouse Companies, not only in the United States, but in Europe, and throughout the world. In 1898, the Walker Company had become so important a factor in the electrical situation, that its absorption was decided upon and accomplished by the financial interests controlling the Westinghouse Company. In December of that year Mr. Short sailed for Europe to complete the arrangements which had already been under discussion with Messrs. Dick, Kerr, and Co., Limited, for the construction of works in England for the manufacture of apparatus under his patents. On June 14 following work was commenced on the excavations for the new buildings at Preston, and only a year later the formal opening took place, the actual production of traction machinery being already well under way.

Since that date Mr. Short has held the position of technical director of the English Electric Manufacturing Company, Limited, and the wide range of the patents and designs by himself and the technical staff which he had organised for the company covers apparatus for electric traction from ordinary tramway equipments to those for the heaviest railway service, generators from the smallest size up to those of 3,000 kw. or 4,000 kw. capacity, and a complete range of polyphase machinery for power and transmission work. It is generally agreed that in his designs Mr. Short has distinctly improved whatever type of machinery he has touched, and in many cases these improvements have been of the most vital and far-reaching nature. In no case was this more clearly shown than in the design of large direct-current generators. He was the first to discover the reason for the "bucking" action in such large machines, and at the same time showed how it could be overcome by cross-connecting numbers of equipotential points in the armature windings. Commutation troubles in such generators were the bane of designers, and it is not too much to say that the Walker generators were the first in which such troubles were really eliminated. Mr. Short during the past year was engaged upon plans which have recently been carried through for the erection of large shops in Paris for the manufacture of machinery under his patents. It has been known to his friends for some time that he regarded his work in Europe as drawing to a finish, and that it was his intention a little later on to return to America with a view to re-entering the electrical field there and carrying out on independent lines an undertaking of a similar nature to that with which he had been associated in England.

Prof. Short was a Fellow of the American Society for the Advancement of Science, a member of the Cleveland Electrical Society, the American Institute of Electrical Engineers, the Institution of Electrical Engineers in London, the Engineering Society of Liverpool, and the New York Electrical Society. Over 500 patents have been issued in his name in the United States and foreign countries, mostly on electrical machinery. Prof. Short was only 44 years of age at the time of his death.

APPOINTMENTS VACANT.

Testing Assistant, Public Health Department, Corporation of London, £200 per annum, Nov. 1. See advertisement.

Resident Electrical Engineer, Hastings Corporation, £300 per annum, rising by £50 to £500 per annum, Nov. 4. See advertisement.

Chief Clerk, Swindon Corporation Electricity Department, £100 per annum, Nov. 18. See advertisement.

Assistant Electrical Engineer, Swindon Corporation, £100 per annum, Nov. 18. See advertisement.

Cable Jointer, Swindon Corporation, 35s. per week, Nov. 18. See advertisement.

Meter Inspector, used to Chamberlain and Hookham and Thomson meters, 25s. per week. See advertisement.

Charge Engineer, London Supply Company, for high-tension alternating station. See advertisement.

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TRADE NOTICES AND NOVELTIES.

Lightning Arresters.

We illustrate herewith two types of lightning arresters supplied by the Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C., for the protection of electrical machinery, transformers, switchboards, underground cables, etc. In the arrester (Fig. 1) there are two short spark-gaps, F 1 and F 2 (see the diagram, Fig. 2), consisting of two

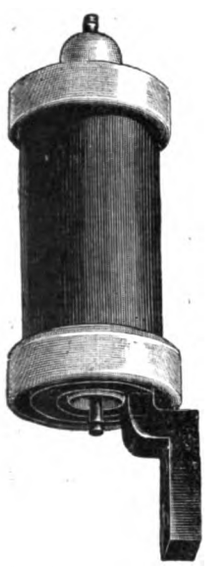

FIG. 1.—Lightning Arrester with Automatic Spark Gap.

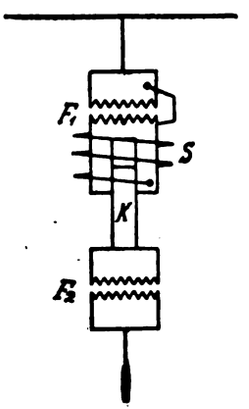

FIG. 2.—Diagram of Lightning Arrester with Automatic Spark Gap.

serrated discs over which the atmospheric discharges are conducted to earth. The iron core, K, is movable inside the solenoid, S, and carries at its lower end one of the serrated discs, which touch one another at F 2 when the core is in its position of rest. In case a short-circuit follows an atmospheric discharge, part of the current is caused to go through the solenoid, thereby raising the core and increasing the spark-gap to such an extent as to extinguish the spark. The current is

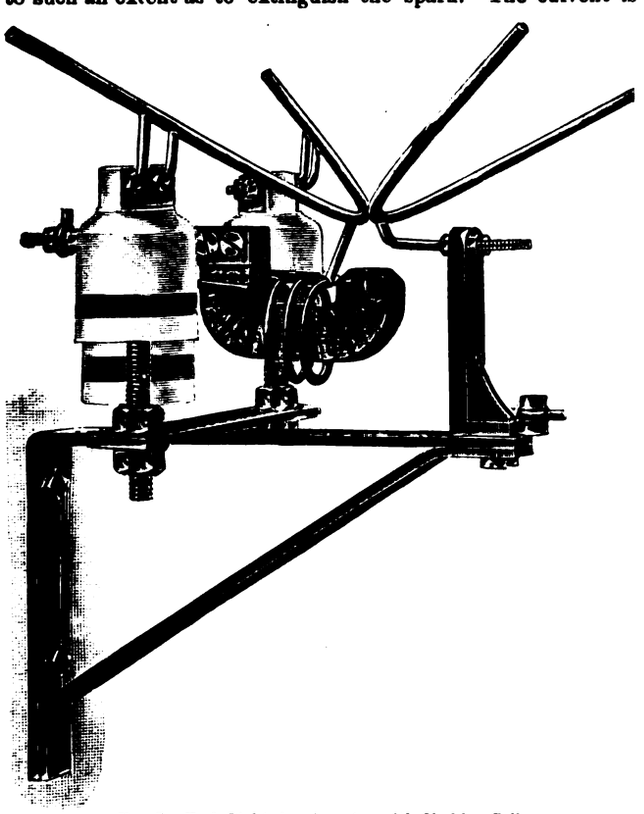

FIG. 3.—Fork-Lightning Arrester with Choking Coil.

interrupted in consequence, the core drops down, and the apparatus is ready for the next discharge. The spark-gap is, however, somewhat limited in this apparatus, which is not intended to be used for higher pressures than 250 volts. For higher voltages the above firm supply their disc arresters, consisting of a series of circular metal discs separated by mica. The topmost disc is connected with the aerial conductor, whilst the lowest one is connected to earth. The discharge has to travel along the outside surface of the whole series of these discs until it reaches the last one, which is connected to earth. In cases where the apparatus to be protected would not alone offer sufficient inductance to ensure the proper working of the arrester, it is necessary to add a choking coil. The firm's fork-lightning arrester (Fig. 3) is provided with such a coil, consisting of an iron core with a few turns of wire, which becoming magnetised serves at the same time to blow out the arc which is formed between the two forks at the nearest point of approach. The arc is thereby forced to travel sideways and upwards until, the spark gap becoming larger, it is forced to go out. Owing to this magnetic blow-out action in the fork-lightning arrester it is possible to make the spark-gap shorter than the total sparking distance in the disc arresters, making the former much more sensitive. The spark-gap is adjustable between 5mm. and 15mm. By reason of the choking coil attached the fork-lightning arrester is particularly adapted for the protection of underground cables or aerial conductors and switchboards.

Piston Rings.

We have received from the Davy-Robertson Engineering Company, 35, New Broad-street, London, E.C., an illustrated circular relating to their patent hammered self-expanding piston rings. These rings are made on scientific principles throughout. After casting they are turned once only to the correct size of the cylinder. Then, by means of the firm's patent graduated hammering machine, they are hammered on the inside surface in such a way that the hardest blow, and therefore the greatest stress, is set up in the ring diametrically opposite to the joint. The blow of the hammer decreases symmetrically on either side of this point until the joint is reached, where it is at a minimum. It is claimed that as a result of this treatment an absolutely uniform spring is set up in the ring, which not only ensures even wear but effectually prevents the ovalising of the cylinders.

Catalogues.

CRYPTO ELECTRICAL SPECIALITIES.—From the Crypto Works Company, Limited, 29, Clerkenwell-road, London, E.C., we have received a copy of their latest illustrated list of electrical specialities, which latter consist for the most part of small continuous and alternating current generators and motors of various types for special purposes, such as lighting small workshops, electroplating and depositing, driving fans, experimental work in the laboratory, etc. Continuous and alternating current transformers for small outputs are also listed, besides ammeters, voltmeters, resistance boxes, etc. We note that the firm supply sets of castings and materials for constructing small dynamos.

RAWHIDE GEAR-WHEELS.—We have received from Messrs. David Brown and Sons, East-parade, Huddersfield, a copy of a treatise on rawhide gearing. It contains all that one wants to know about this class of gearing and is well illustrated.

EDINBURGH ELECTRICITY ACCOUNTS.

The accounts of the Edinburgh Corporation electricity department for the year ended May 15, 1902, show a total expenditure on capital account to that date of £765,612. Abstracts of the revenue account, etc., are appended.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal and other fuel	11,042	1	5
Oil, waste, water, and stores	1,418	10	10
Salaries of engineers	1,137	5	10
Wages at station	2,935	7	3
Repairs, etc., of buildings	63	7	1
Ditto machinery and plant	3,086	9	1
Ditto instruments	20	17	8
	19,703	19	2
Distribution of electricity	2,779	3	10
Public lamps—wages, carbons, and repairs	4,350	13	10
Rents, rates and taxes, and insurance	6,671	14	11
Expenses of management, salaries, etc.	3,984	17	0
Miscellaneous expenses	1,415	15	9
	38,906	4	6
Surplus carried to net revenue account	52,054	4	11
	£90,960	9	5

Cr.	£	s.	d.
Sale of current—private lighting	71,267	18	9
Motor power	8,252	12	8
Arc lamps—public lighting	11,152	10	1
Private lighting	26	0	0
Meter rents	32	3	4
Rents of properties in Torphichen-street	211	0	0
Miscellaneous receipts	18	4	7
	£90,960	9	5

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BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Bank balance on account current	15,598	8	4
Sundry creditors and deposits by consumers	63	17	6
Reserve fund and interest	19,211	3	0
Net revenue account balance	7,605	10	9
Surplus	89,308	18	5
	£131,788	8	0

Cr. Assets.	£	s.	d.
Balance at debit of capital account	89,308	18	5
Stores on hand	2,955	4	11
Advance to engineer to meet petty outlay	50	0	0
Sundry debtors for outstanding revenues	20,263	1	8
Reserve fund investment	19,211	3	0
	£131,788	8	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in units			8,819,254
Quantity sold	Private lighting	5,123,133	7,759,223
	Motor power	1,325,481	
	Arc lamps	1,310,609	
Quantity used in stations			502,317
Quantity unaccounted for			557,714

PROFESSIONAL ETIQUETTE.

Six rules to guide the wand'ring sheep
That from the fold have strayed,
Whose conduct makes the angels weep;
Who wander unafraid.
If ten commandments rule the world
(The gold one makes eleven):
'Would think that six would surely fix
Consultants in their heaven.

Six rules to point the narrow way!
Will sixty score suffice?
To regulate the game they play
Who are not over-nice.
Though some, who up to eyes in work,
Need half a hint or less;
The touting crowd will not be cowed
From neck or nothingness.

Six rules to hedge the chosen few!
The gate is rather wide,
'Twill let the whole caboodle through
Who should be kept outside.
For ways and means will answer still
As they have done before;
And, as of old, the key of gold
Unlocks the stiffest door.

* * * * *

O! readers of these sterling rules,
To whom the rules apply;
Whiche'er ye be—the hand or tools
Heed the official "Fie!"
The word is said that's long been thought;
Your methods you must mend,
Or perhaps your sin will find you in,
And mean will be your end!

B. C. H. J.

FORTHCOMING EVENTS.

SATURDAY, NOV. 1.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Comparison of Alternating and Continuous Currents for Different Purposes," by Mr. W. Benison Hird.

MONDAY, NOV. 3.

Royal Institution.—At 5 p.m., general monthly meeting.

TUESDAY, NOV. 4.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Presidential address of Mr. J. C. Hawkshaw.

WEDNESDAY, NOV. 5.

Cold Storage and Ice Association.—At 8 p.m., ordinary meeting at Institution of Mechanical Engineers. Paper: "The Technical Application of Liquid Air," by Dr. Carl Linde.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "Steam and Electrical Exhibits at the Wolverhampton Exhibition," by Messrs. H. A. Pickett and A. B. Scorer.

THURSDAY, NOV. 6.

Rontgen Society.—At 8.30 p.m., ordinary meeting. President's inaugural address.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

529. With four arc lamps burning in series on a 220-volt direct-current circuit, it is found that some lamps consume the carbons faster than the others. Why is this, and how could they be made to all consume evenly?—C. I. S.

530. I wish to use a three-phase motor as a transmission dynamometer to find the exact power taken by various machines. What is the most accurate method of measuring the power applied, and the various losses (hysteresis, friction, etc.) in the motor? All measurements but speed to be electrical. Answers should deal with both synchronous and induction motors.—DYNAMOMETER.

ANSWERS.

Question No. 523.—At the back of a certain switchboard there is a row of sealed-up small iron boxes—one for each machine in the station—and from one of these boxes (which belong to a 150-kw., 250-volt, direct-current shunt machine, and has a label attached to it with the reading—500 ohms, to take 0·5 amperes momentarily) two wires lead: one direct away from the board and apparently to the dynamo, and the other leads out of sight to some connection on the shunt field regulator. The ordinary shunt-regulating resistance is on a frame at the back of the board. State the use of this high resistance. Why is it kept sealed up separate from the ordinary regulating resistance? And make a drawing of the connections of this resistance with regard to the dynamo.

Answer to No. 523 (*awarded 7s. 6d.*).—The use of this high resistance is, no doubt, to form a circuit into which the high E.M.F. induced in the shunt coils when the

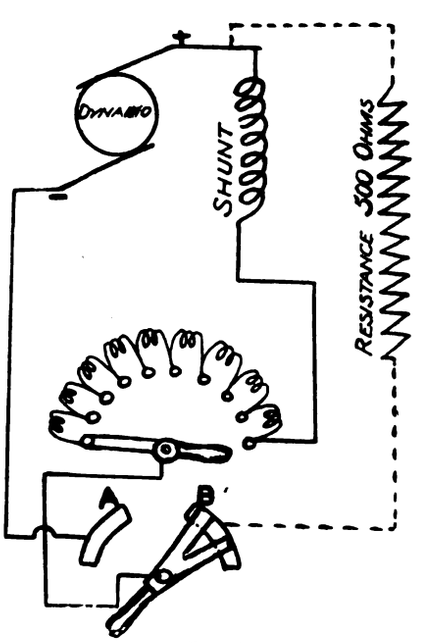

FIG. 1.

circuit is broken can be discharged. No mention is made of a switch being in circuit, but from the fact that all the machines are fitted with one of these resistances, we may conclude that they also have a shunt switch, as otherwise no such resistance would be required. Without some idea of the style of switch it is somewhat difficult to sketch exactly the connections of any particular switchboard, but a reference to Fig. 1 will show one method in which it may be connected. The dotted line shows the connections

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for the 500-ohm resistance, one end going to the + shunt terminal, and the other to contact B on the switch. By tracing the connections round with the switch in position, as shown (which is the off position), it will be seen that there is a closed circuit through both resistances and the shunt coil, so that the instant the switch lever touches contact B after leaving A and breaking the shunt circuit, the very high E.M.F. (which would be induced were the circuit simply broken in the usual way)

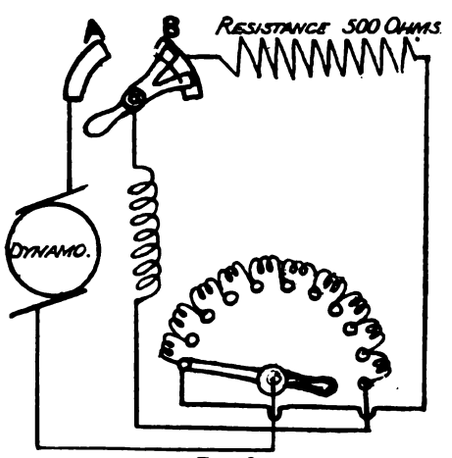

FIG. 2.

is discharged momentarily through the high resistance and also through the regulating resistance, thus avoiding the risk of breaking down the insulation of the field coils and also the armature. Supposing the shunt switch to be fixed on the machine, then one lead from the high resistance *would* go to the dynamo and the other to the regulating resistance, as stated in the question. Fig. 2 will explain how these connections would be made. It has the advantage of having both resistances always in series when switch is on contact B, no matter where the regulating lever may be, though it is the best plan to always put all resistance in a shunt circuit before breaking it. Carbon tips are generally fitted on A and B, also on the arms of the switch lever, in order to take the arcing which necessarily occurs on breaking circuit, and to prevent it damaging

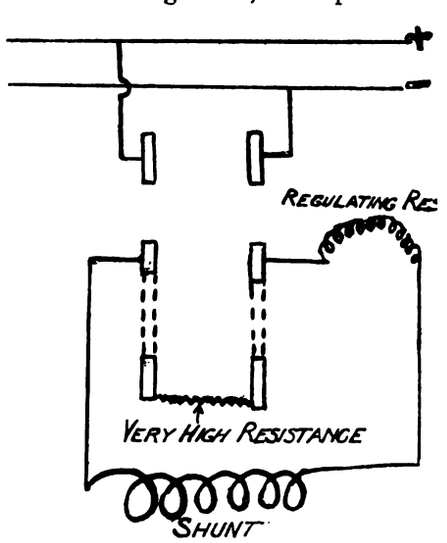

FIG. 3.

the copper contacts. We venture to think that Fig. 1 will prove to be the correct connections, as it is not usual to fix a shunt switch on the dynamo. It is usual when running a number of machines in parallel to separately excite each machine from a pair of exciting 'bus bars. Fig. 3 shows diagrammatically how the connections may be arranged by means of a double-pole throw-over switch so as to produce the same result. As this high resistance has nothing to do with the regulating resistance, and is only in use momentarily when the circuit is broken, this will no doubt account for its being kept separate, and as currents of high E.M.F. pass through it, it is no doubt considered to be the safest plan to seal it up to prevent accidental shocks and to keep everything intact.—C. I. S.

Answer to No. 523 (*awarded* 7*s.* 6*d.*).—The sealed boxes referred to evidently contain the shunt-breaking resistance, which is generally arranged separate from the field-regulating rheostat; but it is not necessarily put into sealed boxes. In this case, perhaps, it has been so arranged to prevent anyone tampering with it and causing the risk of breaking down the insulation of the shunt coils. In the early days such a breakdown was not infrequent; hence the reason for the adoption of the shunt-breaking resistance. From the diagram (Fig. 1) it will be seen that the shunt-breaking switch, which is generally fixed on the main switchboard alongside the field-regulating rheostat, is only a two-way switch, whose function is to serve as a

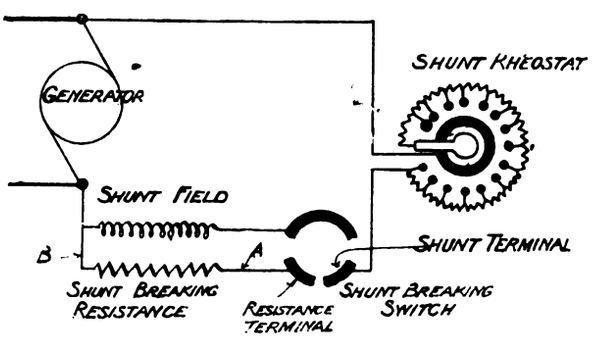

FIG. 1.

make-and-break switch for the shunt field under the condition that before leaving the shunt terminal the switch lever shall make contact with the resistance terminal, thus short-circuiting the shunt field upon itself through the shunt-breaking resistance, whereby the E.M.F. induced in the shunt field by the operation of breaking its circuit is allowed to expend itself in the shunt-breaking resistance, instead of breaking down the insulation of the coil. Suppose that the shunt-breaking resistance and the resistance terminal were removed from the diagram, there would remain merely the regulating rheostat and a plain shunt-breaking switch, as shown in Fig. 2. With this arrangement of connections on high-voltage shunt-wound machines there would be considerable risk of damage to the coils, for the reason that on breaking the circuit the induced E.M.F. in the coils, which would certainly be not less than that of the generator and may be many times greater, would probably pierce the insulation at one or both ends in an endeavour to complete its own circuit through the frame of the machine. Moreover, the flashing at the switch contacts would be very great, probably so great as to fuse them and make them unworkable. By

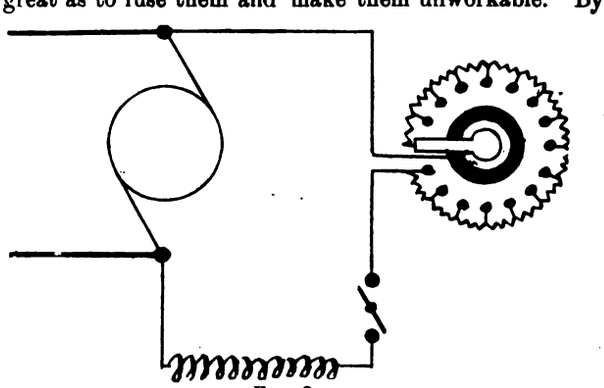

FIG. 2.

connecting a resistance across the ends of the field coils, as shown in the first diagram, all troubles are removed.

A little consideration will show that the conditions are those in Faraday's well-known experiment, by which he discovered the induction currents, and which are explained in all text-books; consequently, it will be observed that on making circuit an E.M.F. will be induced in the coils, tending to stop the flow of current through them, whilst on breaking circuit an E.M.F. will be induced tending to cause a continuance of the flow of current, and it is this which gives rise to the heavy flashing when a highly inductive circuit is broken. If in this particular case the shunt-breaking switch be a component part of the shunt regulator, instead of being separate as on the diagram, then

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the two wires A and B represent those referred to in the question. A represents that which leads "out of sight to some connection on the shunt field regulator," and B that which leads "direct away from the board and apparently to the dynamo."—ALPHA.

Answer to No. 523 (*awarded* 7*s.* 6*d.*).—The resistances described are probably shunt-breaking resistances, the object of which is to enable the shunt circuit of the dynamo to be opened without danger of an arc at the switch or a large inductive rise in voltage, tending to break down the insulation of the field coils.

When the circuit of any magnetising coil is opened the magnetising current, of course, begins to fall off, and with it the number of magnetic lines passing through the coil. This change in flux gives rise to a back voltage or voltage of self induction in the magnetising coil, tending to maintain the current at its original value. If the rate at which the flux is changing be known, the value of this back voltage at any instant can be determined by the expression:

$$\text{Back voltage} = \begin{matrix}\text{Change of flux}\\ \text{through the coil}\\ \text{in C.G.S. lines}\\ \text{per second}\end{matrix} \times \begin{matrix}\text{Number}\\ \text{of turns}\\ \text{in the}\\ \text{coil}\end{matrix} \div 10^8.$$

In the case of large shunt dynamos it has been experimentally proved that this back voltage may easily reach a value 10 times as great as the original exciting voltage if the circuit is broken at all suddenly.

In the case of an ordinary shunt dynamo, with the shunt permanently connected across the brushes, such a voltage rise cannot occur, for the shunt is never broken by hand, the shunt current simply dying down very gradually as the terminal voltage falls off, due to the stopping of the machine.

The machines mentioned in the question are evidently not connected in this way. It is usual when there are a number of machines in a station, all of which are to run in parallel, to separately excite all the shunts directly from the 'bus bars instead of connecting each shunt to the terminals of its own machine. This method enables each machine to be excited from the 'bus bars before the armature is started up and connected to them, thus ensuring that the polarity of the brushes shall always be correct. On the other hand, when the shunts are connected directly across the brushes there is always the possibility of the polarity of a machine becoming reversed, owing, for instance, to a heavy overload or short-circuit, with disastrous results the next time the machine is connected to the 'bus bars. When the shunt is separately excited from the 'bus bars, it becomes necessary to provide some means of safely breaking the shunt circuit when the machine is out of use. This is usually arranged, as in the machines under consideration, by supplying a small resistance for connecting across the shunt at the instant of

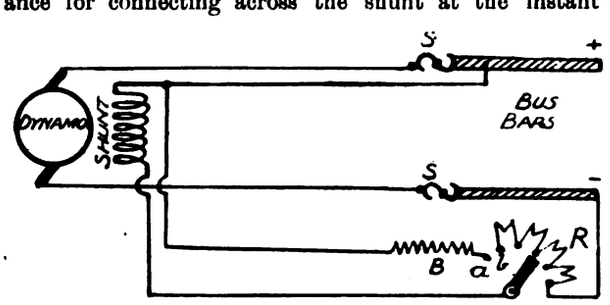


FIG. 1.

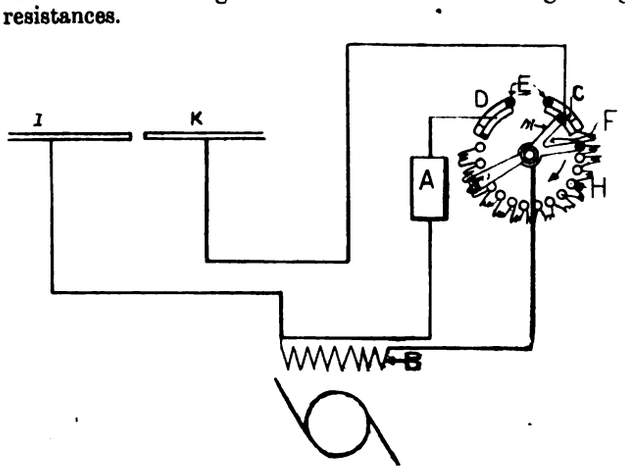
breaking, and thus providing a path through which the shunt current can continue to flow and gradually die down to zero under the action of the back voltage.

Fig. 1 shows the connections for this resistance, R being the ordinary shunt-regulating resistance and B the shunt-breaking resistance connected between one end of the dynamo shunt and the last contact *a* of the shunt regulator switch. During ordinary work B is not in use at all, but when the shunt is to be broken (the machine having been previously disconnected from the 'bus bars by opening switches, *s*) the switch, R, is moved over to contact *b*, thus putting all the regulating resistance into the shunt, and, finally, it is moved on to contact *a*, thus disconnecting the shunt from the 'bus bar and at the same time connecting B across the shunt. The switch, R, is probably arranged so as to make contact with *a* before breaking with *b*, so as to avoid a spark on leaving *b*. When the switch is connecting *a* and *b* in this way, the resistance, B, is directly across the 250-volt 'bus bars and carries a current of $\frac{250 \text{ volts}}{500 \text{ ohms}}$ = half-ampere for an instant, as stated on the label. The action of the resistance, B, is somewhat as follows: As soon as the shunt is disconnected from the circuit and connected to B the shunt current commences to fall. This fall in current (and consequent fall in flux) gives rise to a back voltage in the shunt coil, tending to maintain the current at its old value. This reduces the rate of fall of current, which in turn reduces the back voltage, which again reduces the rate of fall and so on, the current continually dropping but at a constantly decreasing rate. The maximum back voltage occurs at the instant that B is first connected to the shunt and its value cannot possibly exceed

$$\begin{matrix}\text{Shunt current}\\ \text{at that instant}\end{matrix} \times (\text{resistance of shunt} + \text{resistance B}).$$

—Q.

Answer to No. 523 (*awarded* 7*s.* 6*d.*).—When a number of dynamos are run in parallel, the shunt windings of the different machines are generally joined across what are known as the dynamo bars on the main switchboard, so that the machines are separately excited. This being the case, provision must be made for the breaking of the shunt circuit. This shunt circuit must not be broken by the ordinary type of knife switch, because when magnet coil circuits are interrupted a large E.M.F. is the result. If no provision is made for this momentary increase in the E.M.F., it will break down the insulation on the field coils, thus earthing the field circuit. To prevent this breakdown, the switches used are so arranged that before the shunt circuit is broken a large resistance (called the shunt discharge resistance) is placed across the terminals of the field coils, and so the field coils are short-circuited by this resistance. The increase in the E.M.F. still takes place, but it discharges itself through this large resistance. The row of small iron boxes on the back of the switchboard are evidently the shunt discharge resistances mentioned above. They are kept sealed (1) to prevent them from being tampered with; (2) being connected to the opposite side of the shunt winding (as shown in the sketch), there is a difference of 250 volts in this case between the discharge resistances and the shunt-regulating resistances.



In the sketch the dynamo bars are marked I K. From I one shunt wire is run to one terminal of the field winding, B; from the same terminal a wire is run to one terminal of the discharge resistance, A; from the other terminal of A a connection is taken to the discharge resistance contact on the shunt-regulating switch, D. From the terminal on the opposite side of the shunt winding to that from which the discharge resistance connection is taken a connection to the shunt switch arm, F, is made. The various resistance coils are joined to the studs marked H, over which the switch brush moves. The 'bus bar, K, is also joined to the contact, C. The contacts, D and C, are fitted with carbon rollers, E, and the switch arm is also

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fitted in a similar manner. These carbons serves the purpose of taking the spark on the making and breaking of the circuit, and help to keep down the induced E.M.F. in the field coils. To increase the regulating resistance in the field circuit, the switch is moved round in the direction of the arrow; to break the shunt circuit it is moved in the opposite direction. The brush, M, on the switch arm, F, makes contact with the plate, D, before the other brush leaves the contact, C; thus the discharged resistance is placed across the shunt terminals of the dynamo before the shunt circuit is broken, so that the danger of the field insulation being broken down is greatly reduced.—C. G.

Question No. 524.—A small continuous direct-driven set is used for lighting an alternating-current station during the evening. This set is run up slightly higher than its normal voltage, and the lights are then put on to it by plugging over a two-way switch. This operation causes a momentary increase of the volts and then a gradual drop. Explain the reason of this momentary increase.

Best Answer to No. 524 (*awarded* 10*s.*).—The reason of this momentary increase in the voltage on making the circuit, can be explained by considering the characteristic curve of the generator in question. It is evidently a machine which is rather highly compounded, and has a characteristic similar to that shown in Fig. 1

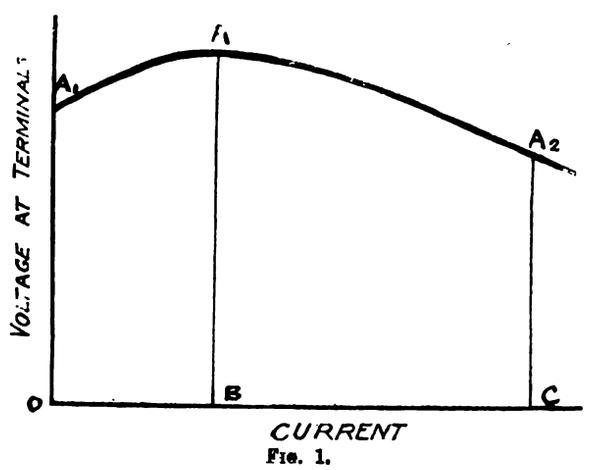

Fig. 1.

As can be seen from this curve, as the current taken from the machine increases in value, the voltage at the terminals rises to a maximum value represented by A B, and then gradually decreases in value. Now suppose current taken by the lamps when the switch is closed is represented by O C. Then, when the switch is closed, some time elapses before the current reaches this final value. For supposing, as is most probably the case, that there are incandescent lamps on circuit, then the current is retarded in growth for two reasons: (1) as the filament of the lamp gets hot its resistance decreases, thus causing the current to gradually rise to its final value; (2) due to the self-induction in the armature of the generator, field windings, and also the lamp filaments, retarding the growth of the current, as expressed by the formula

$$C = \frac{E}{R}\left(1 - \epsilon^{-\frac{R\,t}{L}}\right);$$

where R = resistance in the circuit;
L = self-induction in the circuit.

Corresponding to this gradual increase in the current, the point A will slowly move along the curve from its original position, A_1, to its final position, A_2—*i.e.*, the voltage on making the circuit will increase to a maximum value and then gradually decrease, which is the effect observed by "E. L."—A. P. Y.

Answer to No. 524 (*awarded* 5*s.*).—I assume that the dynamo in question is compound wound. It is run up to speed with no load on, and the shunt coils only are magnetising the field magnets. By means of the two-way switch all the lights in the station are switched over on to this dynamo. This causes a powerful current to flow through the series coils, making the number of magnetic lines flowing through field magnets and armature much greater. The coils in the armature are now cutting more magnetic lines, causing a sudden increase in the voltage. The gradual drop in voltage may be due to a variety of causes, but is most likely due to the speed dropping owing to the load. If the dynamo mentioned by "E. L." were shunt wound, the voltage would suddenly fall when the load was switched on instead of rising. It cannot be a series-wound dynamo, for if so, the machine would not generate full voltage on open circuit. The E.M.F. of any dynamo is proportional to the number of magnetic lines being cut, and this is proportional to (1) the number of magnetic lines provided by field magnets; (2) the number of conductors connected together on the armature; and (3) to the speed at which the conductors are driven. In the case under consideration, the second and third items mentioned above remain constant, but the number of magnetic lines provided by field magnets is suddenly increased, thus raising the voltage.—W. A. T.

Answer to No. 524 (*awarded* 5*s.*).—The momentary increase of voltage is in all probability due to the combined result of the following causes: variation in the speed of the engine, over-compounding of the dynamo, and poor electrical efficiency. When the voltage is taken at open circuit we may have, supposing the normal voltage of dynamo to be 110, say 112 volts, with the engine running at full speed. Owing to the machine being over-compounded, directly the load is thrown on the rise in voltage due to the series winding is greater the drop due to the shunt. Thus the voltmeter may give a reading of 115 volts, or even more. The load will cause the engine to slow up after a few revolutions, momentum of engine and dynamo keeping up the speed for a very short period. A gradual drop in voltage will, therefore, take place, which drop will also be helped by the fact that the current forming the load is sent round a comparatively cold armature and series winding. The passage of this current will cause a rise in temperature and a corresponding increase in resistance; thus more volts will be required for the internal circuit, leaving a smaller available potential at the terminals. The amount due to this cause will, of course, depend upon the electrical efficiency of the dynamo.—M. M.

Answer to No. 524 (*awarded* 5*s.*).—The question does not state whether the small lighting dynamo is shunt, series, or compound wound. In this case we will assume that it is compound wound. Then the momentary rise in volts noticed when switching on the lights is probably caused by the series windings, as, owing to the extra current flowing round them, the magnets would be more powerfully excited, and would, therefore, tend to raise the pressure. But this increased pressure would not be maintained for any length of time, for although the magnets would be excited more powerfully and tend to raise the voltage, yet it must be borne in mind that the extra current not only strengthens the magnets, but also increases the magnetism of the armature, and increased armature reaction results, which always has a tendency to lower the pressure. Hence it will be seen that the rise in pressure will be only momentary and will not be maintained for any length of time, but will quickly fall to its original value; the extra magnetism of the magnets being neutralised by the increased armature reaction. Then, again, a machine when fully loaded always develops a certain amount of heat, which also has a tendency to gradually reduce the pressure. Thus, although the pressure may rise for a second or two somewhat above its normal value at the instant of switching on the load, yet by the combined action of the causes enumerated above it is soon brought to its proper value.—W. F. S.

Answer to No. 524 (*awarded* 5*s.*).—It is much more likely that the voltage rise is apparent rather than real—*i.e.*, that it is due to the action of the voltmeter rather than that of the dynamo. The voltmeter used is probably an ordinary electromagnetic instrument fixed on the switchboard within a short distance of the leads connecting the dynamo to the switch and the switch to the lights. If this is so, it would be quite likely that the reading of the voltmeter would be slightly different (higher in this case) when the current was passing through the leads than at other times, due to a little of the magnetic field set up round the lead by the current penetrating the voltmeter coil and affecting its

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working magnetic field (see Fig. 1). The fact that the effect appears to be only momentary would be due to an actual drop in voltage occurring immediately after the first rush of current, either owing to the engine slowing down slightly or merely to the natural drop of volts in the machine when loaded. The effect of this stray field from the leads would be there all the time, but it would be screened by the much larger actual drop in dynamo volts, except at the first instant, before the engine had had time to slow down or the dynamo field to become weakened by armature reaction.

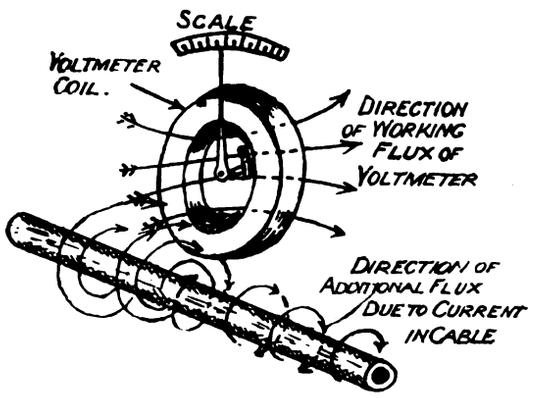

FIG. 1.

There are various ways of proving whether this is the correct explanation. If the leads from the machine are crossed at the machine whilst the voltmeter is kept connected to the same poles as before, the stray field will be reversed relatively to the voltmeter field and no voltage rise would occur, the stray field causing a slight drop, which would be indistinguishable from the natural drop of the machine. Another way would be to disconnect the voltmeter altogether from the circuit, and note whether the needle moves from the zero every time the lights are switched on or off. In order to get rid of the effect, either the electromagnetic instrument should be one surrounded by a thin iron case to shield it from external fields, or it should be replaced by a hot-wire voltmeter.—Q.

TUBE BILLS IN PARLIAMENT.

PICCADILLY AND CITY BILL.

As we briefly announced at the end of our report in last week's issue, Sir Lewis McIver's Committee on Tube Railways declined on Thursday to accept the preamble of the Piccadilly and City Bill, in consequence of the abandonment of the line from Hammersmith to Piccadilly, which was proposed under the London United Electric Railways Bill, withdrawn. Consideration of the former Bill had been postponed from the previous Tuesday to see if the promoters had any suggestions to make for a complete scheme, but at Thursday's sitting

Mr. Balfour Browne, K.C., who appeared for the promoters, said they desired to leave the matter entirely in the hands of the committee.

The **Chairman**, after referring to the withdrawal of the United scheme, which, he remarked, would apparently have been of great public advantage, said that suggestions for the saving of the situation had been made, amongst others, the offer of the counsel for the Piccadilly Bill to pledge his clients to introduce a Bill next session to take up the dropped line of the London United Electric Railways, and so complete the original through route. That was not a proposition which a committee of the House could discuss. Similarly the committee was not competent to deal with the question advanced by the opponents of the Bill as to the extent to which the principle of amalgamation, which was now abandoned, prejudiced other competing schemes in the Upper House. Another suggestion had been that the committee should either make a special report to the House, or suspend its decision, in order to allow time for an independent motion to be made in the House with respect to the Bill. Neither of these propositions commended itself to the committee as warranted either by the circumstances, or, indeed, by precedent. The committee was of opinion that in consequence of the withdrawal of the London United Bill, the Piccadilly Bill no longer represented the scheme sent up to the committee. The Bill provided, in alliance with the withdrawn Bill, for a complete through route from Palmer's Green, *viâ* the City and Piccadilly, to Hammersmith, and there linked up with the London United Electric Tramways. In a large measure it gave effect to the principal recommendations of the Joint Committee on London Underground Railways which reached the House of Commons as an amalgamated and a complete scheme for a through route, and with a preamble wholly meaningless on any other supposition than that of a through route. In the House of Commons it was saddled with an instruction designed to emphasise this particular fact, and to secure, by guarantees, that it should be sanctioned only as a complete and amalgamated scheme for giving London such a through route. The defection of the London United Electric Railways rendered the realisation of this scheme impossible under this Bill. The intention of the House of Commons was to secure the complete through route, and that nothing less should be sanctioned. The instruction was absolutely binding on the committee. On the other hand, the committee could not enforce the instruction of the House, because the promoters of the Bill could not give the required guarantee; and the promoters could not begin their proof till they had given that impossible guarantee. On this ground the committee was unable to proceed with the consideration of the Bill. The preamble could not be proved until the conditions imposed by the instruction of the House of Commons had been complied with.

THE LONDON COUNTY COUNCIL AND THE TUBES.

At the meeting of the London County Council on Tuesday the Parliamentary Committee brought up a recommendation that it be referred to the Parliamentary, Highways, and Finance Committees to at once consider the advisability of the Council promoting in the next session of Parliament a Bill on the subject of underground railways in London.

Mr. Shepherd, in moving the adoption of the report, stated that if the Council controlled the tube railways instead of the companies doing so there would be no delay in construction as at present, whilst financially there would be a very large saving, for whilst the companies had to pay on an average 6¼ per cent., the Council could get money for 3½ per cent. That meant a saving of £200,000 on each £10,000,000 invested, and as it was estimated that the total cost of these railways in London would be £50,000,000, it would be easily seen how large that saving would be. Another strong reason why the Council should undertake the work was that the American financiers had not the real interests of London at heart, but spent their energies in trying to jockey each other out of the field.

Mr. Sidney Low moved an amendment to add the words, "and to further consider the advisability of urging his Majesty's Government to appoint a Royal Commission or Select Committee to consider the whole question of London underground locomotion."

Mr. Phillimore seconded the amendment and the discussion was continued by **Mr. Cornwall** and **Mr. Dew**.

Lord Ribblesdale, who was chairman of one of the committees of the House of Lords in the early part of this session who were charged with the consideration of the Tube Bills, contended that the circumstances of London as regards the development of tube railways were so extraordinary—they might put aside all considerations of time—that he was justified in saying that as a part of the locomotion problem the Council were the proper people to come out and do something. As the chairman of one of the tube committees, he wished to say something about the extreme inconvenience—he might almost say, ultimate disaster—which must result in treating this question of locomotion in London by small instalments, and without any sort of principle or relation one to another. He believed that even at this eleventh hour, if the London County Council came forward and presented an intelligible Bill, they would bring the thing to a head in the way in which it should be done.

After further discussion the amendment was rejected, and the recommendation of the committee was agreed to on a division by 70 to 13.

IN THE HOUSE OF COMMONS.

The discussion of the situation created by the withdrawal of the London United Bill and the rejection of the Piccadilly, City, and North-East London Bill, was on Wednesday transferred to the floor of the House of Commons. The debate arose on the motion of **Mr. Ashton** to recommit the latter measure to the committee. He explained that his sole object in bringing forward this motion was to enable the committee upstairs to deal with the Bill, the preamble of which for the moment they had refused to accept. He submitted that the promoters of the Bill had been hardly dealt with, and were entitled to receive consideration from Parliament in the matter, and that the Morgan group should be given the opportunity of carrying out a through scheme. He further argued that Parliament had been played with and tricked by the promoters of the London United Bill.

Mr. Claude Hay supported the motion.

Sir John Dickson Poynder opposed, suggesting that the mover of the resolution had a well-prepared brief for the Morgan group. It was not for the House to concern itself with the internal differences of speculators.

Mr. Perks also opposed, claiming that the District Railway was entitled to consideration in this matter. It had raised 2½ millions to electrify and improve the line, and hoped to have the work done in about 15 months, and part of it ready very shortly. He added that a scheme was being prepared by the District Railway for a route from Hammersmith to the City, involving an expenditure of about 1½ millions.

Mr. J. W. Lowther (the Chairman of Committees) admitted that the promoters of the Morgan group had been badly used, but not by Parliament. Their enemies were of their own household.

Sir Lewis McIver, the chairman of the Select Committee which had dealt with the Bill, referred to what he called the very unsavory details of the transaction between the promoters of the two Bills—a transaction, a scandal, which had, he thought, probably no precedent in the annals of their committee work upstairs. As one of the workers on the committee upstairs, he would say that, were the motion passed, the committee to which the Bill would be referred would find infinite difficulty in giving effect to the wishes of the House. He said this with the best possible intention and sympathy for this big scheme, which had been wrecked by a Stock Exchange ramp. They should wait till next year, when they could begin with a clear sheet. They would hear all the parties, and on the principle which applied when two of a trade fell out, perhaps the County Council would gets its own.

The motion was then withdrawn.

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LEGAL INTELLIGENCE.

WRONGFUL DISMISSAL.

At the Leicester County Court on Thursday John Shaw Barnes, electrical engineer, of Alfreton, sued Messrs. Lea and Warren, electrical engineers, of Leicester, for £32. 10s., being 13 weeks' wages in lieu of notice. There was a counter-claim for £22, of which £12. 10s. was for part loss said to have been sustained by defendants through plaintiff's negligence in connection with a switchboard which defendants were under contract to make and supply to the Ordnance Survey Works, Southampton. Plaintiff's case was based on an agreement for three months' notice on either side to terminate the engagement. He further stated that following an interview with Mr. Lea in reference to the Southampton contract he received a letter on the Sunday morning saying that his services were no longer required and offering him a week's wages.

Mr. Lea (Messrs. Lea and Warren) said that when he accused plaintiff of having bungled the Southampton work and of having commenced the work without getting the plans passed, plaintiff subsequently promised to make good any loss that might be sustained through the work being incorrect. The switchboard had been rejected, and he estimated his loss at £12. 10s.

The **Judge** said he agreed that there was plenty of ground for dissatisfaction with plaintiff's conduct, and for notice being given him to leave at the end of three months. He did not think, however, that the circumstances justified a summary dismissal, and on that ground he found for plaintiff for £24. 10s. With regard to the counter-claim, he found for defendants for £12, loss sustained in connection with the switchboard, and for £3. 10s., moneys for which plaintiff, as alleged, had not properly accounted. The balance in favour of the plaintiff was therefore £9.

ELECTRO-MOTION CORPORATION.

In the High Court on Tuesday Mr. G. Hart applied to Mr. Justice Byrne, on behalf of certain creditors for £128. 5s., for an order for the winding-up of the above company.

Mr. Hart explained that one of the petitioners was the secretary, who had had to serve notice upon himself, there being nobody else in England whom he could serve. The directors were all foreigners, and the memorandum and articles were printed in French and English. The petitioners' debt was for rent of offices and for salary for secretarial services and for money paid. Service was effected at the company's registered offices, and counsel supposed that it was technically right. The whole thing had become abortive, and he suggested it might be put an end to.

His Lordship said there would be an order for substituted service upon some shareholder, and meanwhile the petition would stand for a fortnight.

CURIOUS COMPENSATION CASE.

A somewhat remarkable claim for compensation against the Corporation of Glasgow was decided by Sheriff Strachan in the County Buildings, Glasgow, recently. The action was brought by a Glasgow lady to recover £12 in respect of damage she alleged she had sustained by being driven in an electric tramcar through a mass of dirty water on the journey from Tollcross to Parkhead. The plaintiff gave evidence that the water had accumulated over the rails at a part of the route to the depth of about 2ft. as the result of a heavy thunderstorm. The progress of the car caused the water to burst through the trap doors on the bottom of the car with such force as to drench more or less severely all the inside passengers.

The Sheriff gave judgment for the plaintiff, and awarded her 25s. damages, and costs.

COMPANIES' MEETINGS AND REPORTS

WESTERN TELEGRAPH.

The ordinary general meeting of the shareholders in this Company was held on Wednesday at River Plate House, Finsbury-circus, E.C., Sir John Wolfe Barry, K.C.B., presiding.

The **Chairman,** in moving the adoption of the report and accounts, said that although the report before them was not altogether so satisfactory as it had been on former occasions, it still showed that the business of the Company was going on in a proper manner. They had experienced a large falling off in message receipts during the period under review in consequence of the adverse conditions which had generally prevailed, and to the fact that business in South America had been on a very small scale. It was estimated that the revenue for the current half-year, however, would be slightly higher than for the corresponding period last year. In referring to the relations existing between the Company and the inventions of wireless telegraphy, he said that the directors had decided to experiment and test the possibilities and non-possibilities of the system for themselves, and with this end in view they had erected an installation at one of their stations, and were fitting up their ships with wireless telegraphic apparatus. Such a system, in the opinion of the Board, might be extremely useful to them, as it would be possible to communicate with any of the Company's ships when perhaps 200 or 300 miles on a journey home, and instruct them to return, and on the way make certain repairs to any of their cables. This would mean not only a very considerable saving, both in coal and a ship's time, but, what was of still more importance, repairs would be done in less time. They were therefore looking forward to being able to effect some economies in that way. With regard to the commercial value of wireless telegraphy, he had gone into the matter some 18 months previously, and his experience was that, so far as could be judged, the system was not likely to be a rival to cable enterprises.

The report was adopted.

TIN ELECTRO-SMELTING (ZINNOXYD).

The ordinary general meeting of the shareholders in this Company was held on Tuesday at the offices, 16, Tokenhouse-yard, under the presidency of Mr. Alfred Leclerc. From the report of the proceedings which has been issued to the Press,

The **Chairman** said the business of the Company was progressing beyond expectation. The balance-sheet had been prepared and certified to Oct. 15 last, and showed the substantial profit of 12 per cent., out of which the directors proposed to distribute an interim dividend of 7s. per share. He thought they would agree with him that the result obtained was highly satisfactory. The successful development of their business was continuing. New markets had opened out for their industry, and afforded them ample spheres for the placing of their products. He concluded by moving the adoption of the report and accounts and payment of an interim dividend of 7s. per share.

The motion was then put and unanimously agreed to.

The **Chairman** having briefly responded to a vote of thanks, the proceedings terminated.

CAPE ELECTRIC TRAMWAYS.

The report of the directors for the year ended June 30 last states that the profit and loss account on the 12 months' working, after provision for debenture interest and redemption of debentures, shows a net balance to credit of £81,498, which, added to the balance of £15,341 brought forward, makes a gross total profit of £96,840. From this sum the directors have paid to the shareholders 16 per cent. upon their capital, represented by three interim dividends. The directors have also placed to the credit of the reserve fund £8,000. These several sums aggregate a gross total of £80,800, and leave £16,040 to be carried forward. From this sum, however, provision has to be made for the remuneration of directors and auditors. A sum of £40,000 2¾ per cent. consols has been purchased at a cost of £37,841 from the special reserve fund of £56,000. The report for the year ended June, 1901, showed a very gratifying increase in the business over previous years, and this increase of traffic has still further developed, both in Cape Town and Port Elizabeth, during the past year. After many unavoidable, though vexatious, delays, owing to the abnormal condition of business in Cape Town, the enlargement of the power station, the erection of additional engine and boilers, the enlargement of the car-shed necessary for the additional cars (now added to the rolling-stock in Cape Town) have all approached final completion, and already some of their new cars were in active operation. The extension from Port Elizabeth to Humewood, referred to in the last report submitted to the shareholders, has now been completed, and will be opened for traffic during the current month. The Bill for the electrification of the Sea Point Railway, after having been drafted for submission to Parliament, was afterwards withdrawn owing to the opposition of the municipality of Cape Town, which endeavoured to embody certain clauses which, with every desire to meet that body, it was impossible for the Board to accept. The appeal which was lodged before the Privy Council by the Eastern Telegraph Company against the decision given in the Company's favour by the Supreme Court in Cape Town in the question of the suit brought against the Company by the telegraph company claiming damages for £50,000 alleged to have been caused to their cable service by the working of the tramways, was heard on April 18 last, and unanimously given in the company's favour. This decision has finally put an end to prolonged litigation, and may be regarded as of the greatest importance as being likely to form a precedent for the settlement of future litigation of an analogous character. The extension to the Cape Town docks has not yet been put in hand owing to further disagreements which have arisen between the Cape Town Municipality and the Harbour Board, without whose joint co-operation, together with that of the Cape Government Railway, the line cannot be constructed. On Jan. 25 last the directors authorised an issue of a further 40,000 ordinary shares of the company at 37s. 6d. per share, being at a premium of 17s. 6d. per share. This issue, as in the case of the previous one, was made to shareholders *pro rata* to their holding.

BROCKIE-PELL ARC LAMP.

The second annual report of the directors, to be presented at the ordinary general meeting of the Company, to be held at the Company's premises, 60, Worship-street, Finsbury, E.C., on Nov. 5 at 12.30 p.m., states that the profit and loss account and balance-sheet for the year ending June 30, 1902, show that after writing off £629. 0s. 4d. depreciation on plant, machinery and tools, etc. (against £435. 17s. 11d. written off in the previous year), there remains a net profit on the year's trading of £2,232. 14s. This added to the amount brought forward from last year makes a total of £4,698. 2s. 7d. for disposal. Out of this sum the directors propose to write off the remainder of the reconstruction expenses—£344. 10s.—and recommend the payment of a dividend of 3 per cent., amounting to £2,392. 10s. 7d., thus leaving a balance of £1,961. 2s. to be carried forward. The Company's business has shown a considerable increase during the year, the sales of lamps and accessories being 40 per cent. in excess of

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those for the preceding period. On the other hand, owing to severe competition on the part of rival manufacturers, the prices obtained have not been so favourable, and the profits have therefore been smaller in proportion. In order to meet this competition the directors have now introduced a cheaper form of their standard lamps, which is enabling them to secure profitable orders which they have hitherto been unable to obtain on account of price. The contract for the lighting of the Glasgow Exhibition has been satisfactorily completed, and a large number of the lamps employed therein have been sold. The directors have also undertaken the lighting of the present exhibition at Wolverhampton, and 350 of the Company's lamps are now in use for that purpose. Amongst other important orders which have been executed during the year may be mentioned those for lamps for street and tramway lighting in Westminster, Edinburgh, Stirling, Manchester, Salford, and Bournemouth. Since the conclusion of the war several important orders have been received from South Africa, and there is every reason to expect a steady development of this branch of the Company's business. The remaining 1s. per share has been called, and duly paid up, in accordance with the notification contained in last year's report, and has enabled the directors to pay off the mortgage debenture of £2,000. In accordance with the articles of association the Hon. R. Brougham retires, and, being eligible, offers himself for re-election. The auditors, Messrs. Mellors, Basden, and Co., also retire, and, being eligible, offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Patent fees, etc.	226	14	0
Directors' fees	450	0	0
Legal expenses and accountancy charges	136	5	1
Income tax	108	4	10
Depreciation of plant, tools, fixtures, etc.	629	0	4
Reserve for doubtful debts	143	12	3
Interest on debenture	6	19	9
Balance carried to balance-sheet	2,232	14	0
	£3,933	10	3

Cr.	£	s.	d.
Balance from trading account	3,901	1	2
Royalties	27	19	1
Transfer fees	4	10	0
	£3,933	10	3

HARROW ELECTRIC LIGHT AND POWER.

The adjourned general meeting of the shareholders in this Company was held on the 16th inst. at the offices, West-street, Harrow. A communication was read from Mr. E. R. Bartley Denniss, who did not attend the meeting, stating his reasons for resigning his seat on the Board in January last, and was considered by the meeting after an explanation from the chairman of the Company. The meeting then re-elected as director Mr. C. E. Ashford, who had been chosen by the directors to the seat vacated by the death of Dr. Stiven, and voted to the directors the sum of £150 as remuneration for their services for the year 1902.

NEW COMPANIES REGISTERED.

Electric Mercantile Agency, Limited.—Capital, £1,200. Objects: to carry on the business of an electric light company, and of electricians, electrical, mechanical, and general engineers, suppliers of electricity, manufacturers of electrical apparatus, etc.

Autocar Construction Company, Limited.—Capital, £25,000. Objects: to acquire and carry on the business of the Pollock Engineering Company as manufacturers of and dealers in motorcars and accessories, mechanical and electrical engineers, etc.

Burma Electric Tramways and Lighting Company, Limited.—Capital, £200,000. Objects: to construct, equip, and work as owners, lessees, managers, and contractors any tramways, light railways, or other roads or ways; to generate, supply, utilise, and distribute electric or other power for locomotion for the working of plant or machinery, etc

Siemens Electric Appliances, Limited.—Capital, £25,000. Objects: to carry on the business of manufacturers of and dealers in electrical goods, appliances, plant, etc.

Leyland Motor-Transit Company, Limited.—Capital, £10,000. Object: to adopt an agreement with the Lancashire Steam Motor Company, Limited, and to carry on business as joint-stock carters of passengers, makers of motors, electricians and electrical engineers, etc.

Rangoon Electric Construction Syndicate.—Capital, £1,000. Objects: to apply for and obtain from the proper authority in Burma concessions and powers for constructing and working electric tramways and electric lighting works, and to turn the same to account.

United Kingdom Lighting Trust, Limited.—Capital, £50,000. Object: to adopt an agreement with J. E. Evered, and as manufacturers of all kinds of lighting and heating appliances; as general engineers; to erect and maintain telegraphs, telephones, and other electric apparatus, etc.

Electromobile Company, Limited.—Capital, £1,000. Objects: to carry on business as builders of motors and electrical engineers, etc.

Nottinghamshire Electric Tramways, Limited.—Capital, £100. Objects: to construct, maintain, and work tramways, light railways, electrical, and other railways, motors, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bristol.—The Electrical Committee invite tenders for arc cables. Tenders by Nov. 14. See advertisement.

Midland Railway Company.—The Directors invite tenders for various annual stores. Tenders by Nov. 11. See advertisement.

Burton-upon-Trent.—The Corporation invite tenders for the overhead equipment of their tramway lines, etc. Tenders by Nov. 5. See advertisement.

Erith.—The Urban District Council invite tenders for the supply of meters (single and three phase) and cut-outs. Tenders by Nov. 12. See advertisement.

Salford.—The Electricity Committee invite tenders for the supply and delivery of 1,500 yards of lead-covered pilot wire. Tenders by Nov. 12. See advertisement.

Lowestoft.—The Corporation invite tenders for overhead line equipment, poles, etc., and underground feeder cables, etc. Tenders by Nov. 26. See advertisement.

Aylesbury.—Tenders are invited for electric lighting, telephones, and tell-tales required at the Bucks County Lunatic Asylum, near Aylesbury. Tenders by Nov. 8. See advertisement.

Sunderland.—The Corporation invite tenders for one steam-driven three-phase generator, motor-generators, and static transformers, and high and low tension switchboards. Tenders by Nov. 28. See advertisement.

Radcliffe.—The Urban District Council invite tenders for the supply and erection of steam-engines and dynamos, boilers, superheaters, and economisers, and jet condenser and feed pumps. Tenders by Nov. 14. See advertisement.

Southampton.—The Corporation invite tenders for the supply of car bodies and electrical equipment, and trucks for 12 motor carriages. Specification, etc., can be obtained from Mr. H. F. Street, borough electrical engineer. Tenders by Nov. 18.

Dewsbury.—Tenders are invited for erecting the installation for the electric light at the Dewsbury and District General Infirmary. Specification, etc., can be obtained from Mr. Charles J. Abbs, secretary. Tenders by 2 p.m. on Nov. 8.

Cheltenham.—The Guardians invite tenders for renewing the electric bell installation at the workhouse, Cheltenham. Specification, etc., may be obtained from Mr. J. Villar, 33, Cambray, Cheltenham. Tenders by 5 p.m. on Nov. 5.

Middleton (Lancs.).—The Middleton and Tonge Industrial Society, Limited, invite tenders for the wiring of central premises for electric lighting. Specifications, etc., can be obtained on applying at the Office, Long-street, Middleton. Tenders by Nov. 3.

Caen (Calvados, France).—The Prefect at this place requires tenders for the concession and working of a light railway between Trouville and Honfleur, a distance of about 10 miles, for goods and passenger traffic. Electric traction preferred. Tenders by Jan. 1, 1903.

Halifax.—The Tramways and Electricity Committee invite tenders for the supply and erection of a new 750-kw. steam dynamo complete, with condenser. Specifications, etc., can be obtained from Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders by Nov. 20.

Leyton (Essex).—The School Board invite tenders for the electric lighting, in situ concrete paving, and heating apparatus required at the Farmer-road Schools, Leyton, E., now in course of erection. Specification, etc., can be obtained on application to Mr. William Jacques, A.R.I.B.A., 2, Fen-court, Fenchurch-street, E.C. Tenders by 6.30 p.m. on Nov. 3.

Newcastle-upon-Tyne.—The Tramways Committee invite tenders for the supply and erection complete of a new triple-expansion direct-coupled engine, of 3,000 h.p., at the power station, Newcastle-upon-Tyne. Specification, etc., may be obtained from the general manager and engineer, Mr. A. E. Le Rossignol, M.I.E.E., Manors Power Station, Newcastle-upon-Tyne. Tenders by Nov. 8.

Dumfries (Scotland).—The Town Council invite tenders from companies as follows—viz.: (1) for the burgh's electric light provisional order, and alternately (2) for light and traction combined; (3) for a supply of electricity to drive the cars, if the Council resolve to conduct the traction; (4) if the Council construct the works, tenders for a lease of each. Tenders by Dec. 1. See advertisement.

London.—The County Council invite tenders for the supply and delivery of one 50-ton electric power overhead travelling crane, with auxiliary two-ton hoist, and for the erection of the same in the Council's electricity generating station at Greenwich. Delivery and erection of this plant at Greenwich is required as soon as the buildings are ready to receive it, which, it is anticipated, will be within about 15 months. Specification, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by Nov. 18.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

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London.—The County Council invite tenders for the roadwork and platelaying required for the reconstruction on the conduit system for electrical traction of the tramways (a) from the Elephant and Castle, *via* New and Old Kent Roads, to East Greenwich, and (b) from the Elephant and Castle, *via* Walworth-road, Camberwell Green, Church-street, Peckham-road, and Queen's-road, to New Cross-gate. The contractor will be required to use the track rails and fastenings, the slot rails and conductor tees, which will be furnished by the Council under another contract; but all the remaining metal work and other materials, and all the special work at junctions, crossings, cross-overs, car-shed entrances, etc., beyond the track and slot rails and the conductor tees, will be included in this contract. Specifications, etc., can be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Nov. 18.

RESULTS OF TENDERS.

Oban.—The Town Council have accepted the tender of Messrs. Claud Hamilton, Limited, for wiring and fitting the generating station at £105, and spare stores at £8.

Cape Colony.—Ferranti Limited, Hollinwood, Lancashire, have just secured the order for the supply of transformers to the King William's Town Electric Light and Cold Storage Company.

Grimsby.—The Town Council have accepted the tender of the National Telephone Company for the fixing of electrical communication bells between the central fire station and the firemen's houses.

West Ham.—The Corporation have accepted the tender of Estler Bros., 25, Laurence Pountney-lane, E.C., for supply of 46 combined arc lighting and traction poles with side brackets, at £10. 15s. per pole.

Leeds.—The Leeds Industrial Wholesale Co-operative Society have ordered from Willans and Robinson, Limited, engines of the Willans type for direct coupling to dynamos of the British Thomson-Houston Company's make, for use in their new power house.

Newcastle-on-Tyne.—The Wholesale Co-operative Society have ordered from Willans and Robinson, Limited, two 250-h.p. Willans engines for direct coupling to dynamos of the Westinghouse type, for supplying power to their new mills at Dunston-on-Tyne.

Middlesex.—The following tenders for the construction of light railways have been received by the Middlesex County Council:—

Railway No. 1.—Lordship-lane and Bruce-grove.

T. Adams	£33,414	17	2
Binns	36,412	9	8
R. W. Blackwell and Co.	35,584	1	0
R. C. Brebner and Co.	43,846	9	4
Dick, Kerr, and Co.	28,498	18	6
J. A. Dunmore	52,946	19	0
J. A. Ewart	30,983	17	4
A. Faulkes	30,374	15	8
W. Griffiths and Co., Limited	28,336	13	0
W. Griffiths and Co., Limited*	28,329	3	8
A. Kellett and Sons	32,982	6	4
Kirk and Randall	37,830	5	4
Macartney, McElroy, and Co.	31,754	8	2
W. Manders	30,216	16	6
W. L. Meredith and Co.	36,944	2	4
E. Nuttall	32,326	6	8
A. Porter	37,311	13	4
P. Smith	33,483	10	8
C. Wall	36,068	6	4
J. G. White and Co., Limited	28,232	1	0
J. G. White and Co., Limited, if English rails	28,380	9	9

Railway No. 3.—Archway-road and Great North-road.

R. W. Blackwell and Co.	63,298	19	2
R. C. Brebner and Co.	86,740	17	4
Dick, Kerr, and Co.	50,644	0	2
J. A. Ewart	56,580	12	8
A. Faulkes	54,964	12	5
W. Griffiths and Co., Limited*	50,224	16	3
A. Kellett and Sons	58,989	9	6
Kirk and Randall	67,658	17	2
Macartney, McElroy, and Co.	57,585	1	6
W. L. Meredith and Co.	70,628	3	5
E. Nuttall	59,086	18	6
P. Smith	61,403	5	8
C. Wall	61,337	13	10
J. G. White and Co., Limited	50,022	3	1

Railway No. 5.—Edgware-road.

R. W. Blackwell and Co.	66,857	7	11
R. C. Brebner and Co.	85,278	8	10
Dick, Kerr, and Co.	50,367	6	6
J. A. Ewart	57,039	10	0
W. Griffiths and Co., Limited	50,221	16	11
A. Kellett and Sons	60,431	14	4
Kirk and Randall	67,598	17	8
Macartney, McElroy, and Co.	58,184	8	7
W. L. Meredith and Co.	72,339	6	8
H. Morecroft	64,927	10	0
J. Mowlem and Co.	57,965	4	1
E. Nuttall	59,990	3	4
P. Smith	61,665	15	0
C. Wall	59,992	0	10
J. G. White and Co., Limited	49,537	5	5
J. G. White and Co., Limited*	49,881	10	5
W. G. Wimpey	55,271	4	8

* Tenders recommended for acceptance. English rails to be supplied.

London County Council.—The Council have received the following tenders for the supply and erection of two electrical car traversers to be used at the Clapham and Balham car-sheds respectively, for the purpose of removing cars from one set of lines to another:

Dick, Kerr, and Co., London (accepted)	£900
Ransomes and Rapier, Limited, London	920
British Thomson-Houston Company, Limited, Rugby	964
C. and A. Musker (1901), Limited, Liverpool	1,040
R. W. Blackwell and Co., Limited, London	1,170
T. Green and Son, Limited, Leeds	1,400

French Submarine Cable.—Two contractors—the Société Industrielle des Téléphones and Messrs. Grammont—only sent in tenders for the contracts, details of which have already appeared in our columns. They included cables (1) from Brest to Dakar, 2,415 miles; between Saigon and Pontianak, 800 miles; and two cables from Tamatave to Réunion, etc., 610 miles. No. 2 only has been settled, and has been adjudicated to Messrs. Grammont at 4,960,500frs.. The tender for No. 1 by the Société Industrielle at 16,495,000frs. was still above the maximum fixed by the Government, as was the tender for No. 3. Both companies combined, as the contract was only open to French companies, to force the Government to advance the maximum offer.

Leicester.—The Town Council have accepted the following tenders for rails, fishplates, points, and crossings in connection with the electric tramways: the North-Eastern Steel Company, Limited, Middlesbrough, 4,800 tons of rails and 175 tons of fishplates, £32,325; the Hadfield Steel Foundry Company, Limited, Sheffield, points and crossings and construction of lay-outs and special track work, £13,041. With regard to the former tender 12 firms submitted 14 tenders; seven tenders were for English rails and seven for foreign rails. The prices for foreign rails varied from £30,485 to £32,579. The English tenders varied from £32,325 to £39,276. For the special track work eight firms tendered, including English, American, and Belgian, and varied from £6,695 to £13,722.

Swansea.—The Town Council have received the following tenders for telephone equipment: Henley's Telegraph Works Company, Cannon-street, London, E.C., conduits and manholes, and supplying and laying telephone cables; Armstrong, Addison, and Co., Sunderland, creosoted poles; Bullers, Limited, Cannon-street, London, telephone insulators: T. Aspden and Sons, Daisyfield, Blackburn, oak arms; Bryden and Middleton, Scotstoun, Glasgow, ironwork; Guest, Keen, and Nettlefolds, London Works, near Birmingham, arms, bolts, etc.; F. Smith and Co., Anaconda Works, Salford, copper wire; W. F. Dennis and Co., Billiter-street, London, E.C., bronze wire, stay wire, and insulated wires; International Electric Company, Limited, Barbican, London, lightning arresters, high-tension guards, etc.; British Insulated Wire Company, Helsby, near Warrington, batteries; Ericsson-Bell Telephone Company, 50, Wellington-street, Glasgow, telephone instruments; British Insulated Wire Company, switchboards. Note.—The above are accepted subject to the approval of the Local Government Board to the borrowing of the money required.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Leeds.—A number of extensions of electric mains have been agreed to.

Barrow.—Mr. Bennett has been asked to report upon a municipal telephone scheme.

Eastbourne.—The electrical engineer is recommending a further expenditure of £8,000.

Earsden.—The Urban District Council have decided to proceed with the lighting of Holywell by electricity.

Breconshire.—The County Council are proceeding with the electric light installation at the new asylum buildings.

Leigh.—The Town Council have resolved to bring in a Bill in which power is sought, *i.a.*, for the supply of electricity.

Cav. Marconi.—The King of Italy has appointed Signor Marconi to be a Chevalier of the Order of Industrial Merit.

Watford.—There has been an increase of £300 in the income of the Watford electric light undertaking during the past six months.

Inverness.—The Electric Supply Corporation are about to apply for a provisional order for the supply of electric light to the burgh.

Bath.—The last report from the Electric Lighting Committee stated that the new engines at the electric light works are running well.

Panteg.—The South Wales Electrical Power Distributing Company propose shortly to proceed with the erection of their generating station.

Hoylake and West Kirby.—We are informed that the new resident electrical engineer to the District Council, Mr. M'Haffie, has taken up his duties.

Cowes.—The District Council have decided to oppose the proposals of the Isle of Wight Electric Light and Power Company now before the Board of Trade.

Ashford.—The Urban District Council have decided to "farm" its provisional order for electric supply purposes, and is endeavouring to arrange a contract to that end.

Penrith.—A scheme is being considered by the Urban District Council for providing a system of electric lighting for the town. The minimum cost is put at £18,000.

Brockie-Pell Arc Lamp, Limited.—The transfer books will be closed from Nov. 3 to Nov. 18, both days inclusive. The meeting will be held on Nov. 5 at 60, Worship-street, E.C.

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Bedwellty.—At the last meeting of the District Council it was decided to engage an expert to report to the Council upon the proposal to provide the district with an electric lighting supply.

Dodworth.—The Urban District Council are about to make enquiries from a number of electric firms with a view of ascertaining the cost of putting down a plant and maintaining the light.

Callender's Cable and Construction Co.—The directors have resolved to pay an interim dividend of 5s. per share to the holders of ordinary shares Nos. 1 to 30,000 and Nos. 40,001 to 45,000.

East Barnet.—Application is to be made for sanction to borrow £14,000, the estimated cost of the proposed electric lighting scheme, and £400, the estimated cost of land for the proposed depôt.

Twickenham.—The Twickenham and Teddington Electric Supply Company have received sanction to lay down main cables and boxes for connecting up the same in a number of roads in the district.

Aberdeen.—Applications for extensions of electric mains in various parts of the city have been approved of on the usual terms. The electric lighting of Union-street was finally agreed to on Tuesday.

Rugby.—The Urban District Council have adopted Mr. Trentham's amended estimate of expense, adding £3,000 to the former amount of £9,000, and will apply for sanction to the borrowing of £12,000 for electric lighting purposes.

German West Africa.—The Budget for 1903 provides for the construction of a telegraph line between Duala and E'dez. A line from Duala to Buea has been begun, and a telephone between the latter place and Victoria is being discussed.

Buckley.—The Council are considering the advisability of asking the Cheshire and North Staffordshire Electrical Supply Syndicate to include Buckley in the scheme on the same terms and conditions as those proposed for Chester and Birkenhead.

Newton Abbot.—The Urban District Councilhave asked the Urban Electric Supply Company upon what terms they would furnish 20 arc lamps (each with two incandescents), 196 all-night lamps, and 58 half-nights, and in the alternative 98 all-night lamps.

Brechin.—The work of fitting-up the electric light in the muncipal chambers has now been practically completed, and the light was turned on for the first time on Monday. The work has been most satisfactorily carried out by Messrs. C. Middleton and Son, Brechin.

Carlisle Telegraph Messengers.—The Carlisle Telegraph Messengers, to the number of 30, who were drilled by Mr. Pollard, were inspected in the gymnasium at the Castle by Colonel Brind last week. Mr. Percy James, the postmaster, and others were present.

New Technical Institute.—A technical institute is to be erected in Poplar by the London County Council. The building will be opened in about 12 months time, and will be used as a centre of instruction mainly for the mercantile marine and engineering and shipbuilding trades.

Luton.—The electrical engineer's last report states that since Sept. 12 7,474 units have been generated, and an equivalent of 592 8-c.p. lamps connected, making a total of 74 consumers with 5,643 lamps and seven motors of 25 h.p.; and that at present there are 396 additional lamps being wired.

Horsham.—At the last meeting of the Urban District Council it was stated that the electric lighting department would pay its expenses by the end of February if properly treated. This is very satisfactory, seeing that the committee make a very low charge for current used for public lighting.

Durban.—The Natal Government Railways have placed the order for the boiler-house equipment of 10 stokers, and compressed-air furnaces with automatic steam regulators and complete coal and ash elevating, conveying, and storage plant, with Messrs. Ed. Bennis and Co., Limited, of Bolton and London.

Rangoon.—The question of providing an improved system of lighting by electricity is still engaging the committee's attention. The Council first put their considering cap on with regard to that matter somewhere in 1884 or 1885, so that at this rate we may expect progress to be reported at the end of the century.

Eliand.—The Electricity Committee of the District Council have decided that the sale price of electricity for lighting purposes shall be 4d. per unit, instead of 5d., as originally intended. It is very unlikely that the price of the current for power purposes will be more than 2d. per unit, although it has not yet been fixed.

Darlington.—Mr. J. C. Pottinger has held an enquiry into the Town Council's application for sanction to borrow £14,500 for the purposes of extending the electric power stations. At the present time the plant will supply about 16,000 8-c.p. lamps, and as there are already 14,156 connected, but a small margin is left, while demand is still increasing.

Ormskirk.—At the last meeting of the Urban District Council a letter was read from the County Council refusing their permission to the laying of an electric cable between Southport and Ormskirk on the main road for the purpose of the supply of electricity to the latter by the borough for the public and private lighting of the town. The letter was referred to the committee for further consideration.

Farnworth.—The report of Mr. J. D. Pember, A.M.I.E.E., gives the following figures concerning the working of the electric lighting department for the quarter ending Sept. 30, 1902: 105,303 units sold; receipts, £1,104. 12s. 0½d.; working expenses, £538. 5s. = 1·22d. per unit. Motors connected to date 160 h.p., over 200 h.p. applied for; lamps connected to date 9,480 8 c.p.

Brussels-London Telephone.—The new telephone cable to Belgium has been laid, and telephonic communication between London and Brussels will be opened as soon as the necessary arrangements can be completed. The Postmaster-General stated in the House of Commons on Thursday that the establishment of communication between London and Brussels was not feasible at present.

Manchester.—At Wednesday's meeting the recommendation of the Electricity Committee to apply for sanction to the borrowing of £10,000 for electricity purposes was discussed. An amendment was carried to the effect that the application be deferred until a full report was presented to the Council showing the total expenditure up to date, and the financial obligations already in prospect under contract.

Brighton.—Sanction has been received to borrow £42,000 for the establishment of a municipal telephone service. The Guardians have adopted a report recommending that the old infirmary, the quarantine wards, and the long and west (C) wards be lighted by electricity; that the offer of Mr. Coote to prepare specifications at a remuneration of 5 per cent. on the contract be accepted, and that tenders be invited to carry out the work.

Dartmouth.—The main streets of Dartmouth were lighted for the first time last week by 10 arc lamps of Johnson and Phillips's type, running 10 in series on a circuit of 480 volts. We are informed that the lamps are giving most satisfactory results, and that the lighting will be continued. The undertakers—the Urban Electric Supply Company, Limited—are urging the erection of 120 incandescent lamps for the by-streets of 25-c.p. each.

Carburate of Calcium.—It appears that the Italian company manufacturing carburate of calcium propose to establish a factory at Sebenico, Dalmatia. The waters of the Kerka are to be utilised to drive the most important turbine installation yet laid down on the Continent of Europe. The falls are about six miles from the town, and pipe-ways will be constructed. Messrs. Ganz and Co. are to erect two Francis turbines of 3,500 h.p. each.

Falkirk.—Messrs. Burstall and Monkhouse are making good progress with the electric light works and the extension in the Gartcows district. It has been agreed to lay a cable in Gartcows-road and to advertise for an assistant engineer at a salary of £100 per annum. A small deputation is to visit Stirling, Motherwell, and Greenock to ascertain the system of working at these stations, and the system of keeping accounts and other clerical work.

Sale of Plant.—An important lot of electrical machinery is for sale at the Electrical Works Rheydt, Limited (formerly Max Schorch und Cie., A.-G.), Rheydt (Rheinland), consisting of a number of machines which have been at work at the recent Düsseldorf Exhibition. Included in the sale are about 60 dynamos and electromotors of different sizes which were exhibited at the Düsseldorf Exhibition, but were not working. Further particulars appear in another column.

Coventry.—The Vice-Chairman of the Estates and Finance Committee of the City Council (Councillor Johnson), in presenting the half-yearly estimates on Tuesday, referred to the electric light undertaking, and mentioned that the deficiency on the electric light was only £291, as against £493 in the corresponding half of last year. That spoke for itself. He thought that at last the undertaking was reaching that corner which would lead to profits for the relief of the rates in future.

Battery Combine.—Rumours are again afloat about the combine in the storage battery trade. It is said that the machinery part of the enterprise will be looked after by the Stanley Electric Company of Massachusetts, which recently passed into the control of the Whitney-Ryan-Widener combination. The New York Press thinks it not unlikely that a combination of the Electric Storage Battery, the Stanley Electric Company, and the English Electric Storage Battery Company will be formed.

Barnstaple.—Mr. J. W. Hadfield, the resident engineer, has been appointed engineer and general manager at a salary of £180. The last report of the Electric Lighting Committee states that the cost of producing electricity per unit, including engineer's charges, coal, and all other expenses, would work out at less than the original estimate—viz., 3d. per unit. It has been decided that arc lamps be fixed in the streets. The remainder of the streets in the compulsory area is to be lighted by incandescent lamps.

Chichester.—Amended draft agreements in connection with the transfer of the electric lighting order to the County of Sussex Electrical Power Distribution Company, Limited, have been submitted to the company for approval. Letters from the United Electric Light and Power Company and the Provisional Electric Supply and Traction Company of their intention to make application for a provisional order to supply electricity within the city of Chichester are before the Electric Lighting Committee of the City Council.

Stock Exchange.—The Stock Exchange Committee have ordered the Colombo Electric Tramways and Lighting Company's £120,000 5 per cent. first mortgage debenture stock to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Metropolitan Electric Tramways 314,016 5 per cent. cumulative preferred shares of £1 each fully paid. Nos 500,001 to 814,016, and 314,016 deferred ordinary shares of £1 each fully paid, Nos. 1,000,001 to 1,314,016.

Pacific Cable.—It is reported that the "Anglia" will lay the cable between Fanning and Fiji Islands before Nov. 1, thus completing the British telegraphic circuit of the globe. The "Anglia" and the "Colonia" will next co-operate in laying the American cable to the Philippines, which is to be finished before July 4. The all-British Pacific cable is to be officially opened to-day. Arrangements have been made for sending congratulatory messages from Lord Tennyson, acting Governor-General of the Commonwealth, to Mr. Chamberlain.

Ipswich.—Major C. E. Norton, C.E., on Wednesday held an enquiry into the Town Council's application for sanction to borrow £69,900 for purposes connected with the supply of electrical energy. No street-lighting is for the present intended. Owing to the changed conditions which have taken place in the electrical industry, Prof. Kennedy's estimate of £69,900 has been reduced by the provisional

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acceptance of tenders at £61,706, which have already appeared in these columns; £2,900 has been deducted for arc lamps and pillars originally provided for.

Lantern Lectures.—It might be useful to some of our readers, especially secretaries of societies, to know that the *Photogram*, Effingham House, Arundel-street, W.C., is sending out lantern lectures of varied character. Amongst those suitable for amateurs we note "Marvels of Photography," "The Dawn of Photography," and "Night Photography." An article on the latter appears in the *Photogram* this month, wherein the writer explains and illustrates how the amateur photographer may photograph himself in bed with the expenditure of two candles and a quarter-plate.

Siemens Electric Appliances, Limited.—We are informed that this company has been formed for the purpose of supplying articles manufactured by Messrs. Siemens Bros. and Co., Limited, of London, and Messrs. Siemens and Halske, of Berlin, and that Messrs. Oscar Krupka and Hermann Jacoby, of the firm of Messrs. Krupka and Jacoby, of 61 and 62, Watling-street, E.C., have been appointed managers of the company. The firm of Messrs. Krupka and Jacoby will be continued, as hitherto, for the sale of the manufactures of Dr. Albert Lessing, of Nurnberg, at the same address.

Oxford.—During the year ending Sept. 29 the electric company have added the equivalent of 5,600 8-c.p. lamps. Accommodation for four boilers has been added to the works, and a new boiler of 500 actual horse-power has been fixed. Extensions of the mains have been made in a number of places, and a further extension as far as the railway stations is contemplated. The trunk mains supplying high-tension current for the distributing machinery have been increased about 25 per cent. in capacity, while new transformer stations have been erected at Christ Church and in Staverton-road.

Cardiff.—An offer has been made to Sir W. T. Lewis on behalf of the Cardiff Railway Company to supply electrical energy in bulk to the company for distribution at the Bute Docks at the following rates—viz.: for a consumption per annum of 500 units or over that amount per electric horse-power demanded, 1d. per Board of Trade unit; for a consumption per annum of under 500 units and over 350 units per electric horse-power demanded, 1½d. per Board of Trade unit; for a consumption per annum of under 350 units and over 250 units per electric horse-power demanded, 1¼d. per Board of Trade unit.

Acton.—The District Council have adopted a report of the Lighting Committee recommending that the Council should immediately take up the question of electric lighting for the district, and that the committee be authorised to visit various electric lighting stations. The committee have also reported that they had decided to take no action with reference to the notices served by the Provincial Electric Supply and Traction Company and the United Electric Light and Power Company of their intention to apply to the Board of Trade for a provisional order authorising the supply of electricity in Acton for public and private purposes.

Accidents.—An inquest was held last week at Nottingham into the cause of the death of a painter, whose death took place after an accident sustained whilst he was engaged in painting one of the standards used for supporting the electric tram wires. The jury found that death was due to injuries to the head caused by an accidental fall from a ladder through deceased's hand coming into contact with an electric wire while painting a post. A party of Sir Hiram Maxim's men who were working at the Great Central electric light station, Grove-road, Marylebone, met with a serious accident on Wednesday. They were carrying some heavy machinery over planking from the boiler house to the pumping room when the plank broke. One of the workmen, Arthur B. Redand, was killed, and his brother was seriously injured. Both were conveyed to St. Mary's Hospital.

Mansfield.—We learn that the contractors of the electric light station are getting on very fast with the work. All the machinery is ready, and only waiting for the buildings, so that in about a week some of the machinery will be moved in. The advisability of reducing the price of current is being suggested, and it is proposed that the rate of 7d. for the first 100 hours maximum demand and 2d. after, should be reduced to 6d. for the first 100 and afterwards 2d., or that for the first 90 hours it should be 7d. and then 2d.; 2,500 8-c.p. lamps have already been applied for. Mr. Hammond's report estimated 12,500 lamps of 8 c.p. to bring in a revenue of rather less than £4,000. To this is to be added £380 for public lighting and sundry little sums. But a considerable larger sum has been substituted for public lighting. A revenue of £4,550 and an expenditure of £2,525 is anticipated.

Huddersfield.—A preliminary meeting of tradesmen interested in securing a more efficient and less costly telephone service, was held last week to discuss the question of forming a private company for Huddersfield and district. Mr. Bennett was present. A committee was formed, with power to add to their number, and eventually summon a larger meeting to deal with the matter. At the Milton Church School on Monday, the chairman of the joint committee of the P.S.A.'s and P.M.E.'s, and other similar societies, most appropriately named T. S. Sparke, presented an X-ray apparatus to the governors of the infirmary. The cost has been defrayed by subscriptions of the P.S.A. and similar committees in Huddersfield, who early in the year issued 3,000 1s. subscription cards. The response was a hearty one, and besides paying £80 for the apparatus, the cost of fitting up a room for it at the infirmary has been defrayed.

Ayr.—An installation of electric light presented to the County Hospital by Mr. Andrew M'Ilwraith, of St. Albans, Herts, a son of the late Bailie M'Ilwraith, Ayr, was inaugurated last week by the Countess of Eglinton and Winton. Subsequently Lady Eglinton unveiled a bronze memorial tablet in the main corridor of the hospital bearing the following inscription: "The electrical installation in the hospital was presented by Andrew M'Ilwraith, of St. Albans, Herts, for the benefit of the sick and suffering of his native town of Ayr, and in memory of his dearly loved sons, John Clifford M'Ilwraith who died at Reitz, Orange River Colony, on Dec. 17, 1900, and James Howard M'Ilwraith, who died at Winburgh, Orange River Colony, on June 22, 1901, while serving their Queen and country in South Africa." The cost of the installation has been about £1,000. Messrs. Still, Mackay, and Co., electrical engineers, Ayr, carried out the work.

Bann Water Power.—The Antrim County Council on Tuesday passed the following resolution: "That, seeing that electricity is becoming a popular and useful agent for lighting purposes and the provision of motive power, and furnishes every prospect of becoming an agent of general and valuable public utility, this Council appoint a special committee to investigate and report upon the following points: (1) How far the county of Antrim is covered by electric supply companies working under Acts of Parliament; (2) enquire as to any special facilities existing in the county for generating electricity by waterfalls, and as to the practicability of such facilities being employed to advantage in the county; (3) enquire as to the financial result of electric schemes undertaken by municipal bodies; (4) enquire how far it would be practicable and wise to develop a scheme for an electric supply for the county or through the medium of urban and rural councils, consistent with Acts of Parliament already obtained by existing companies; (5) to enquire into how far the drainage would be affected; (6) report as to the best mode of procedure for giving effect to their findings and recommendations."

London County Council.—The Council on Tuesday agreed to lend the Hammersmith Borough Council £18,150 for electric lighting, street-lighting, and meters. Notices under Electric Lighting Acts and orders were agreed to as follows: from the Blackheath and Greenwich District Electric Light Company of intention to lay low-tension mains across Brandram-road and along Church-terrace; the County of London and Brush Provincial Electric Lighting Company, high and low tension along Mitcham-road and low-tension mains along Skipton-street; the Lewisham and District Electric Supply Company, high and low tension mains along Bromley-road and Berlin-road, and to construct three transformer boxes in those roads; the Metropolitan Electric Supply Company, high-tension mains along a portion of Carlton-vale and along a portion of Shirland-road; the Westminster Electric Supply Corporation, mains along Frederick-mews, Kinnerton-street, and across Vauxhall Bridge-road. Notices served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works, were also received from the Islington Borough Council of intention to lay mains along Hornsey-lane, Hornsey Rise-gardens, Sunnyside-road, Orleans-road, Cromartie-road, Waterville-road, Highcroft-road, Ashley-road, and Crouch-hill, and along a portion of Caledonian-road and along Brady-street; and the Stepney Borough Council of intention to lay mains along Stepney-green, Stepney High-street, Belgravia-street, Ben Jonson-road, White Horse-street, Troon-street, and Salmon-lane.

Hampstead.—The Lighting Committee at the last meeting of the Borough Council reported the receipt of a report from the borough accountant showing that the amount of the accounts of private consumers of electric light for the quarter ended at Midsummer was £4,655. 2s. 6d., as compared with £3,486 0s. 6d. for the corresponding quarter of last year. The total amount of the accounts (private and public) was £5,825. 1s. 10d., as compared with £4,570. 2s. 9d. In the quarter under notice 144 new consumers had their premises connected, as compared with 119 in the corresponding quarter last year, and in the quarter ended at Michaelmas 132 new consumers had their premises connected, as compared with 120 in the Michaelmas quarter of last year. The same committee also reported that they had received a report by Prof. Silvanus Thompson on the breakdown on the switchboard at the electric lighting station, and the "arc" from No. 10 to No. 9 panel, on Sunday evening, June 15 last. The report still left the cause in doubt. The cause of the breakdown of the electric light in West End on the previous Friday was referred to, and it was said that one of the transformers in the sub-station at Donnington Park-road broke down, with the result that a fuse went at the central station. The defect was remedied as quickly as possible, and some of the lights were on again within a quarter of an hour. A resolution was also adopted of the same committee that, with reference to the letter from Messrs. Hancock and Symonds, expressing the hope that the better lighting of Shoot-up-hill might be extended to the shops at the Parade, Cricklewood, they be informed of the resolution passed by this Council to light with arc lamps the whole line of thoroughfare from Maida-vale to the borough boundary at Cricklewood. The borough engineer is about to remove the emergency gas lamps from the roads in which the arc lamp columns have been fitted with incandescent electric lamp brackets and lamps.

Guildhall.—In connection with the King's visit last week a fairy palace was erected by Messrs. Simmons Bros., of Newton-street, High Holborn, upon the piazza in front of the ancient City building. Arches of soft material in two well-blended shades of blue on cream and gold and pillars clothed in the same colour scheme supported a dome extending over the whole area. In the centre of the dome an octagon had been fixed, the lighting of which was what one might well call a luminous idea. A corridor led to the main pavilion from King Edward-street. From the entrance a carpet in red and blue was laid, and on each side of this gangway, profusely decorated with plants and flowers, rose the tiers which had been built to accommodate those invited to view the procession into luncheon. Behind the seats were two galleries which were to serve as the soldiers' dining hall. Behind these we found a special 20-way switchboard fitted up. Here we also met Mr. Stokes, the electrical engineer in charge of the electric lighting part of the contract, who kindly showed us some of the details of the electrical arrangements. In all an equivalent of 469 8-c.p. lamps had been fitted up, but they were so well placed that the effect produced would have led one to suppose that at least double the number had been employed. In the centre were fixed five beautiful crystal chandeliers (*ancien empire*)

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which had been originally used for candles, and were now remodelled, the centre one bearing 48 8-c.p. and the four others 24 5-c.p. lamps each. In the main pavilion and the hall there were, besides, eight candelabra of three 16-c.p. and 12 of 3-c.p lamps each, eight corner brackets of six 8-c p. lamps and 14 of three 16-c.p. each, and a number of 8-c.p. lamps hidden in baskets of real flowers completed the effect. All these lights were fixed on imitation candles. In the octagon 40 8-c.p. lamps were arranged. A number of fairy lamps were hung in the galleries and bandstand. The corner candelabra require special mention. They are the invention of Mr. Simmons, and take easily to pieces, thus greatly facilitating their fixing, transport, and packing. The whole scheme of decorating and lighting was extremely well carried out, and distinctly struck the note of joyfulness appropriate to the occasion.

TRACTION.

Bingley.—At their last meeting the Town Council decided to apply for a provisional order for electric tramways.

Hull.—A deputation from the Corporation have visited Glasgow for the purpose of inspecting the electric tramways in that city.

Automobile Race.—The Automobile Club of France has decided to organise a big motor race in June next from Paris to Madrid.

Aberdeen.—In the Bill to be promoted next session power will be sought to double the tramway line on the circular route and to lay a line along Fonthill-road.

Bakewell.—It is understood that a Bill will be promoted in the next session of Parliament for powers to construct a light railway between Bakewell and Sheffield.

Birkenhead.—A conference of tradesmen and other ratepayers of Grange Ward has declared in favour of a tramway along Oxton-road, Grange-road, and Whetstone-lane.

North Lindsey Light Railway.—It is stated that there is every prospect of this railway being made, the matter having been taken up by the Great Central Railway Company.

Burton and Ashby Light Railway.—The difficulties in the way of the promotion of the above scheme have practically been removed by the promoters conceding the demands both of the Swadlincote and Ashby Urban Councils.

Southport.—Considerable headway has made with the laying of the new tramline in Southport. All the lines are now laid from Shakespeare-street to the Birkdale boundary, and most of the line has been laid up Duke-street.

Macclesfield.—The statutory formalities in connection with the Macclesfield tramways scheme, to the principle of which the Corporation gave formal approval a short time ago, are now in progress, and the detailed scheme will be completed before long.

Swansea.—The Electricity Committee decided on Tuesday with regard to the tramway extensions "that the Dolter system be seriously entertained," and it was resolved to accept the invitation of the company to visit Paris and see the system in operation.

Ripon.—The City Council have received a letter from the Power and Traction Company desiring permission to lay tramways from Ripon Station to the city and on to Studley Park. The matter has been referred to the Highways Committee for conference and report.

Amesbury.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of a light railway in the county of Wilts, from Amesbury to Bulford, by the London and South-Western Railway Company.

Fareham.—A special meeting of the Urban District Council last week generally approved a scheme for the extension of the tramways from Brockhurst to Fareham. The scheme also includes the reconstruction of the line from Gosport to Brockhurst for electric traction.

Hawick.—In connection with the proposal to establish a system of electric tramways here, a letter has been received from a company stating that a provisional order for such a system will be applied for within the next year. The Town Council have promised their support.

Islington.—At the last meeting of the Borough Council, reference was made to the proposal for a light railway through the grounds of the Alexandra Palace. It was stated that the scheme for a generating station had been dropped, as the engineer to the tramway company had decided against it.

Birmingham.—The Public Works Committee of the City Council have approved the plans of the City of Birmingham Tramways Company for the extension of their lines from the existing terminus on the Coventry-road, through Hay Mills, to the Swan Hotel at Yardley, a distance of about 1½ miles.

Edinburgh.—At their meeting on Tuesday the Town Council had under consideration a letter from the managing director of the Drake and Gorham Electric Power and Traction (Pioneer) Syndicate regarding an agreement for the junction at Joppa between the Musselburgh and the Corporation tramway systems.

Croydon.—A debate took place at the last Borough Council meeting on a proposition from the British Electric Traction Company, who are the lessees of the Croydon tramways, to purchase five additional cars to cope with the traffic in the borough. Eventually the proposal was agreed to by a large majority.

Harrow.—The enquiry by the Light Railway Commissioners into the proposal of the Middlesex County Council to run a line of electric trams from Willesden through Wembley, Harrow, Wealdstone, Harrow Weald, Stanmore and Edgware, to Cricklewood, which was adjourned last Friday, will not be resumed till Nov. 31 next.

Strood.—The Kent Electric Power Syndicate have asked the Rural District Council for their favourable consideration of a scheme of electric tramways along the Gravesend-road, to be worked in connection with the proposed trams at Rochester. It was decided to reply that the Council are in favour of electric trams.

American Control in London.—Mr. Yerkes has (says a Laffan telegram from New York) made a tempting offer to Mr. H. H. Vreeland, president of the Metropolitan Street Railway Company of New York, to come to London to direct the construction of and manage the tube railways in which Mr. Yerkes is interested.

Leicester.—The Light Railway Commissioners opened an enquiry at Leicester on Wednesday into the application of a company to lay down light railways between Leicester, Anstey, Groby, and Newtown Linford. At the close of the evidence the Earl of Jersey said the Commissioners would recommend the Board of Trade to grant an order.

South Shields.—Nothing has yet been definitely decided as to who shall provide an electric tram service in the town, the Corporation or the British Electric Traction Company, both of whom are promoting Bills in Parliament with this object. Negotiations between the parties have so far led to no good results, but they are still proceeding.

Return Tickets on Tube Railways.—An effort is being made by the metropolitan corporations, headed by the City Corporation, to have a clause inserted in Tube Railway Bills before Parliament providing that "every passenger ticket issued by the company for a return journey shall be available at any time after date of issue."

Kensington.—The Borough Council are withholding their consent to the proposal of the London County Council to seek parliamentary powers next session for the construction of a tramway from Shepherd's Bush-road, *via* Richmond-road, Holland Park-avenue, High-street, Notting Hill, and Bayswater-road, to a point near the Marble Arch.

Altrincham.—The Manchester Corporation propose to obtain powers in the next session of Parliament for a tramway from the terminus of their present lines, in Stretford, through to Altrincham. The British Electric Traction Company have a similar scheme under consideration, which they will ask Parliament to sanction next session.

Bridlington.—At the meeting of the Town Council yesterday a resolution was brought up: "That this Council take steps to obtain powers to construct and work an electric tramway between the quay and the old town, and that the matter be referred to the Parliamentary and General Purposes Committee for consideration and report."

Perth.—A special meeting of the Town Council has passed a resolution requiring the Perth and District Tramways Company, Limited, to sell to the Corporation that portion of their undertaking which is within the burgh, and to apply to the Board of Trade for their approval of a notice in writing to that effect being given to the company.

North-Eastern Railway.—The directors of this railway have received the tenders for the electrical equipment of several sections of their lines in the vicinity of Newcastle. The tenders were informally considered on Friday, but the detailed consideration will occupy some time, and it is anticipated it will be a few weeks before a definite decision is arrived at.

Light Railways in Essex.—The order made by the Light Railway Commissioners, and modified and confirmed by the Board of Trade, has now been issued authorising the construction of a light railway in the county of Essex to join the proposed Elsenham, Thaxted, and Bardfield light railway with the Colne Valley and Halstead Railway.

Cheltenham Light Railway.—The Board of Trade has confirmed the order of the Light Railway Commissioners authorising the extensions of the Cheltenham light railway to Leckhampton and Charlton Kings in its entirety, and upon the issue of the order—which it is expected will take place with little further delay—no time will be lost in commencing the work.

Bolton.—The Corporation electric tramways continue to give satisfactory returns on a running of close on 6,000 miles per day. By connection with the South Lancashire tramway system it is now possible to travel to Leigh. An extension is contemplated to Brownlow Fold, and it is proposed to also extend the Breightmet track to Ainsworth, so as ultimately to give a through route to Bury.

New South Wales.—A Sydney dispatch says that the tramway revenue for the September quarter was £166,900, as compared with £136,049 for the corresponding period last year, the expenditure being £143,528, as against £117,168. The increase in the expenditure is due to the carriage of water and fodder at nominal rates concessions relative to the transport of starving stock from the drought-stricken districts, £29,000 for relaying lines, and £10.000 to meet the extension of the eight-hour system to the running staff.

Additional Traffic Returns.—Anglo-Argentine, £79 decrease; Barcelona Ensanche y Gracia, £30 increase; Barcelona, £347 increase; Brisbane, £347 increase (month of September, £9,757, increase £994); Buenos Ayres and Belgrano Electric, £5 increase (month of September, £12,476, decrease £150); Calcutta, £183 increase; Cape Town (month of August), receipts £15,450, expenditure £7,801; Isle of Thanet Electric, £20 decrease; Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £8 increase; Port Elizabeth (month of August), receipts £4,014, expenditure £1,979

Northwich.—On Tuesday a letter was read at a meeting of the Urban Council from the Light Railway Commissioners stating that difficulties had arisen respecting the order to authorise the Warrington Corporation light railways, which would form a connecting link between Warrington and Northwich light railway and the borough of Warrington. These difficulties prevented the Commissioners settling the Warrington-Northwich light railway order, but they hoped during a week or so to settle both. The Council hoped that the railway, which had hung fire for two years, would soon be dealt with, the opinion being expressed that a more useful scheme of tramways might have been carried out in parts of the district.

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Middlesex Light Railways.—The Light Railway Commissioners have rejected the Middlesex County Council scheme of light railways from Cricklewood through Hendon, and deferred the line from Cricklewood to Kilburn pending the decision on the London County Council Bill with reference to the line from Marble Arch to Cricklewood.

South London.—A general meeting of the South London Tramways Company will be held on the 12th prox., and at the close of the ordinary business a provisional agreement which has been entered into by the directors with the London County Council for the sale of the undertaking to the Council will be submitted for consideration.

Glasgow.—The tramway from Scotstoun to Yoker having been inspected by the Board of Trade, was opened for traffic yesterday. A close service of cars was given all day between London-road terminus and Yoker, a distance of eight miles, or 16 miles for the round journey. The fare from Yoker to Queen-street is 2½d., and the fare for the whole distance is 3½d.

Flamborough Light Railway.—With regard to this scheme, it is now stated that the Board of Trade declined to extend the Flamborough and Bridlington Light Railway Order of 1897, not because of the objections of the local authorities only, but because it was stopping any other scheme from being brought forward It is understood that another company with a very different project are waiting to bring theirs forward.

East Barnet.—The Urban District Council have received an intimation from the Light Railways Commissioners that they hope shortly to be in a position to deal with the County of Hertford Light Railway (Barnet) Order, a copy of which as provisionally drafted by them will in due course be forwarded to the Council for observations before the order is finally settled by the Commissioners and submitted to the Board of Trade for confirmation.

Brighton.—At yesterday's meeting of the Town Council the Tramways Committee reported with reference to the proposed tramway route between Dyke-road and Victoria Gardens, that they have further considered the question as to the construction of the portion of the line down Terminus-road and Surrey-street into Queen's-road, and they made certain recommendations with regard to the arrangements for carrying out the extensions proposed.

Cork.—A rather serious accident occurred on the electric tramways here on Thursday last week. The first car of the early morning service had just started out—down Summer-hill—when, it is reported, the brakes refused to act. The car collided with several vehicles on the hill, but was eventually brought to a standstill by crashing into a brewery float. The driver was severely injured about the back and legs. No passengers were on the car at the time.

Doncaster.—The Bentley section of the Corporation electrical tramway system was inspected by Major Druitt, of the Board of Trade, on Monday, and on being approved by him was at once opened to the public. Unfortunately, owing to the Great Northern Railway crossing the route in Marshgate, the section is divided in two, and separate cars run from the railway station to the crossing and from the crossing to Bentley, the total distance being just under two miles.

Gloucester.—More than a month ago the City Council resolved to ratify and confirm their agreement with the Gloucester Tramways Company to purchase the whole of their undertaking and rights for £26,000. The Council have not yet taken over the concern nor paid the money, and the company have recently given the Council a written notice that they are carrying on the business on their behalf at a loss, and that they will charge them the loss incurred and expect payment.

Brighton Electric Railway.—The "Brighton Electric Railway (Preliminary) Syndicate" has been formed, apparently to carry out the necessary work of preparing the way for the introduction of a Bill in the ensuing session of Parliament similar to that which was known as the London and Brighton Electric Railway, and was thrown out last spring for non-compliance with standing orders. The capital of the syndicate is £40,000. Details of the scheme appeared in a recent issue of this journal.

Sheffield.—Mr. A. Muir Wilson, a solicitor, of Sheffield, has delivered a statement of claim in the action which he is bringing against the City Council, to restrain the Corporation from paying out of the tramway profits (1) £1,000 to form the local fund asked for by the Yorkshire Agricultural Society in connection with their show in the city in 1903; and (2) £500, the cost of the presentation to Lord Kitchener when he was made a freeman of the city. Mr. Muir Wilson contends that these payments are illegal.

Newcastle.—On Monday a further extension of the tramways was opened to the public—viz., from Raby-street along Walker-road to St. Anthonys. A collision took place in Mosley-street on Friday. A Westmorland-road car was about to ascend the incline at the foot of Grey-street, when the trolley left the wire. A Westgate Hill and Byker car, which was travelling on the same line, was struck by the other car, and somewhat badly damaged. There were some passengers in the cars, but no one was hurt as the result of the accident.

Barton Light Railway.—The Board of Trade have confirmed the Barton-upon-Irwell light railway order made by the Light Railway Commissioners. The railway authorised is to commence at the junction with the Salford tramways in Manchester-road at the boundary of Clifton and Swinton and Pendlebury, and to terminate at the junction with the authorised Kearsley tramways at the boundary of Clifton and Kearsley. The order provides for the generation and supply of electricity. The railway is to be completed within three years.

Farnworth.—The total revenue from the tramways for the quarter ended Sept. 30 last amounted to £1,912. 18s. 4½d., as against working expenses to the tune of £1,748. 2s. 7d., or 7·16d. per car mile. These expenses include the cost of replacing car wheels broken by running over the old track in Manchester-road which is now being relaid, and also a sum paid to the Bolton Corporation towards cost of renewal of the electrical equipment of the Manchester-road track, which track was handed over to Farnworth at the termination of the lease in June last. It has been found that ½d. fares have not been a success, and the committee have decided to abolish them, subject to the approval of the Council.

Ayr.—A report compiled by the manager of the operations of the tramways for the first completed year shows that the total number of passengers carried was 2,979,275 and the number of car miles run 290,099. The total income was £12,503. 19s. 1d. and the total expenditure £10,434. 13s. 11d., leaving a free surplus of £2,069. 5s. 2d., after allowing £1,910. 10s. 11d. for depreciation, £1,875. 8s. 7d. (interest on borrowed money), and £824. 5s. 2d. for sinking fund. The number of Board of Trade units of electricity used was 271,634, which had been supplied at a cost of £1,548. 9s. 6d. The total receipts per car mile were 10·34d.; working expenses per car mile, 4 2d.; and the total expenses per car mile, 8·63d.

Bradford.—The recent addition to the Allerton section of the Bradford city tramways, which adds about five-eighths of a mile to its length, was opened for regular traffic last Friday. In the Bill to be promoted by the Corporation next session powers will be sought, among other things, to enforce the "queue" system for regulating the admission of persons to the tramcars, and to construct additional tramways along Church Bank and Barkerend-road to Otley-road, double line; along Norfolk-street, Nelson-street, and Croft-street to Bridge street, double line; from the Allerton terminus, along Thornton-road and Stoney-lane, to Prune Park-lane, single line, with passing places; from the Heaton terminus to Leylands-lane, double line.

Tramways to the Crystal Palace.—The chairman of the Crystal Palace Company informed the shareholders at the half-yearly meeting last week that the Bill authorising the extension of the Croydon electric tramways, *viâ* Penge and Anerley-hill, to the Palace had received the Royal assent, and it was probable that the line would be constructed and the cars running in the course of next year. In view of the remarkable success and popularity of electric tramways in the provinces and abroad, and their equally successful introduction in West London and Croydon, it might be hoped that the Crystal Palace and the very large population in the surrounding districts who desired to visit it would not much longer be denied the facilities which would have existed years ago in any other city.

Stoke-on-Trent.—The Town Council have adopted a recommendation of the Light Railway Committee that, subject to the provisions of the agreement of Jan. 30, 1902, and the recommendations of the borough surveyor being agreed to and carried out by the Potteries Electric Traction Company, Limited, the Corporation gives its consent to a double line of rails from the commencement of the railway in High-street to a point where such railway joins the loop at the Newcastle boundary; that such terms be embodied in an agreement between the Corporation and the electric traction company; that after the commencement of the railway all matters in connection therewith during construction up to completion of such railway be under the control of the Highway Committee, subject to confirmation by the Council.

Barrow.—Attention was called at the last meeting of the Town Council to the delay in making a start with the laying down of the electric tramway system. One member spoke of the delay which he said was caused in other places by the British Electric Traction Company, who pegged out more work throughout the country than they could develop. He thought the Corporation ought to be on their guard. There should be clauses in the agreement to inflict penalties for delay. It was stated that the committee had, subject to the approval of the Council, arranged for the construction of the new permanent way, and they hoped to be in a position shortly to recommend the style of car to be used. They had no reason to fear that the British Electric Traction Company would fail to carry out the work expeditiously.

Bray.—The Judicial Committee of the Privy Council at Dublin have approved a scheme for an electric tramway system in Bray, consisting of five separate lines, extending 3¼ miles. The Dublin, Wicklow, and Wexford Railway Company opposed the scheme. The approval of the Privy Council is subject to that of the Board of Works as to gradients and passage under bridges and to reducing the line near the railway by 16 yards. The promoters are the General Electric Company of Ireland, whose capital is £2,000, with power to increase it to any amount. Accordingly the Privy Council, while reporting in favour of the proposed tramways, adjourned the further hearing for four months to enable the promoters to satisfy the committee of their financial position, with liberty to bring the matter forward at an earlier date if ready.

Burma.—The Burma Electric Tramways and Lighting Company has been formed to develop and work a concession for electric tramways in Mandalay granted by the Government of Burma. Its capital is to amount to £200,000, in £5 shares, half of which will be 6 per cent. cumulative preference shares. The concession for the tramways is for 40 years from June 6 last, but the Municipality of Mandalay, which has a population of about 181,000, may buy up the property, together with the works and materials belonging to the company in connection therewith, the lands, building, equipment, etc., on six months' notice given within any subsequent period of five years after the concession has run out. A rental varying with the mileage laid, but in no case exceeding Rs.1,000 per mile per annum, will be paid by the company to the Municipality.

Blackburn.—The statement of the working of the Corporation tramways for the six months ended Sept. 30, just issued, shows that for the three months ended June 30 there was a slight profit, exclusive

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of depreciation, of £71. 3s. 7d., but on the six months' working this is turned into a loss of £158. 3s. 1d. The expenses on the six months' working totalled £13,730. 18s. 9d., equal to 7·38d. per car mile. The total receipts were £23,630. 3s. 11d., equivalent to 12·71d. per car mile This leaves a gross balance of £9,899. 5s. 2d., which, with bank interest (£91. 10s. 11d.), is brought to £9,990. 16s. 1d. Instalment of loans repaid totalled £3,205. 10s.; interest had absorbed £4,247. 15s. 8d. and sinking fund £2,695. 13s. 6d., and after deducting these items the debit balance of £158. 3s. 1d. remains. The average receipts per car mile were 12·51d.

Auckland (N.Z.).—The following cutting, showing the progress of the scheme for the establishment of an electric tramway service in Auckland, is taken from the *New Zealand Mining, Engineering, and Building Journal* of Sept. 4: "The general topic of conversation in the fair city of the north is the electric tramline installation, the work for which is progressing slowly. Twenty-eight cars are ready, and one section of the track should be ready in the course of a week or two, but the power-house is a long way from completion, and although the service was supposed to be ready in June last, it is likely to be in the New Year before the people will get the slightest atom of comfort in the shape of conveyances. All other cities where electricity is likely to be installed should profit by Auckland's experience and insist on much more stringent arrangements being made. The alteration to streets, etc., will probably cost more to the City Council than the track to the company, and the travelling public have had to do the best they can in the meantime."

Cardiff.—An interesting report was presented to the Cardiff Tramways Committee on Friday by Mr. Arthur Ellis, the electrical engineer and manager. Mr. Ellis stated that more boiler accommodation would soon be required, as the demand for electricity, both for lighting and power, was rapidly increasing. He therefore suggested that the borough engineer be asked to prepare drawings for a boiler-house, to be erected on the opposite side of the present engine-house. For the three months ended Sept. 30 the car miles travelled amounted to 494,829, and the passengers were 5,247,246. The receipts for the three months were £21,863. 10s. 6d., as against £15,484. 6s. 4½d. for the three months ended June 30. The total traffic receipts for the six months were £37,347. 16s. 10½d., and the receipts from all sources were £37,621 13s. 10d. After the end of this month, added Mr. Ellis, the cars would have a better chance, as the whole of the horses would be disposed of, and the losses sustained by the horse cars would disappear. At a special meeting of the Corporation to-day a motion will be proposed against the continuation of the tramway system over the canal bridge and through James-street The Cardiff and Penarth District Tramways Company have appointed Mr. John Fell to value the track on their behalf in view of the negotiations pending for purchase by the Cardiff Corporation. The proposal is to join up the Penarth line with the Cardiff tramways at Grangetown. A syndicate is also in the field with a scheme to construct an electric tramway over the same ground.

Manchester.—At the last meeting of the municipal year of the Tramways Committee on Tuesday the chairman gave some statistics showing the progress of the department in the past 12 months. He said that the total length of track which had been laid and relaid was 100 miles. The estimated cost of laying was £5,210 per mile, the actual cost had been £4,650. The estimated cost of overhead equipment and rail bonding was £1,764 per mile, but the work had actually been done at £1,000 per mile. These figures related entirely to work done by the Corporation. Only one contract—that for overhead equipment of the first routes opened—had been let. Granite setts had been used to the extent of 41,000 tons, and the total weight of steel girder rails employed on the work was 17,000 tons. Granite setts had been done by men directly employed by the Corporation, whose number in the streets had averaged and still averaged about 2,000 weekly. The recently-published report gave details of the traffic for the 10 months ending March 31 last. The chairman supplemented these with figures for the six months ended Sept. 30. Comparisons showed that whilst during the 10 months ended March 31, 1902, the number of car miles run was 1,831,126, during the six months it had risen to 2,290,554 car miles run. In the 10 months referred to 23,603,248 passengers were carried; in the six months ended Sept. 30 the passengers numbered 26,418,591. The total receipts for the 10 months reached £91,619; whilst for the six months they came up to £119,385. The average receipts per car mile were 1s during the 10 months and 1s. 0¼d. during the six months. The balance sheet for the last half-year gave a rosy prospect, enabling them to say that under the present conditions on the lines now working, and without reckoning any receipts whatever from the southern route, which would be newly opened on Dec. 1, their receipts for the year ending March 31 next would be quite equal to the estimate of £250,000 which was submitted to the Council some months ago. There was consequently no doubt about their being able to hand over what they estimated to the city fund—namely, £30,000.

London County Council.—At their usual weekly meeting on Tuesday the London County Council adopted the recommendation of the Highways Committee in favour of an application to Parliament next session for powers to construct a double line of tramways from the present tramway terminus in Westminster Bridge-road, *viâ* Westminster Bridge, Victoria-embankment, and that portion of the subway already authorised between the Strand and the Embankment, to join, at a point near the Strand, the proposed underground tramway from the Strand to Holborn. Reporting on the financial aspect of the scheme, the Finance Committee showed that the proposed tramway over Westminster Bridge and along the Embankment must be considered in connection with the cost of the subway and the tramway already authorised by Parliament, as, from a traffic point of view, the Highways Committee regard the whole as one complete scheme. The total estimated cost of the scheme as a whole is £449,050. The Highways Committee presented a report with regard to the training of motormen who will be required to drive the electric cars to be used on the reconstructed tramways in South London. The committee propose to utilise for the purpose one of the electrical cars already supplied and now at the Streatham cable depôt, and the power required for driving the car will be obtained by placing at the depôt one of the three exciter sets which have been ordered for the electricity generating station at Greenwich. The committee also propose that, as has been done by other public bodies in similar circumstances, preference shall be given to the drivers now in the Council's service. About 250 men will be required as motormen, and with the object of giving the men now in the Council's service full opportunity of learning to discharge properly the duties which will devolve upon them as motormen, the committee propose to establish a training school at the Streatham depôt, so soon as the exciter set above referred to can be placed in position and be ready for working, which will, it is anticipated, be within about a month from this date. They are informed that about 12 days' instruction will probably be sufficient to enable an intelligent horse-driver to learn what will be required of him as a motorman. The school will be opened daily, under the superintendence of two competent instructors.

Tramway Officials at Sheffield.—The Association of Tramway and Light Railway Officials held its fourth general meeting last Friday at Sheffield, the home of its president, Mr. A. L. C. Fell, who holds the combined office of electrical engineer and general manager of the city tramway system. The members met at an early hour in the town hall, and practically the whole of the day was spent in looking over some of the more interesting engineering plants which are to be found in the city of Sheffield. A visit was first made to the Kelham Island power station, which supplies the electricity for working the tramway system, and more than an hour was occupied in inspecting the plant. The next place visited was the works of Hadfield's Steel Foundry Company, who have lately developed a large business in tramway material. In the foundry the visitors were shown the moulding and casting of points, followed by a look into the annealing and machine shops. The company's speciality is manganese steel, and an attempt was made, quite unsuccessfully, to machine it, showing that it is specially fitted to withstand the wear and tear of traffic upon it. Mr. Fell, in thanking the company for their hospitality, complimented them on their enterprise, which had caused other English manufacturers of tramway material to "wake up." In return, Mr Hadfield, a member of the firm, complimented Mr. Fell on the efficient state of the tramway system in Sheffield. The party next visited the Yorkshire Steel and Engineering Works of Messrs. Askham Bros. and Wilson. This establishment is also of particular interest to those engaged in tramway work, as a speciality is made of points and crossings, tiebars, soleplates, etc., of crucible cast steel. Large new works are in course of erection at Millhouses, where nine acres of land have been obtained. The Broughton-lane steelworks are now being used for laying-out special track work. The present works are the oldest in Great Britain making tramway points and crossings, and Mr. Askham stated that after 20 years' experience the company were quite sure that crucible cast-steel points and crossings were the best and most reliable for electric traction. In the fitting-up shop the special renewable centres made by the firm were pointed out. The actual point is cast separately from the rail which it accompanies, and is keyed in and fastened with soft metal. This can easily be chiselled out when the point is worn, with the result that, instead of a whole casting having to be replaced, the point itself can be renewed. Another speciality pointed out was an improvement in the springs for passing places, which obviates the noisy click when the tongue returns to its normal position. In the foundry various sections of rails were being cast, and in the tiebar shop a considerable number of bars were undergoing the forging process. The pattern shops were also visited. The party afterwards adjourned to the town hall for the transaction of the business of the association.

PROVISIONAL PATENTS, 1902.

Oct. 20.

22760. Improvements in tramway and railway rails, and in means of bonding such rails for the purpose of electrical connection. Henry Malcolm Bigwood and Horace Malcolm Bigwood, Prince's-chambers, Wolverhampton.

22774. Improvement in apparatus for controlling the supply of electricity by a combined lock switch and plug, applicable as a lock switch. Edwin Liddle and Henry Carter Watson, Central-buildings, Stockton-on-Tees.

22783. Improvements in electrical switches. Harry William Cox, Brougham-chambers, Nottingham.

22808. Optical lantern for use with Nernst lamps. Maurice Solomon and Eustace Graham Sheppard, 12, Edith-road, West Kensington, London.

22809. Apparatus for using the Nernst light in optical or magic lanterns. Maurice Solomon and Eustace Graham Sheppard, 12, Edith-road, West Kensington, London.

22817. Improvements in trolley heads for electric railways and tramways on the overhead system. Charles Stafford Schultz, 24, Southampton-buildings, Chancery-lane, London.

22825. Improvements in automatic switches for single-phase and polyphase transformers. Alfred Schlatter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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22814. Improvements in protectors for telephone receivers and like apparatus. Edouard Bardac and Pierre Albert Martin, 1, Queen Victoria-street, London.

22827. Improvements relating to incandescent electric lamps. La Société Anonyme la Lampe "Hollub," 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 30, 1901, being date of application in France. (Complete specification.)

22829. Improvements in electro-pneumatic controlling systems for railway vehicles. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (George Westinghouse, United States.)

22841. Improvements in or relating to speed indicators, applicable to electric tramcars and other vehicles, and to shafts and other rotating bodies. Alfred Henry Walton, 46, Lincoln's-inn-fields, London.

Oct. 21.

22854. Improvements in electric fuses. William Bourne Dalf, 51, Wilmslow-road, Rusholme, Manchester. (Complete specification.)

22900. Improvements in or relating to electrical cultivating machinery. Robert John Halliburton Beaty and John Edward Ellis, 8, Quality-court, Chancery-lane, London.

22942. An improvement in or applicable to electrical cells or batteries. Alfred George Wass, 321, High Holborn, London.

22956. Improved construction of incandescent electric lamp-holders. Eduard Schulz, 173, Fleet-street, London.

22957. Improved construction of electric switch. Eduard Schulz, 173, Fleet-street, London.

Oct. 22.

22993. Improvements in pole finders for electric lamps and the like. Arthur Handley and David Shanks, 5, Corporation-street, Birmingham.

23011. Improvements in and relating to telephone receivers. Alexander Marr, 18, Cawdor-road, Fallowfield, Manchester

23021. Improvements in or connected with apparatus for electrically igniting miners' safety lamps. Robert Octavius Best and Ackroyd and Best, Limited, 33, Chancery-lane, London.

23022. Improvements in or connected with apparatus for electrically igniting miners' safety lamps. Robert Octavius Best and Ackroyd and Best, Limited, 33, Chancery-lane, London.

23045. Improvements in electrical arc light. Friedrich Julius Gerard, 14, Great Chapel-street, London.

23047. Improvements in the manufacture of tubular metallic telegraph and like poles, and in machinery to be used in the said manufacture. Frederick Charles Guy, 7, Staple-inn, London.

23048. A winding device for cables to which movable electric apparatus is attached. Gregoir Ackermann and Gustav Engisch, 40, Chancery-lane, London. (Complete specification.)

Oct. 23.

23066. Improvements in systems of electric lighting. Henry Leitner and Richard Norman Lucas, Rose Villa, Byfleet.

23110. Improvements in electric projectors with colour-changing devices. August Engelsmann, 111, Hatton-garden, London. (Complete specification.)

23114. Improvements in and relating to storage and other batteries. Job Thomas Niblett, 139, Queen Victoria-street, London.

23115. Improvements in or relating to current or charge meters or indicators for use chiefly in connection with storage batteries. Job Thomas Niblett, 139, Queen-Victoria-street, London.

23116. Improvements in or relating to current regulators for use in connection with the charging of storage batteries and for other purposes. Job Thomas Niblett, 139, Queen Victoria-street, London.

12134. Improvements in and relating to the taking of the readings of gas and electricity meters, and similar purposes. George Gilbert Bell, 323, High Holborn, London.

Oct. 24

23191. Improvements in and connected with clips for electrical fuses. Arthur Handley, David Shanks, and Joseph Enright Hayes, 5, Corporation-street, Birmingham.

23230. Improvements relating to electrical connections or couplings. Franz Krükl, 45, Southampton-buildings, Chancery-lane, London.

23231. Improvements in signal devices for telephone systems. Edward Payson Baird, 45, Southampton-buildings, Chancery-lane, London.

23243. Improved insulating material for electrical purposes and process for manufacturing the same. Herbert Sefton-Jones, of the firm of W. P. Thompson and Co., 322, High Holborn, London. (Isola Werke Actiengesellschaft, Switzerland.)

23255. Improvements in apparatus for use in electric telegraphy or the like. Charles Mark Jacobs and Arthur Harold Nicholson, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London.

23257. An improvement in flexible metallic tubing for armouring insulated electrical conductors. William Henry Kanzon Bowley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

23262. Improvements in or relating to the manufacture of carbons for arc lamps and the like. André Blondel, 111, Hatton-garden, London.

23278. Improvements in electric conduits or insulators. Robert Illemann, 9, Warwick-court, Gray's-inn, London.

23279. Improvements in and relating to the prevention of sparking on the interruption or variation of powerful electric currents. Kristian Birkland, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 24, 1901, being date of application in Norway.) (Complete specification.)

23288. Improvements in and relating to alternating-current dynamo-electric apparatus. Gabriel Winter and Friedrich Eichberg, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 13.

1901.

18760. Telemeters. Saegmuller and Searle.

21750. Method of and means for tandem connecting asynchronous alternating electric current motors or generators. Danielson.

22224. Electrical steering gear for ships. Brougham.

23399. Equipment of electrically-propelled cars. Siemens Bros. and Co., Limited. (Lydall.)

23400. Equipment of electrically-propelled cars. Siemens Bros. and Co., Limited. (Lydall.)

23401. Controllers for electrically-propelled cars. Siemens Bros. and Co., Limited. (Lydall.)

23668. Street feeder boxes or disconnecting pillar boxes for electric traction, electric lighting, or electric power purposes. Fletcher and Fletcher.

23838. Telephone systems. Parsons and Sloper.

24992. Electric primary cells or batteries. Tully.

1902.

146. Method of utilising two conductors and earth for transmitting a number of different electrical communications. Jacobs and Nicholson.

1544. Flash lights and electric igniters therefor. Lake. (Fabrik Elektrischer Zünder Gesellschaft mit beschränkter Haftung.)

3617. Combined electrical piano-playing and recording attachment. Davis.

11102. Electric heaters and rheostats. Krueger.

12570. Telephonic instruments. Birnbaum.

16191. Electric signalling apparatus for railways. Hare and Hare.

16402. Wireless telegraph systems. Shoemaker.

16983. Rail connections for electric railways. Lake. (Continuous Rail Joint Company of America.)

17703. Signalling and transmitting electric energy by electromagnetic waves. Fessenden.

17704. Wireless signalling. Fessenden.

18580. Telegraphic apparatus for double transmission by pulsatory and continuous currents. Wise. (Crehore.

18808. Electric belt for medical purposes. Smellie.

18858. Measurement of the energy of electric currents. Stanley.

18859. Generation and distribution of electrical energy. Stanley and Kelly.

19420. Electric switches. Imray. (Sprague Electric Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7¾-8¼
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	101-103
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15¼-16½
—— 5 per cent. Pref.	5 ..	5¼-6¼
Crompton and Co.	3 ..	2¼-2¾
—— 5 per cent. Debentures	100 ..	101-106 pm
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¾-⅞
—— "A" Shares, 01-017,139	5 ..	1¾-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10½
—— 4 per cent, 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16-17
—— 4½ per cent. Preference	5	5½-5⅝
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	99-102
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅜-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3½-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9½-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13-13½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12½-12⅝
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2½-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4½-5½
—— 4 per cent. 1st Mortgage Debentures	100	100-103
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4½-5
—— 4 per cent. Debenture Stock	100	96-99
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	11½-12
—— " " " " "	5	8¾-9⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	106-108
" " Prov. Crts.	50	81-83
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8½-9
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	16s.	3 16
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c.	80 p.c

Electric Railways.—

Central London, Ordinary	100	108-111
—— 4 per cent. Pref.	100	107-110
—— " " deferred	100	108-111
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	72-74
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	91 94

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	105-108
Bournemouth and Poole, Ordinary	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	9½-10½
—— Debenture Stock, Red.	100	105-106
Brompton and Kensington, Ordinary	5	10½-10⅝
—— 7 per cent. Preference	5	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7-8
—— Nos. 20,001-30,000	5	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	1⅝
—— " " £10 Ord.	6	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-109
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4⅜-5⅛
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5½-6
—— 4½ per cent. Debentures	100	108-112
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	13½-14½
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104-107
County of London and Brush Provincial, Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6-6½
—— 6 per cent. Cum. Pref.	5	6-6½
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3½-4⅛
—— 5 per cent. Debenture Stock, Red.	100	98-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	6-6½
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	3	1⅞-2⅛
—— 6 per cent. Pref.	5	4⅞-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	110-115
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9½
—— Preference	4	6½-6⅝
Notting Hill Electric Lighting	10	13½-14½
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oriental, 1879	1	—
—— £5 Shares	5	—
—— £4½ Shares, New	4½	—
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1⅞-2⅛
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2⅜-3⅛
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8½-9½
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3⅛-4⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3⅛-4⅛
Westminster, Ordinary	5	11½-12½
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	6-6½

Telephones.—

National Telephone, Preferred	100	93-95
—— Deferred Stock	100	56-58
—— 6 per cent. Cum. First Pref.	10	12½-13½
—— 6 per cent. Cum. Second Pref.	10	11½-12½
—— 5 per cent. Non. Cum. Third Pref.	5	4⅝-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	96-99
—— 4 per cent. Deb. Stock, Red.	100	102-106
Oriental Telephone and Electric Company	1	⅛-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 18	925	685	+ 239	+ 5,377	19½	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	" 25	5,194	4,748	+ 446	+14,198	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	" 25	734	782	− 48	+ 3,607	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	" 23	402	363	+ 39	+ 39	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	" 25	265	244	+ 21	+ 286	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 26	1,640	1,440	+ 200	+ 3,167	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	" 26	3,208	1,090	+2,118	+82,937	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57*
Bristol Tramways Company	" 24	4,465	3,896	+ 569	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	" 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	" 25	7,243	6,613	+ 630	+ 9,536*h*	12	12	" 31	335,086	41,188,389	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	" 26	3,757	2,183	+1,574	+17,102	12½	9½	" 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	" 23	733	443	+ 289	+ 5,417	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	" 25	200	208	− 8	− 49	4½	—	" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 26	107	89	+ 18	+ 31*h*	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	" 24	3,655	3,431	+ 224	+1,502	46	46	" 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	" 24	761	758	+ 3											
Dundee City Tramways	" 22	753	614	+ 139	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	" 25	12,544	13,097	− 553	—	104	95	" 31	582,146*e*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	" 22	1,139	1,028	+ 111	+ 2,225	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	" 25	1,057	901	+ 156	—	48	48	Sept. 30	29,061*h*	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	" 25	1,728	1,602	+ 122	+ 2,257	19	9½	" 30	72,331*h*	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	" 18	9,978	9,373	+ 605	+31,761	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	" 26	1,541	1,444	+ 97	− 1,049	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	" 26	4,166	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	" 23	961	888	+ 72	—	11	—	" 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	" 26	1,036	989	+ 47	+ 2,653	19	17	" 31	57,307	13,569,808	1,179,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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NOTES.

Electro-Harmonic Society.—The next concert of the above society is a ladies' night, and takes place on Friday evening, the 14th inst., in the Crown Room of the Holborn Restaurant. Extra tickets of admission to this concert may be obtained from the hon. secretary at the reduced price of 1s. each.

Glasgow Local Section.—The opening meeting of this section of the Institution of Electrical Engineers takes place on Tuesday, the 11th inst., when the chairman, Mr. Henry A. Mavor, will deliver his inaugural address. It is hoped that members of all grades of the Institution will assist the committee in making this section in the coming session as successful as in the past, by attending the meetings and taking part in the discussions on the papers brought forward. Members are always cordially invited to introduce visitors, and the same vouchers may be made use of as for the London meetings.

Society of Arts.—The above society has arranged to hold the opening meeting of its new session on Wednesday, the 19th inst. The inaugural address this year will be given by Sir Wm. H. Preece, K.C.B., chairman of the council. The arrangements completed up to Christmas include a series of four Cantor lectures by Prof. Vivian B. Lewes on the subject of "The Future of Coal Gas and Allied Illuminants"; a paper by Mr. Alfred Watkin on "Some Aspects of Photographic Development"; and another treating of the "South Russian Iron Industry," contributed by Mr. Archibald P. Head, M.I.C.E.

Cable Landing Rights.—Sir Edward Sassoon asked the Postmaster-General in the House of Commons a few days ago whether he could instruct the Governor of Hong Kong to make it publicly known that landing rights will forthwith be granted to any individual or company seeking for them in Hong Kong and its dependencies, under reasonable conditions, for purposes of laying cables. Mr. Austen Chamberlain replied that the instruction suggested by Sir E. Sassoon could not be given to the Governor of Hong Kong, in view of the terms of an agreement made in 1893 with the Eastern Extension Telegraph Company.

Time-Setting by Wireless Telegraphy.—A short time ago the proposal was made and seriously entertained in some quarters to distribute Greenwich time to vessels at sea as well as inland by wireless telegraphy, and, according to our contemporary, *Cosmos*, Messrs. Burgos, a firm of clockmakers at Ocejos, have devised an apparatus for carrying out the distribution inland. A standard or primary clock determines the discharge of an oscillator at regular intervals. The local or secondary clocks have each an air wire to direct the electric waves on to a detector, which actuates a mechanism and corrects the hands on the dials. We are not aware that the above plan has been put into practice yet, nor is information available as to the results of experiments. The difficulty appears to be that other signals by wireless telegraphy will affect the clocks.

Wireless Telegraphy.—Mr. Marconi has promised to make some important announcements very soon, but what form they will take is as yet only known to Marconi himself. He is now at Table Head, Nova Scotia, working at his new station there. A dispatch dated Halifax, Nov. 1, says that he hopes to commence experiments in communicating with England in a week's time, so it is possible that the "important announcement" will reach this country by wireless telegraphy. According to a statement he is reported to have made on landing at Table Head, Marconi's experiments while crossing the Atlantic in the Italian cruiser "Carlo Alberto" have been successful, but in what particulars is not stated. He would not say whether he was in constant communication with Cornwall during the voyage or not.

Engineering Standards Committee.—The above body have appointed a committee on the standardisation of electrical plant, with Sir William Preece, K.C.B., as chairman. The other members of the committee are: Mr. J. Gavey, engineer-in-chief to the Post Office; Colonel Holden and Captain A. H. Dumaresq, representing the War Office; Commandant G. L. Sclater, R.N., and Mr. L. J. Steele, representing the Admiralty; Mr. A. P. Trotter, representing the Board of Trade; Colonel Crompton, C.B.; and Messrs. Philip Dawson, S. Z. de Ferranti, Robert Kaye Gray, Mark Robinson, R. Percy Sellon, Alexander Siemens, James Swinburne, and C. H. Wordingham. This committee is one of several now organised for the standardisation of various materials and plant under the auspices of the engineering institutions.

Physical Papers.—The volume containing the physical papers of the late Prof. Henry A. Rowland, the preparation of which for publication was announced in April of this year, is now nearly ready for distribution to its subscribers. It has been edited under the direction of a committee, consisting of President Remsen, Prof. Welch, and Prof. Ames, who have made every effort to present to the world in a suitable form this memorial of their colleague. The subjects treated in these papers cover a wide range. For instance, in electricity and magnetism there are the fundamental researches on magnetisation, on the magnetic effect of electrical convection, on the value of the ohm, and on the theory and use of alternating currents, etc. The price of the volume is £1. 1s., and orders may be sent to Prof. Joseph S. Ames, Johns Hopkins University, Baltimore, Maryland.

Underground Telegraphs to the North.—The Post Office is pushing on with the work of laying underground telegraphs to the North. The mains are now laid along three sections on the West Coast route—viz., from Stafford to Warrington, from Preston to Preston Richard, about 10 miles north of Lancaster, and from Kendal to Shap. The cables have not yet been taken through all the mains, and it is not intended to place the cable in the Kendal-Shap section this year. The other two sections, however, have most of the cable laid. The completion of these three new sections will, it is hoped, make the total severance of telegraph communication with Scotland in the case of a breakdown of the overhead wires almost an impossibility. They do not, it will be seen, form a continuous line, but they are the most exposed sections on the route between London and Glasgow and Edinburgh.

Rubber Exports from Para.—According to the final returns, the shipment of rubber from the Amazon Valley last season amounted to 29,997 tons, or 2,317 tons more than in the previous year. In the present season it is anticipated a record crop will be harvested. The rubber fields of the lower river, and especially on the islands, are slowly but surely failing, both in quantity and quality, but the decrease is more than made up by the development of new fields and the expansion of the old fields on the Upper Amazon. While all the more important tributaries of the Amazon are supplying their full quota of rubber, and even making a promising increase, interest will focus in the now famous Acre territory, and in South-Eastern Ecuador. Many seringueiros, or rubber gatherers, are heading for these regions, and it is reported that several syndicates are about to begin operations in new fields in Bolivia and Peru. Bolivia continues to offer inducements for the colonisation and development of her vast area of rich rubber and mining territory.

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Electrolysis of Silver Nitrate.—It is generally stated that silver nitrate becomes acid during electrolysis, but Rodger and Watson found that the acidity of a silver nitrate bath diminished. The apparent contradiction, as explained by Mr. A. Leduc in a recently published paper, is due to a difference of condition; with platinum electrodes in a sufficiently concentrated solution, a brown solid containing a higher oxide of silver is formed with simultaneous formation of nitric acid, which, however, when a sufficient concentration is reached, reacts on the compound with formation of oxygen. Similar results are obtained with soluble anodes and current of sufficient density, and the acidity of the bath therefore leads to a limiting value. The author finds that corrosion or solution of the cathode deposit does not take place, and the experiments also indicate that in a silver nitrate voltameter the polarisation E M.F. is about 0·03 volt.

Royal Institution.—A general monthly meeting of the members of the above institution was held on Monday afternoon, Sir James Crichton-Browne (treasurer and vice-president) in the chair. The following were elected members: Mr. G. H. Baillie, Mr. W. D. Butcher, Mrs. A. R. Cox, Sir Archibald Campbell Lawrie, Mr. G. J. Morrison, and Mr. A. B. Tubini. The special thanks of the members were returned to Sir Andrew Noble, Bart., K.C.B., F.R.S., for his donation of £150 and to Dr. Ludwig Mond, F.R.S., for his donation of £200 to the fund for the promotion of experimental research at low temperatures. The annual course of Christmas lectures, specially adapted to young people, at the Royal Institution, will be delivered by Prof. H. S. Hele-Shaw, LL.D., F.R.S., professor of engineering in University College, Liverpool, whose subject is "Locomotion: on the Earth, through the Water, in the Air." The first lecture will take place on Saturday, Dec. 27, at 3 o'clock, and the remaining lectures will be delivered on Dec. 30, 1902, and on Jan. 1, 3, 6, and 8, 1903.

Electric Power in North Wales.—At the inaugural meeting of the Welsh National Society's winter session Sir Wm. H. Preece, K.C.B., delivered an interesting lecture, in which he advocated the extension of electrical distribution in North Wales on the lines which were now being undertaken in the southern part of the Principality. He suggested that a station at Carnarvon would serve for the transmission of electrical energy to every part of Carnarvonshire, Flintshire, and Denbighshire, and that another station would be required in the neighbourhood of the Dee. We quite agree with the lecturer that North Wales is backward in respect to electrical works, but the reason for this is not far to seek. The large mining industries of South Wales were the primary cause of the establishment of a power distribution scheme to serve them, and in North Wales the industries are almost conspicuous by their absence. The stone and slate quarries which exist would, of course, gain great advantage from the provision of a cheap power supply, and it is quite possible that the same would enable mines to be reopened which are not now being worked.

Duration of Charge and Deformation of Condensers.—As the result of experiment on the above subject, Mr. G. Ercolini has been led to the following conclusions: The deformation of condensers increases with the time of charge, except that in the first moments it remains constant in general for a time which is longer the greater the potential. The increase of deformation diminishes with the duration of the charge. Discharges do not restore a condenser to its original condition. The residual deformation increases when the potential or the duration of the charge increases. After a certain time, always short, the condenser returns to the original condition, passes it, and remains deformed for a long time, never less than, say, five minutes. Under potentials maintained constant the deformations are less than those under rising potentials. During charge or discharge there is an exchange of heat energy between the condenser and its environment, and there is a change in the thermic capacity of the condenser, which diminishes as the difference of potential between its plates increases. These two phenomena tend to produce opposite variations of temperature. The slower the charging the more the condenser cools down.

War Honours.—Glancing through the honours list issued by the War Office last Friday in respect of services rendered in the South African war, we notice the name of Quartermaster-Sergeant J. Gunn, of the Electrical Engineers (R.E.) Volunteers, who has been awarded the distinguished conduct medal. This is the only representative of the Electrical Engineers in South Africa to receive practical recognition in the present list, but we are pleased to note that a couple of well-known railway engineers have had the dignity of Knight Batchelor conferred upon them. They are Lieutenant-Colonel F. Harrison, of the Engineer and Railway Volunteer Staff Corps, and Lieutenant-Colonel C. J. Owens, of the Railway Volunteer Staff Corps. The former is general manager of the London and North-Western Railway, and has been prominently associated with the recently established corps, of which he is lieutenant-colonel. Mr. Charles John Owens, now Sir Charles Owens, succeeded Sir Charles Scotter as general manager of the London and South-Western Railway at the beginning of 1898. In that capacity he has been largely responsible for the satisfactory working of the railway arrangements in connection with the dispatch of troops to and from Southampton during the continuance of the war and since the conclusion of peace.

Power Transmission.—At the opening meeting of the new session of the Birmingham University Engineering Society Prof. F. W. Burstall gave an interesting address on power supply over large areas. At the outset he showed the advantages of combining a large variety of consumers on to one station, as it improved the power factor, and hence reduced the cost of generation. Prof. Burstall's idea was that in the course of time large gas-engines would be much more largely used than steam-engines. The ideal method of generating power was to lay down one huge factory from three to five miles from the centre of a town, from which three saleable products could be turned out. In this factory the Mond gas-generation process would be used, and the valuable sulphate of ammonia would be recovered from the slack coal. The next commodity would be the power gas which, used for heating purposes, would do much to abolish smoke nuisance in towns. It could also be employed for driving gas-engines, but the lecturer hesitated as to whether the general power consumers would be supplied from gas-engines on their own premises, or by electricity driven from large gas-engines at the gas generating works. A number of questions have to be practically determined before the relative advantages of transmission by gas and electricity can be definitely compared, but up to the present electricity has, without a doubt, the advantage of flexibility and of cheapness.

The Cork Industrial Conference.—At the recent meeting of the Industrial Conference held in connection with the Cork Exhibition, a number of papers were read which interest electrical engineers. Amongst these was one by Mr. F. J. Dick, who, it will be remembered, contributed some information to the recent meeting of the British Association on water power in Ireland. In his

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communication to the Cork conference Mr. Dick was rather more hopeful, but he again emphasised the fact that in a large number of cases the maximum water power available in the summer is low. This has involved the laying down of an auxiliary steam plant in several instances, which, of course, runs up the capital cost of the undertaking. We are pleased to know, however, that Mr. Dick, as at Belfast, did not get the whole field to himself. Mr. S. Macrory was also present at Cork, and brought forward his views as to the application of the Bann Falls, and as to such class of work being placed in the hands of the county councils. At another meeting of the conference Mr. C. L. de Muralt read a paper on "The Distribution of Power by Electricity." In this there was a good review given of progress in other countries, the conclusion being that what Switzerland had done could also be carried out to a certain extent in Ireland with great advantage to the country. Without a doubt the opportunities in the country are great, but they are not enhanced by the national characteristics of the people.

Telephone Pipes in Metropolitan Streets.—A very sensible and well-informed suggestion is made by the Works Committee of the metropolitan borough of Islington with regard to the laying of conduits for telephone and telegraph wires under the public footways. It is that the conduits should be laid in vertical sets of three, one under the other, instead of side by side, as is usually done. Obviously, if this plan were generally adopted, it would result in a great saving of space and time, and the obstruction caused by such works to traffic would be appreciably relieved. It is very probable that the experiment will first be tried in Islington, as the Postmaster-General has applied for the consent of the local authority to lay pipes and conduits for telephones in some of the streets of the borough, and the Council will only give their consent on certain conditions, one of which is that the pipes shall be laid vertically and not side by side. A formal reply to the application, however, has not yet been made, pending the result of the deputation which has been appointed, at the instance of the Battersea Borough Council, to wait on the Postmaster-General with reference to his using his statutory powers to enable an irresponsible body such as the National Telephone Company to gain underground access to the streets of the Metropolis. If the result prove unsatisfactory, the Islington Corporation will only give their consent to the laying of the pipes in their streets on the conditions referred to.

Tramway Track Maintenance.—An interurban number of the *Street Railway Journal* issued last month contains a large number of special articles on interurban tramway work in the United States. These lines, where worked as tramways, are really light railways connecting up a number of towns. As an example of the distances to which they go, it may be mentioned that the Detroit United Railway has under its care 188 miles of track in the city and 192 miles of interurban track. The maintenance of this is no light matter, and it speaks well for the engineer responsible for it, Mr. John Kerwin, that the average cost is as low as £3. 2s per mile per annum. This is much less than the cost of maintenance on railways, due without doubt to the lighter weights of the moving vehicles. Practically all the rails on these interurban tracks are either of 60lb. or 70lb. section. The lengths employed are both 30ft. and 60ft. It is found that the 60ft. rails, while reducing the cost of maintenance so far as the joints are concerned, are more expensive due to creeping. The point is noted that all special work at crossings, and at places where transition is made from one type of rail to another, the special castings are cast-welded on to the rails, which greatly increased the life. A good part of the track is laid without ties on concrete foundations under each rail, 12in. deep and 18in. wide. These foundations are connected by stringers. A great feature in connection with the economic maintenance of these large lengths of track is that all the auxiliary plant required for repairs, or for dealing with the prompt construction of new track, is worked mechanically. For instance, the whole of the gravel required in ballasting is elevated on to the ballast trucks by electrically-driven elevators, thus avoiding large sums in unskilled labour.

Institution of Junior Engineers.—On Thursday evening last week the members of this institution were afforded the opportunity for visiting the headquarters of the Electrical Engineers (R.E.) Corps of Volunteers, Regency-street, Westminster, and a large number availed themselves of it. The party was received by the commanding officer (Major R. S. Erskine, M I.E.E.) and staff. A short description of the general work of the corps was first given. Their duties consisted principally of the running of searchlights at different positions round the coast. There were at present nine such stations equipped with apparatus for the use of the corps, and no member was considered efficient unless he had served a period of training at one of these stations. The corps had given a good account of themselves in the operations in South Africa, and Lord Roberts had stated that by their services in supplying light for the reconstruction during night-time of the damaged bridges, etc., before Pretoria he had been able to make his entry into that town some days earlier than would otherwise have been possible. Captain J. H. S. Phillips explained the construction and working of the 25-h.p. Hornsby-Ackroyd oil-engine which is used for driving the compound-wound dynamo, giving a current of 80 volts and 200 amperes. This plant is the standard set installed at the stations for instructional purposes. One of the portable searchlight sets, which had done duty in South Africa, was connected up, and the special features of the mounting of the lamp and general equipment were indicated. An interesting object was a small lamp used by the Boers, fitted with a shutter, by means of which signalling by the Morse code could be carried out, but as it was only of small power its utility to any extent seemed open to question.

Technical Education.—The issue of the London *Technical Education Gazette* for the months of September and October contains an interesting list of the various classes in the Metropolis, divided up into the subjects taught. This gives a good opportunity for anyone wishing to take up a given course of study to select the nearest institution. Another advantage of the system of classification is that it affords a good idea of what subjects are almost universally taught in the polytechnics, and what are neglected. For instance, while 22 institutions teach physics (including electricity, magnetism, sound, light, and heat), only 13 have classes in electrical engineering. It is worthy of note that out of these 13, all but three have workshops in which the students can obtain practical instruction. In the same way the mechanical engineering classes are held in 22 institutions, but of these 10 have no workshops. When, however, one comes to the applied sciences, in which specialisation is required, it is realised what great room there is for improvement. For instance, electrical metallurgy is only taught at the Northampton Institute, while electroplating and depositing is only better provided for by there being three classes within the metropolitan area. Opticians, again, can only obtain practical instruction at the Northampton Institute, but theoretical information is given at the City and Guilds Finsbury College. While these classes on special subjects ought to be largely

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extended, it is only right that they should be confined to those districts in which the workers in such special subjects are to be found. There are, however, in London engineering centres which are lamentably deficient in this respect. The enterprise of the London County Council may be gauged from the fact that while some of our electrical subjects are insufficiently taught, there is one institute in which instruction in expert hair-dressing is imparted.

Electrical Laboratories in America.—Leaders of science are just now greatly exercised with regard to the question of the provision of electrical laboratories in the important engineering centres in the States. The Government also are pursuing the estimable policy of establishing State laboratories, which in the near future promise to prove of immense value to the electrical profession. One of the largest laboratories of electrical engineering now in course of erection in the States is the Augustus Lowell Laboratory in Boston, which is being erected in honour of the services which the late Augustus Lowell rendered to science. There are to be five important working parts of the new laboratory—*i.e.*, the power-room and main laboratory, the smaller research-rooms, the standardising-room, the lecture-room, and, finally, the workshop. The building covers 40,000 square feet of land. In the power-room, which is naturally the heart of the laboratory, plant is to be installed giving an aggregate of 1,000 h.p., which will furnish current for light, power, and experimental purposes. The actual experimental work will be conducted with the aid of a number of small portable dynamos, which a 10-ton overhead crane, running from one end of the hall to the other, will carry backwards and forwards as required. An interesting feature of the amphitheatre, with a seating capacity for 300 students, is its connection with the adjoining power-room and main laboratory by a system of double tracks, which run like a narrow-gauge railroad across the lecture platform. In place of trains running on these tracks there will be moving tables for the arrangement of apparatus used in illustrating the lectures. The standardising-room, in accordance with its importance, is to have an equipment which, it is hoped, will at least equal the famous Reichsanstalt in Germany. The exterior simplicity of this latest addition to the laboratories of America is worthy of notice. It rests upon permanent foundations, yet is so simply constructed that, if required, it could be rebuilt without incurring any serious waste of money.

Tramway Employes.—Amongst the great variety of duties which fall to the lot of electrical engineers is the management of tramways, and more especially of tramway employés. This class of labour has, as a rule, to be specially trained after engagement, and the control of it is by no means easy. Usually in this country, as elsewhere, the punishment for infringement of rules is to lay off the employé, who loses time and hence wages. This system has its disadvantages, and falls more heavily, not on the offender, but on his family. In the issue of the *Street Railway Journal* for October there is a good description of the merit system of controlling tramway employés as used on the Detroit United Railway. It consists in keeping a record of the behaviour of all conductors and drivers, and placing against their names marks every time they infringe regulations, have accidents, or otherwise misconduct themselves. Every three months, if a reprimand has not been necessary, five marks are deducted from the total so arrived at. If, however, in spite of this the number of marks against an employé creeps up to 60, he is at once dismissed. The scheme is said to work uncommonly well, and the number of marks to be placed against a man's name for any offence has been arrived at after careful consideration by the heads of departments. In this way the personal feeling of a local superintendent has no influence on the future of the employés under him. Another good point is that any time a mark is placed against the name of a man he is informed of the same and has an opportunity of bringing evidence in his favour. Special merit marks are awarded for cases of heroism or for good work done in cases of breakdown, etc. The records obtained in this way are considered when any chances of promotion to higher classes of work occur. We note, in passing, that it is the custom with this company to instruct the new conductors and the motormen on cars running on the normal service. After they have been instructed they run for 60 days on trial, after which a medical examination has to be undergone at their own expense. It is said that only 40 per cent. of applicants actually get into the service.

The County Council's Tube Proposals.—After much deliberation during the past week, the Joint Committee of the London County Council, appointed to consider at once the advisability of promoting a Bill next session on the subject of underground railways in London, have lighted on a fact which must have been patent to anyone who considered the matter from the first—*i.e.*, it is impossible within the time limited by the Standing Orders for the Council to prepare a scheme and lodge it in Parliament for promotion in the ensuing session. Thus, at the very outset of the report which the committee presented to the Council last Tuesday, they admit inability to give the locomotion problem in London that practical and immediate attention which the public have a right to demand. The only alternative open to the committee, therefore, was to try and persuade the Government to throw the whole matter over till 1904—a course of action which we sincerely hope will not meet with approval in the proper quarter. The proposal of the committee, in a word, is that a commission of enquiry shall be appointed to consider whether it is possible and desirable to formulate some general scheme of underground railway accommodation capable of serving the requirements of London as a whole, and by whom such general scheme can best be carried out. A deputation from the London County Council is to wait upon the President of the Board of Trade, and ask him to assist in obtaining the appointment of a commission to hold such enquiry. It need hardly be said that the adoption of this proposal would mean the "hanging-up" of the schemes to be brought forward next session by the companies, and a still further delay of over 12 months in the solution of the underground railway problem in London The committee contend that it would be detrimental to the interests of London if any Bill for the construction of a tube railway is proceeded with in Parliament until a full enquiry after the nature suggested by the committee is held; but we may point out that a very general and thorough investigation into the whole matter was made in 1901 by a Joint Committee of the two Houses of Parliament, who made a number of definite recommendations for the guidance of the Select Committees, the soundness of which would, we think, hardly be questioned by the London County Council themselves. It is difficult, therefore, to find any legitimate excuse for the policy proposed by the Council, but they are evidently bent on attaining their object if they possibly can, and have sympathetically decided to prepare a complete scheme of locomotion for London in order to be in a position to lay full information before the commission, should it be appointed.

Aluminium Production at Niagara.—The Pittsburg Reduction Company, which works the Hall process

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of producing aluminium at Niagara, was the first plant to utilise the power derived from the Falls when in 1893 the Niagara Falls Power Company completed its pioneer power-house. Special inducements were offered the Reduction Company to take the direct current needed for the process from this source, and a private arrangement was come to between the two companies under which a certain price per horse-power hour was agreed upon. This is understood not to be over £3. 12s. per horse-power per year, and it is said to be the only case in which the power company have furnished current transformed to suit the customers' purpose or at such a low figure. The average price now is more like £4 per horse-power per year for the alternating current at 2,250 volts, the purchasers putting in their own transformer machinery. In the October number of *Electro-chemical Industry* Mr. J. W Richards continues his able exposition of the electro-chemical industries of Niagara Falls, devoting considerable space to a description of the process in operation at the works of the Reduction Company. The alternating current is first reduced in potential to 115 volts, and is then passed to rotary transformers, of which there are six. These transformers transform the alternating into direct current at 160 volts, and furnish two currents of approximately 10,000 amperes. Each current passes through a line of reducing pots, being conducted on aluminium bars giving a carrying capacity of over 500 amperes per square inch of conductor. The voltage drop at each pot is a little over five volts, each pot absorbing about 65 h.p. The current passes into each pot through carbon electrodes, 3in. in diameter by 18in. long, each carrying 250 amperes of current. It is found that this is about the maximum current which can be carried by the copper-rod connections without undue heating. About one-half the energy of the current is absorbed in the chemical work of decomposing alumina. The other half is converted into heat, and keeps the bath at the proper temperature and fluidity necessary for electrolysis—about 850deg. to 900deg. C. The efficiency of recovery reckoned on the amperes used is between 80 and 90 per cent. The bath is the ordinary Hall bath, containing cryolite, to which is added aluminium fluoride as the solvent, and with alumina dissolved therein. The action of the current sets free aluminium and oxygen, the latter uniting with the carbon anodes to carbonic oxide. The aluminium obtained averages 0·1 per cent. iron, 0·3 per cent. silicon, with smaller amounts of copper, titanium, carbon, and sodium, but is guaranteed over 99 per cent. pure, averaging more nearly 99·5 per cent. The selling price of such metal is, in ton lots, 1s. 3d. per pound; less pure metal is made from less pure alumina, and sold for use in casting iron and steel at 1s. 2d. per pound. The company now has two plants in operation, the one using 4,000 h.p. and the other 6,500 h.p. This latter takes current from the Hydraulic Power and Manufacturing Company.

Electrical Distribution in Paris.—In the last issue of *L'Industrie Electrique* Mr. F. Laffargue gives a good *résumé* of the present equipment of the various electric lighting undertakings in Paris. The information is in tabular form, and is exceedingly convenient for reference. It does not, however, give quite that class of information which the electrical engineers of this country expect to find about undertakings which have been at work for years—in other words, while the plant is described in full, the financial outcome of a year's working is not given, nor are the output and cost of supply. The reason for this evidently is that the period for which the present companies have the right to supply is drawing to a close, and any such figures would be apt to prejudice the negotiations which are shortly to be undertaken between the companies and the Paris authorities. The author's conclusions as to the general changes made since our contemporary last published similar tables are as follows: All the companies have practically resolved to erect works outside Paris, from which electrical energy will be transmitted into the city and there distributed by means of sub-stations. A number of the companies have already got their suburban works in operation. It is also noted that in almost all the stations and sub-stations belting is now not used as a means of connecting up engines and generators. Instead, as is usual in this country, the dynamos are directly connected on to the engines. The author adds that the underground cables of Paris continue to give good results as a rule. Some of the systems are excellent, but others, on the other hand, are bad, and only provide exceedingly low insulation. It is found that these faults in insulation are often not due to the underground cables, properly speaking. Thus, if a cable has a fault, external damage due to pickaxes in repairing the public streets or to inundations of the conduits by storm water are often the reasons, while the companies localise and remove the faults as quickly as possible. At the same time, considerable trouble is caused by the bad work done on some of the consumers' premises We gather that fittings for both gas and electricity are still used in cases, and this is a common cause of low insulation. It is only fair to say, however, that remarkably good work is done in other instances. Since the last table of equipment of these electric lighting undertakings was issued the Compagnie Continental Edison has opened its new works at St. Denis, where 4,400 kw. of plant have been installed. The article states that the energy is transmitted to Paris by continuous current with three wires at 22,200 volts, but this, we think, is a misprint. The works at St. Ouen of another company have also been considerably increased. Two-phase alternators are employed for the transmission at high voltages of energy to several other stations and sub-stations in Paris. In connection with these the Hutin and Leblanc transforming rectifiers are used to transform the two-phase currents into continuous for distribution. A third company has opened a three-phase station at Asnieres, which we have described recently in our columns. But what is more interesting than a full statement of progress is the information that the applications of electrical energy in Paris have not progressed as they should. This is due to the high price charged for electrical energy, which makes it prohibitive in numerous cases. These prices are not likely to be reduced until the Municipal Council has come to a definite conclusion as to the renewal of the concessions. The companies as a whole supplied at the end of 1900 13,900 arc lamps, and just over a million incandescent lamps. It is rather in the application of electricity for motive power that further development is retarded by the uncertainty of the policy of the Council. We gather, however, that electric lifts have proved themselves in Paris, even at the present high price of electricity, more economical than any of their competitors. The author of the article before us gives the following figures as to the actual cost for power of a complete journey up and down a six-storey building with the different types of lifts mentioned: hydraulic lift, 1·58d.; compressed-air lift, from 0·45d. to 0·29d.; while with the electric lift the cost is only 0 24d. This last figure is worked out on the assumption that the electrical energy is paid for at the rate of nearly 6d. per Board of Trade unit. One naturally concludes this rate of charge is not unusual for power, and it can then be realised that even with the London companies we are much better off in this country, where 2½d. per unit for power is not considered low.

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LEEDS ELECTRICITY WORKS.

The progress of the electric supply undertaking in Leeds has been eminently satisfactory from the date when the supply was first given in May, 1893. The increase in units sold per annum has been regular, and, what is equally satisfactory to all but advocates of private enterprise against municipal trading, the price charged per unit has always been on the decrease. The Leeds supply was commenced by the Yorkshire House-to-House Electricity Company in 1893, but the undertaking was transferred to the Corporation in October, 1898. For that year the number of lamps connected expressed as the equivalent in 8 c.p. was 73,950, and the units sold were 1,199,566. The progress made since the undertaking was transferred is shown by the fact that for the year ending March 25, 1902, the lamp connections had gone up to 178,422, and the units sold to 3,055,165. Before the undertaking was transferred the price charged for lighting was from 5d. to 6d. per unit with discounts, and for power 3d. per unit, less 5 per cent. At the present time the consumers in Leeds get their electrical energy for lighting at 4d. per unit, less 5 per cent. for prompt payment, while those using electricity for power are charged at rates varying from 1½d. to 2d. per unit, with the same discount.

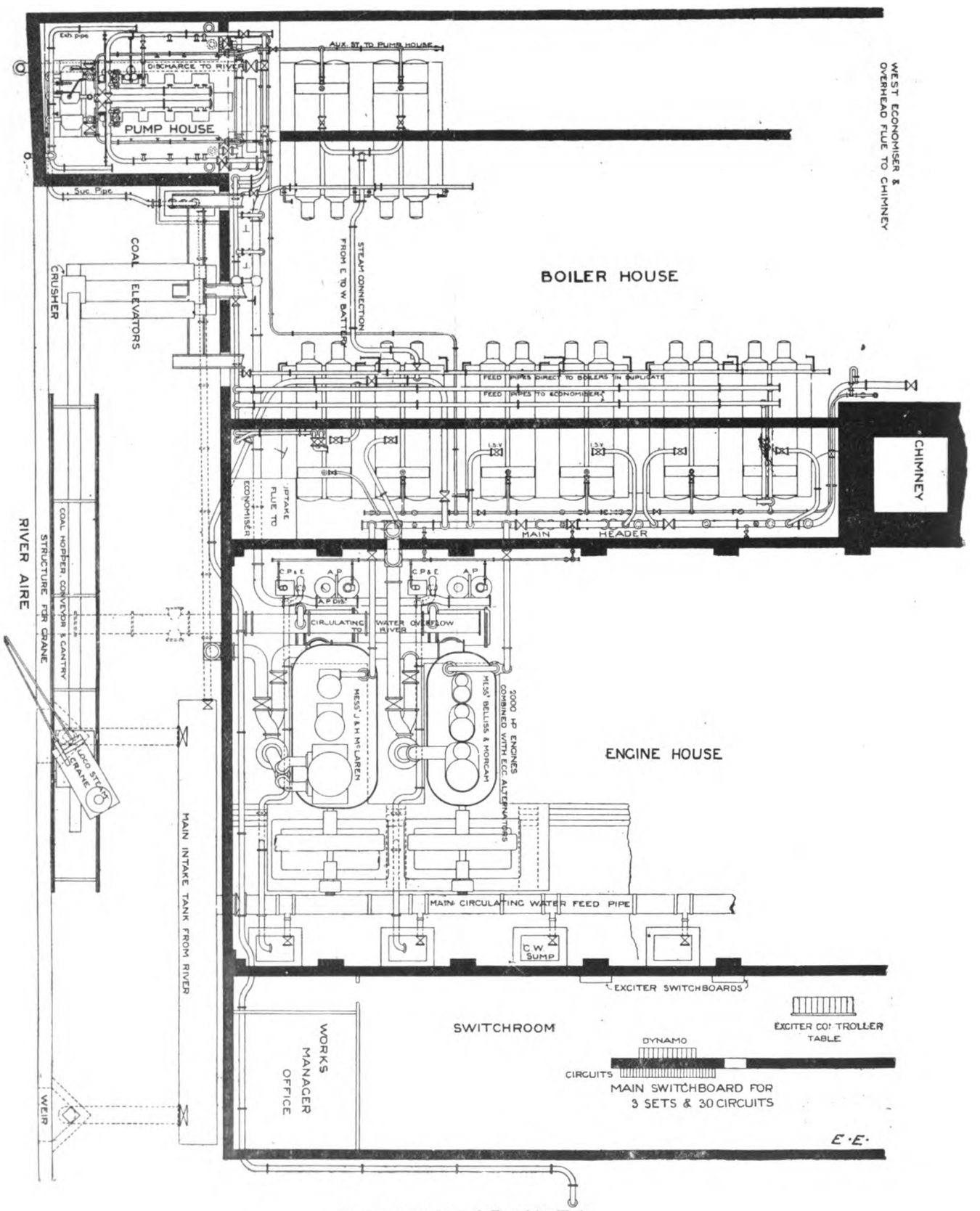

FIG. 1.—Plan of the Leeds Electricity Works.

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The undertaking is under the control of Mr. H. Dickinson, the Corporation's electrical engineer, and he has been quick to see the advantages of a good motor load, and to so frame his regulations and charges as to obtain the same. Not only have the works had to be enlarged in consequence, but Mr. Dickinson, realising the limitations of a single-phase alternate-current supply, has changed over to a certain extent to the two-phase system. To this end a certain number of the old alternators have been rewound for the two-phase system, and have also been provided with new field-magnet systems in order to decrease the frequency of supply from 83 to 50. These alterations have been carried out without in any way interfering with the regularity of the supply, while at the same time large extensions of work have been found necessary. These extensions we propose to describe in the following article have been erected on a site 290ft. by 180ft. adjoining the river. This site, belonging to the Corporation, was available when the need arose, and is now practically covered with buildings. The architectural design of these was entrusted to Mr. Chas. France, of Bradford, while the whole of the engineering and electrical work was designed by Mr. Dickinson. It will be seen from the illustrations (Figs. 1 and 2) that these buildings have been designed to contain larger plant than has been installed in them as yet. The following particulars of these buildings will be of interest.

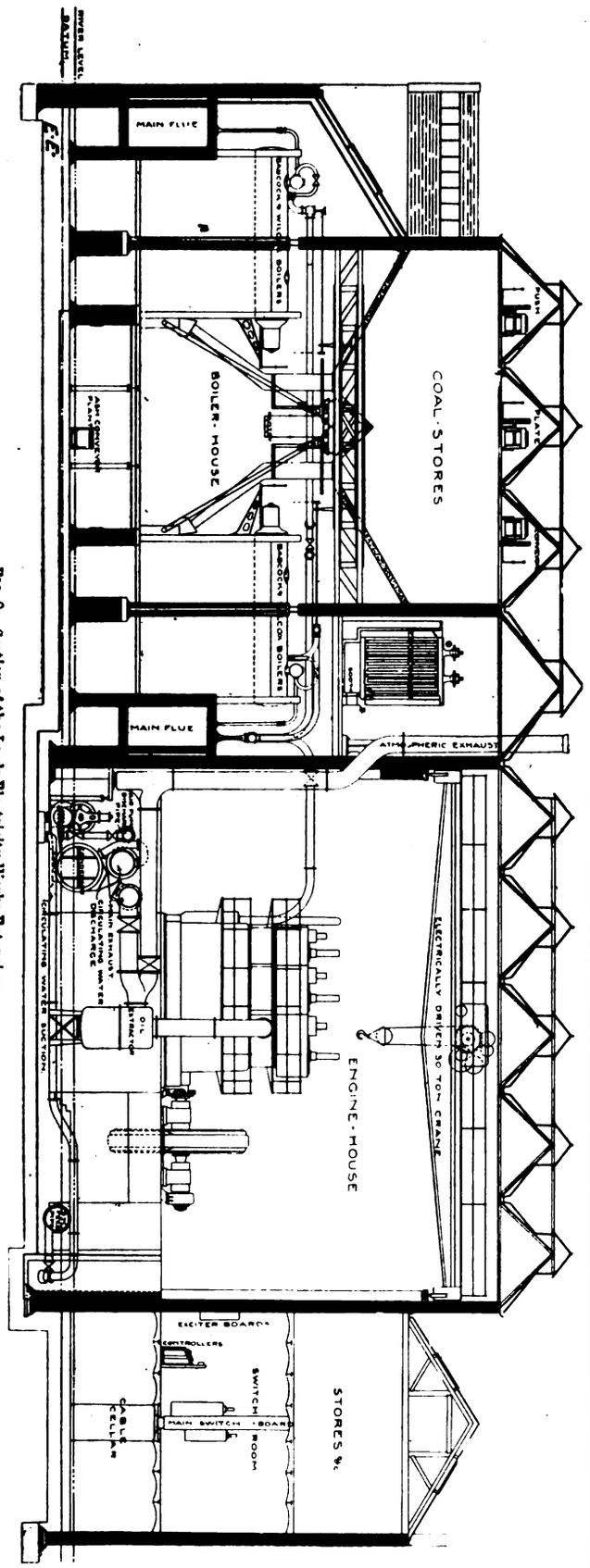

Fig. 2.—Section of the Leeds Electricity Works Extensions.

The engine-house is 220ft. long by 65ft. in width by 33ft. high from floor line to crane rail, and 44ft. from floor line to the underside of the roof binders. The switch-room is 170ft. long by 28ft. wide by 16ft. high, and is built with a view of accommodating step-up transformers for feeding the outlying districts of the city at extra high pressure if it should be necessary later on. Underneath the switchroom is a cable cellar leading to the subway running from the works to Queen-street. This extends the whole length of the switchroom, and forms a ready means of bringing the cables from the dynamos to the switchboard, and taking the circuits away to the different parts of the town. Over the switchroom is the stores, running the full length of the switchroom. The boiler-house is 231ft. long by 82ft. wide by 24ft. in height from the floor line to the underside of the coal stores. In the middle of the boiler-house is placed the chimney, which is 12ft. 6in. square, inside dimensions, and 210ft. high. Over the boiler-house is placed a coal store, which is capable of holding 4,000 tons of coal—estimated to be a month's consumption.

The boiler-house is arranged to hold 24 water-tube boilers, with 4,300 square feet of heating surface each. At the present time there are installed eight Babcock and Wilcox water-tube boilers, fitted with superheaters and purifiers. The tubes are arranged in 17 sections, with 12 best solid-drawn steel tubes to each section. The boilers are fitted with Meldrum's coking stoker, and forced draught. They are arranged to be placed 12 on one side of the boiler-house and 12 on the other, with a space of 26ft. between the fronts of the boilers. Immediately above the boiler-house is the coal store, where the coal is stored, and from which it gravitates by means of inclined shoots into the mechanical stokers. There are two shoots to each stoker. The coal, after being placed in the overhead bunker, thus gravitates automatically through the coal shoots into the hopper of the mechanical stoker, and it is then passed through the fires mechanically by means of the moving bars, etc., in the stoker, and when burnt the clinker is thrown off the end of the bars on to an inclined shoot and the ashes are removed into a cellar under the boiler-house floor, where provision is made for slacking them, and they are taken away by means of an ash conveyor and stored in an overhead bin at the north end of the boiler-house until they are removed from the works. An economiser is placed over the boilers between the coal store and the western wall of the engine-house. This economiser is made by Messrs. E. Green and Son, Limited, Wakefield, and consists of 960 tubes of their standard make. Special provision, however, is made to provide for expansion and contraction in this long length. Provision is also made in this boiler-house for three other economisers of the same size—one economiser to each set of six boilers. There is only one chimney placed in the centre at the eastern side of the boiler-house, the boilers from the west side of the boiler-house being connected to the chimney by means of an overhead flue. The line shafting for driving the mechanical stokers and the conveying plan all driven by means of two-phase motors.

The pump-house is situated at the south end of the boiler-house, and is fitted with two feed tanks, and is capable of holding seven Weir pumps, which would feed the whole 24 boilers. At present there are provided two pumps with a capacity of 4,000 gallons per hour each, and one with a capacity of 8,000 gallons per hour. There are

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also installed two Worthington pumps, one with a capacity of 12,500 gallons per hour and the other 25,000 gallons per hour. These pumps are used for drawing the water from the river and passing it through a battery of Hawksley,

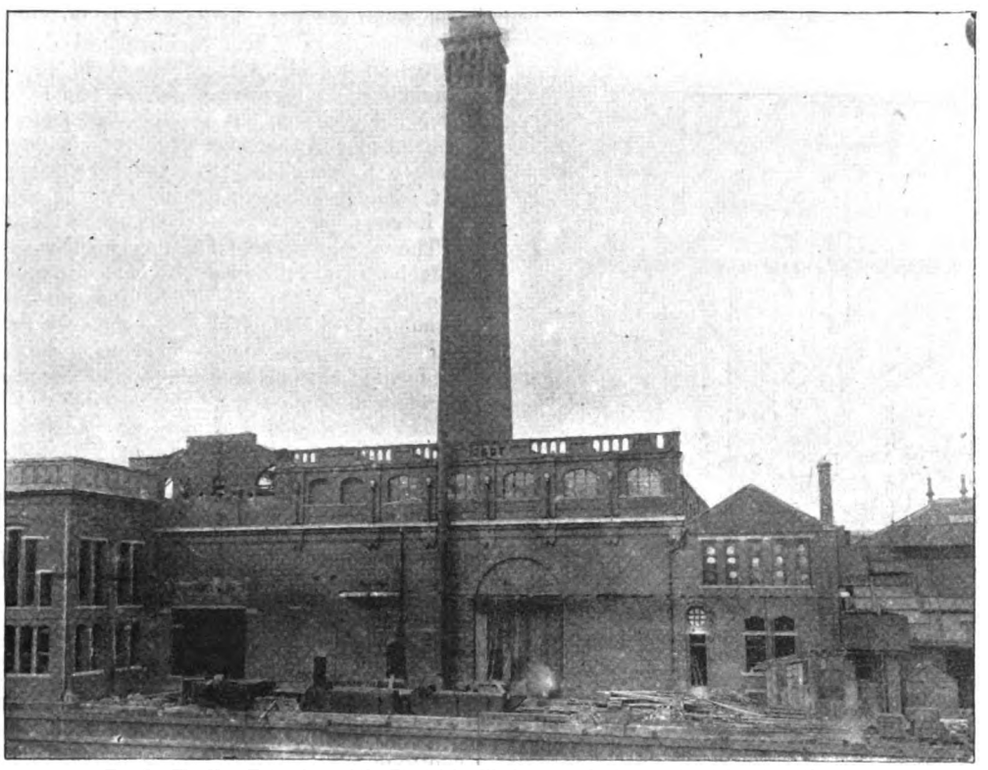

FIG. 3.—The New Extensions of the Electricity Works at Leeds, from a view taken from the river.

Wild, and Co.'s filters, and then discharging the water into the overhead storage tank.

The coal-conveying plant, not yet erected, is supplied by the New Conveyor Company, and consists of elevators and conveyors for the coal and ash conveying plant for the ashes. The coal is brought down to the works in the Corporation's own boats, and discharged by means of a crane made by Mr. Thomas Smith, of Rodley. This crane is mounted on an elevated structure 15ft. above the wharf level, and is capable of travelling over a distance of about 60ft. on this structure. It is fitted with a grab to enable the coal to be handled as quickly as possible. Immediately under the crane rails is placed a plate conveyor which runs under the whole length of the elevated structure for the crane. The plate conveyor is 3ft. wide, and fitted immediately above the plate conveyor are sheet-iron sides placed on an angle to direct the coal when discharged from the grab direct on to the conveyor. The coal is then taken to a hopper immediately outside the boiler-house entrance, and is there elevated by means of two conveyors to the coal stores and is transmitted through the coal stores on three push-plate conveyors, one in the middle, and one on either side of the bunkers. The coal can thus be discharged at any point in the stores as required. The plant can deal with 40 tons of coal per hour. From the stores the coal gravitates

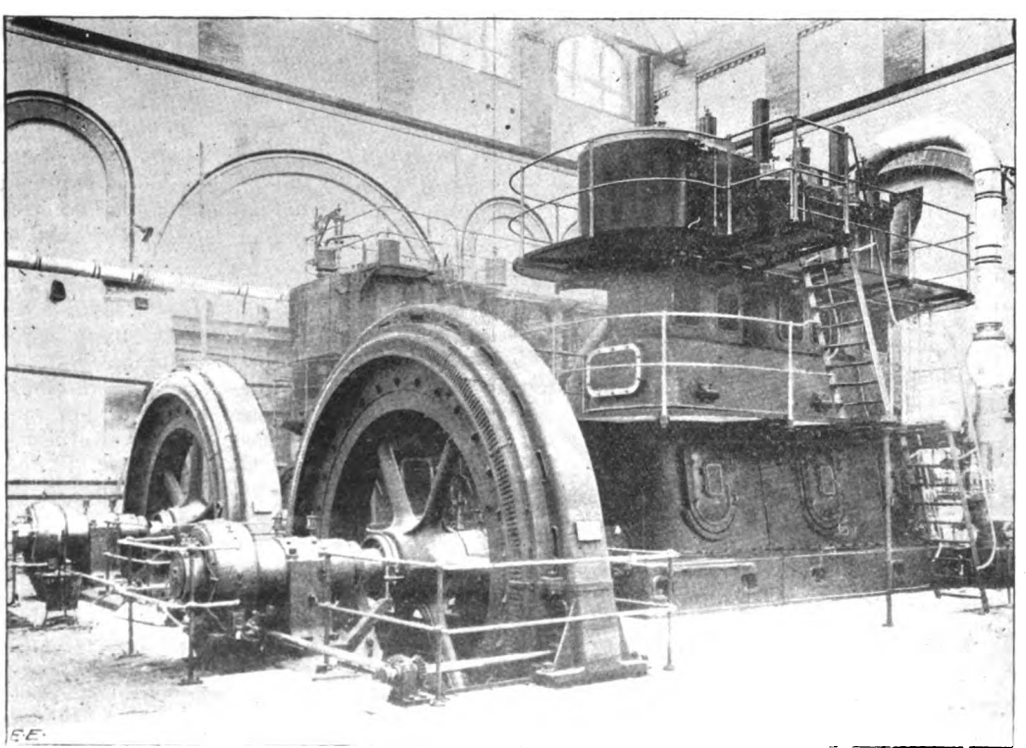

FIG. 4.—View of the Electric Construction Company's 1,500-kw Two-Phase Alternators at Leeds, Coupled to Belliss and to Maclaren Engines.

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down the inclined shoots to the mechanical stokers as explained above. The ash conveyor is of the plate conveyor type, and carries all the ashes to the north end of the boiler-house. The ashes are then discharged into a bucket elevator, and are carried up and discharged into an overhead ashbin, from which they are released and discharged into carts by means of opening a shoot at the bottom of the bunker.

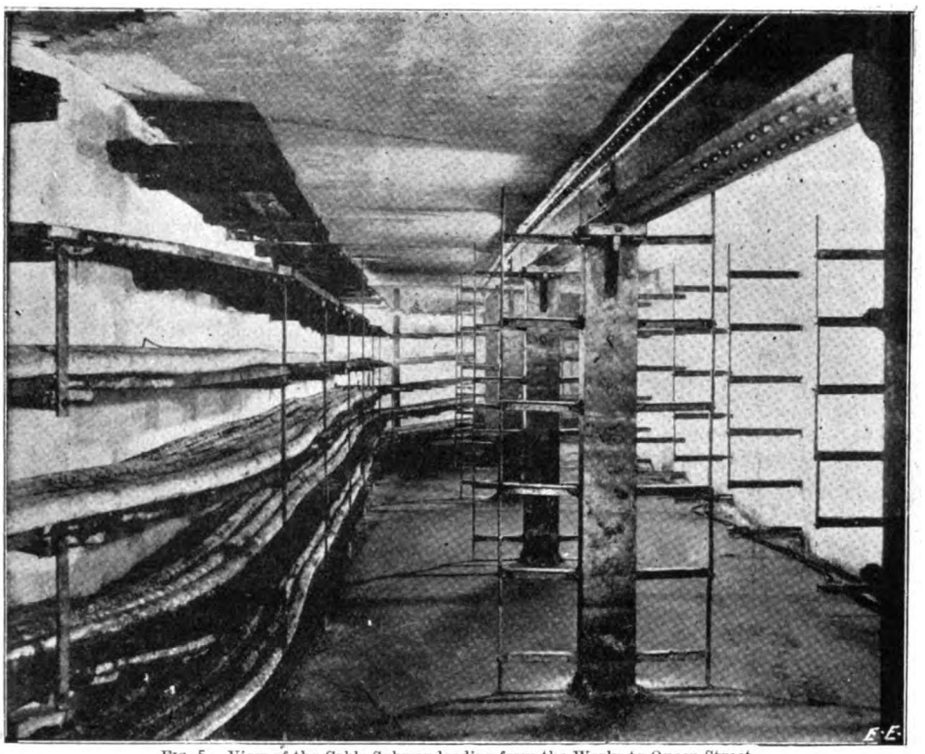

FIG. 5.—View of the Cable Subway leading from the Works to Queen Street.

The plant installed in the engine-room consists of one McLaren engine and one Belliss engine (Fig. 4), both coupled to alternators made by the Electric Construction Company. The normal output of each of the engines is 2,400 h.p., and the normal capacity of the dynamos is 1,500 kw. each. The engines are of the triple-expansion enclosed type with forced lubrication. The dimensions of the McLaren engine are as follows: high-pressure cylinder, 27½in. diameter; intermediate, 39½in. diameter; low-pressure, 64½in.; stroke, 24in.; speed, 200 revolutions per minute. The valves in this engine are trick ported slide valves, balanced horizontally and vertically. The floor space occupied is 24ft. by 9ft. by 20ft. high, and the space occupied by the whole plant, engine and alternator, is 38ft. by 18ft. 6in. The governor is of Messrs. McLaren's patent automatic expansion type. The dimensions of the Belliss engine are as follows: high-pressure cylinder, 22½in. diameter; intermediate cylinder, 35in. diameter; low-pressure cylinder, 55in. diameter; stroke, 2ft. 6in.; speed, 200 revolutions per minute. The valves are piston, and the governor is of the throttle type. The floor space occupied is 25ft. 3in. by 8ft. by 22ft. high, and the space occupied by the whole plant, engine and alternator, is 38ft. by 18ft. 6in.

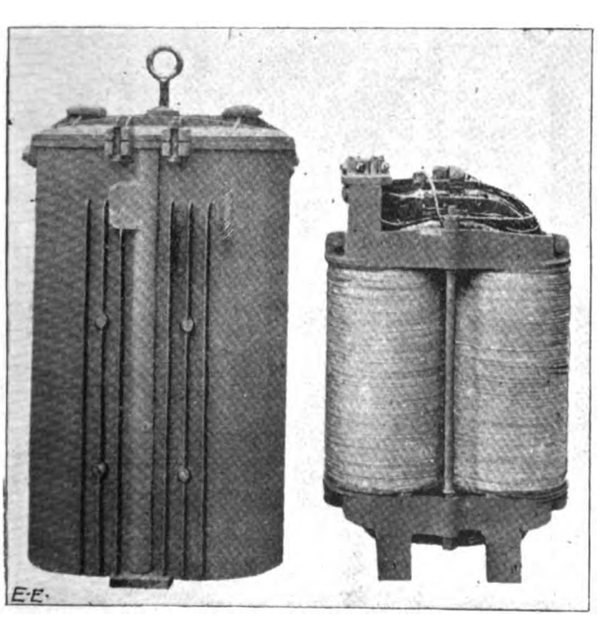

FIG. 6.—Transformers of the E.C.C. type as used at Leeds.

The dynamos are made to supply two-phase energy at 50 periods per second, and generate 2,000 volts on each phase. The armature is stationary and the field magnets revolve. The alternator shaft is bolted up direct to the engine coupling, and runs, therefore, at 200 revolutions per minute. The diameter over the field magnets is 13ft. 6in., and the weight of the magnets and wheel and shaft is 28 tons. The 30 magnet poles are bolted to a cast-steel ring which fits over a cast-steel spider. The armature winding is of the usual Electric Construction Company's slot type. The maximum output of each alternator is 1,750 kilovolt-amperes at 2,200 volts on a load having a power factor of ·8. The flywheel effect is such as to reduce the fluctuation in velocity during a revolution to less than one-twentieth of 1 per cent. from the mean velocity, and the parallelling force is so great that the synchronising current is hardly perceptible. The guaranteed commercial efficiency is 95 per cent. at half load, while close regulation of voltage being so essential with two-phase machines required to work on a combined motor and lighting load, the specification calls for a maximum drop in voltage from no load to full non-inductive load of 4 per cent., and of 12 per cent. on a load having a power factor of ·8. It is further guaranteed by the contractor that when one phase is carrying full non-inductive load, the other being on open circuit, the difference in the voltages of the two phases will not exceed 3½ per cent. The makers have no doubt that the machines will give even better results than the specification calls for, as their 700-kw. two-phase machines working in the same station, when officially tested by Mr. Robert Hammond for the Corporation, showed a drop of less than 3 per cent. and a voltage difference of 2¾ per cent., one phase loaded and the other on open circuit. The exciter for each machine is mounted on the alternator shaft, and is of 8 kw. capacity.

In the cellar below the engines are placed two surface-condensing plants, made by Messrs. Cole, Marchent, and Morley, one condenser for each engine, in connection with

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which are two centrifugal pumps made by Messrs. Belliss and Morcom, Limited. The condensers have 3,400 square feet of heating surface each, and the number of tubes in each condenser is 2,245 of ¾in. internal bore, and 7ft. 9in. travelling crane, supplied by Messrs. J. Booth and Brothers, Limited, of Rodley, is equipped with a two-phase motor.

The switchboard was made by Messrs. Ferranti Limited, and consists of six sets of their two-phase oil-break switches

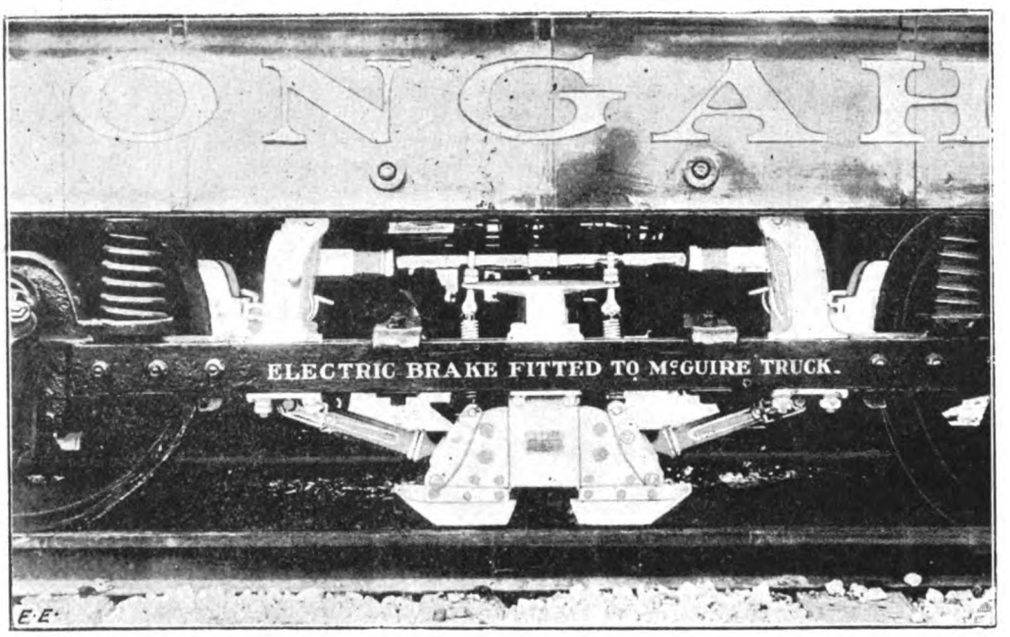

FIG. 7.—The Westinghouse Magnetic Truck Brake.

in length. The steam, feed, exhaust, suction, and air-pump discharge pipes, oil-filters, etc., were supplied by Messrs. John Spencer, Limited, of Wednesbury. The steam-pipes are lap-welded steel, with flanges welded on. The exhaust pipes are wrought iron, riveted, and the remainder of the pipes are cast iron. In the exhaust pipe, between the engine and its condenser, is placed a Holden and Brooke's oil separator for extracting the oil from the exhaust steam before it passes into the condenser, and the discharge water from the air-pump for the condensers is passed into the feed tanks placed in the pump-house. The 30-ton overhead on the dynamo board, with necessary 'bus bars, synchronising apparatus, etc., and 30 circuit panels of the ordinary spring-break type. The apparatus is mounted on a glazed brick wall, the dynamo board being on one side and the circuit board on the other side of the wall. The exciter regulators are placed on a separate table away from the board, with the instruments in the exciting circuit placed on a small board at the back of the controlling table. The new board is coupled up to the existing switchboards by three sets of feeders. The cable cellar, running under the floor of the switchroom, is so arranged that the cables

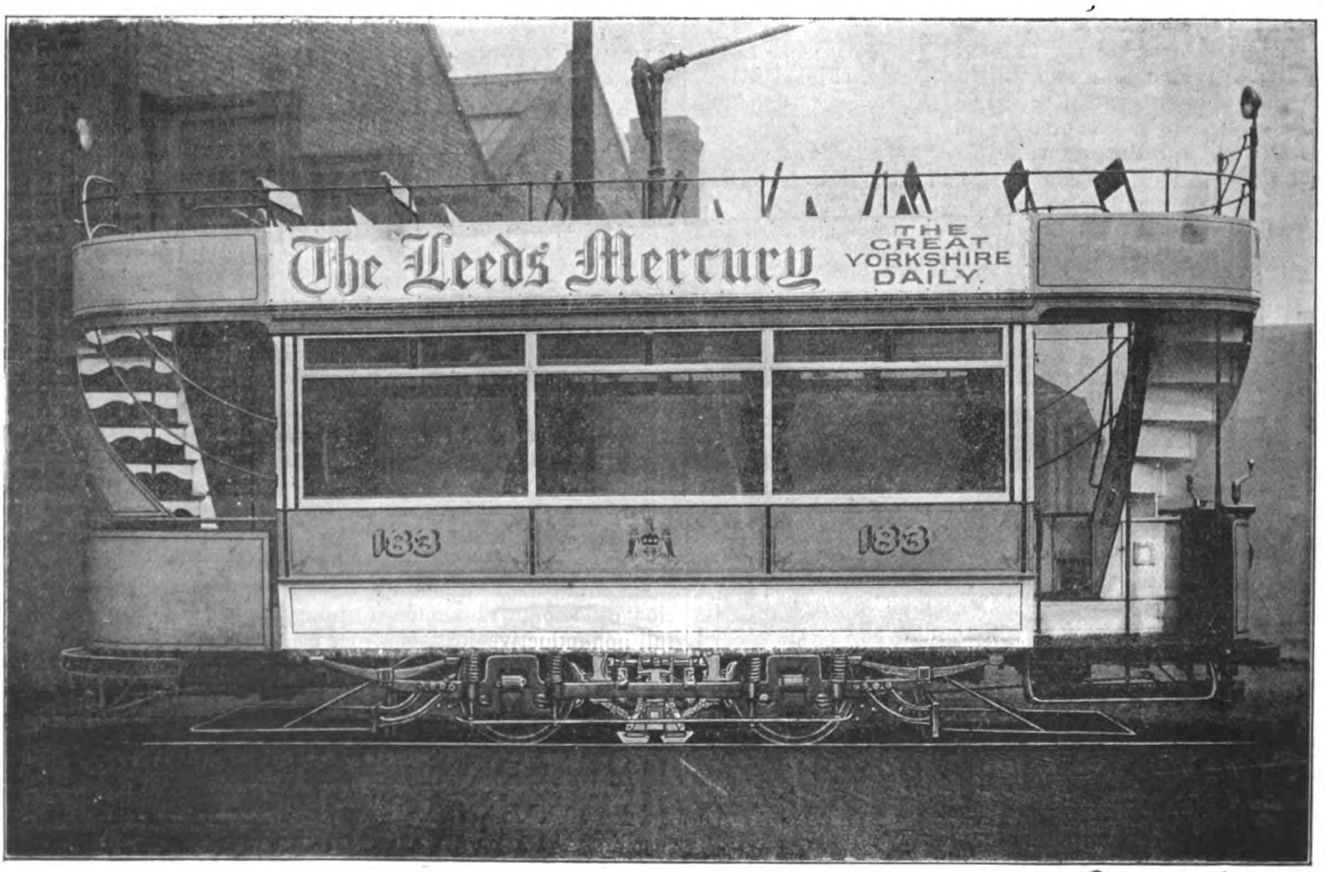

FIG. 8.—View of the Westinghouse Magnetic Truck Brake attached to a Leeds Tramcar.

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leaving the board are carried down direct on to shelves supported on brackets carried on iron pillars, and the cables then pass away into the cable subway, which runs as far as Queen-street, a distance of 350 yards (Fig. 5). By this means it is possible to get at any cable easily and at any time, as there is a space of 2ft. 6in. between each tier of shelves through which the attendant can walk. The subway proper is 11ft. wide by 7ft. high, with a line of pillars supporting the girders in the roof. The brackets in this subway are fastened into each of the side walls, forming a line of shelves on each side, and there are also brackets placed on the centre columns, one tier of brackets on each side of each pier, thus leaving a walk of 2ft. 6in. on either side between the wall brackets and the pier brackets. The subway is capable of holding 200 cables. Outlets are provided at each street crossing for the exit of cables. The whole of the subway is enclosed in waterproof course.

The Electric Construction Company have also supplied a number of sub-station equipments with transformers. The output of each sub-station transformer (Fig. 6) is 60 kw., the primary current being supplied at 2,000 volts, 50 periods; the secondaries are wound to give either 205 or 410 volts. These transformers are of the Electric Construction Company's patented type, the special feature being the use of circular stampings, having only one joint, thus giving the lowest possible magnetic resistance for a given coil area. The split-ring stampings are sprung over the coils after they have been put together. The tests show an open circuit loss of 460 watts, and a guarantee is given that the magnetising watts will not increase after the transformers are put to work, the drop in voltage from no load to full non-inductive load being just 1 per cent., while on a load having a power factor of ·75 the drop is still under 2 per cent.

We have to thank Mr. Dickinson for the matter from which this article is prepared and illustrated.

Magnetic Track-Brake on the Leeds Tramways.

While discussing the Leeds electricity works our attention was called to this new type of track-brake being used on the Leeds tramways. This is of the Newell type manufactured by the British Westinghouse Company at their Trafford Park works. That the brakes used on many tramcars are ineffective in emergency is proved by the accidents which have happened, and even when these accidents have primarily been due to incompetent driving the brake equipments have not always been free from blame. With the heavy cars now generally used, hand brakes are bound to go out of favour, and power brakes will be adopted for ordinary use. Power brakes may be divided under the headings of pneumatic and electric brakes. The pneumatic brake has great advantages. Its reliability is evinced by the fact that it is universal for railway use. Its force of application can be regulated to a nicety, and it has the advantage over the electric brake that when it is being applied the motors are at rest, and so have a chance to cool off; whereas when electric brakes are fitted they are in use as motors or generators practically all the time. But the difficulty is the provision of the supply of compressed air. If a cheaper and more simple method of pumping the air could be discovered there is no doubt that these brakes would soon become very popular, but at present the first cost and upkeep expenses are prohibitive, and so the pneumatic brake must be put on one side. The electric brake has at the outset one particular advantage attained by no other equipment. It is well known that the coefficient of friction between the wheels and rails increases with the speed of the car, so that the brakes may be applied with much greater force at high speeds than at low, without causing the wheels to skid. As the current furnished by the motors as generators is proportional to the speed of the car, it follows that the brake-shoe pressure is automatically adjusted to decrease with the speed of the car, and skidding becomes impossible, as the moment it commences the current stops, and the brake pressure is decreased, so that the wheels start revolving again at once.

The type of brake which the above company have introduced is the Westinghouse magnetic brake. A double track shoe of peculiar construction (Fig. 7) is strongly magnetised by a current from the motors, acting as generators, and so is attracted to and grips the rail with great force. Sundry castings and forgings connect the track shoes to shoes of the ordinary type acting on the wheels, and transmit the downward pull and resultant drag into lateral pressure upon the wheels. Being electrically operated, the four brake sets of a double-truck car can be easily operated in unison, thus escaping the disadvantages of the ordinary slipper brake. The retardation of the car is thus effected in four distinct ways, only two of which are utilised by any other electric brake: firstly, there is the braking effect upon the axles due to the loading of the motors as generators—this is common to all electric brakes; secondly, the retardation produced by the track brake; thirdly, the maximum braking effect on the wheels; and fourthly, a noticeable increase in the pressure of the wheels on the track due to the downward pull of the magnets—this feature is entirely unique. When an ordinary track-brake is strongly applied it takes a considerable portion of the weight of the car, so that the weight on the wheels is considerably lessened, and if the hand brake is applied they will skid on the least provocation; with the magnetic brake the exact converse of this is true. Another advantage is that the pressure on the wheels automatically adapts itself to the condition of the rail surface: if dry and sandy, the drag of the track shoes and the consequent lateral thrust upon the wheels is very great; if wet and greasy, it is considerably less. It is well known that when a car in motion is being rapidly stopped, the forward wheels of the truck carry rather more than their share of the weight, and so by an ingenious mechanical arrangement slightly greater brake pressure is applied to the front than the rear wheel of the truck, in whichever direction the car is going. No separate handle, wheel, or lever is required for the application or release of this brake, which is operated from the main controller handle, a continuation of the motion of which beyond the "off" position applies the brake. Suitable steps are arranged in the controller so that the brake may be applied with moderate force for ordinary stops, and with equal ease the maximum power may be used in emergency. The experience of Westinghouse Company's engineers in brake work is quite unequalled, and the patentee, Mr. F. C. Newell, has been fortunate in having their assistance in the detailed design and construction of this remarkable device. Besides the Leeds Corporation, the Glasgow Corporation, after exhaustive trials of several systems, are fitting 100 of their cars with this brake.

THE PACIFIC CABLE.

The last link of the all-British Pacific cable was completed at 3 a.m. (Greenwich time) on Friday last, Oct. 31. The connection at Suva, Fiji, of the last section of this cable enabled direct communication to take place between British Columbia and Australia and New Zealand, and saved 10,000 miles in route as compared with the previously existing telegraphic connections between these countries. The completion of this Pacific cable is a matter for congratulation to all concerned, and especially to Mr. Joseph Chamberlain, as the Colonial Secretary under whose *régime* the work has been organised and completed. The history of the various attempts which have been made to form a company for the laying of a Pacific cable, or to organise joint action by the various Governments interested, extends back to 1874. The difficulties to be overcome from an engineering point of view were many, owing to the great distances involved, but the greatest difficulties lay in overcoming the well-equipped opposition of the cable companies which control the alternative routes of communication to our colonies. For instance, at a Colonial conference in 1887, the chairman of the Eastern Company declared that the coral in the Pacific would render the life of a cable exceedingly short, and another

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interested advocate of the cable companies confidently predicted that the depth in the Pacific approached 12,000 fathoms. As a result, the delegates of the Colonial conference of that date agreed that while the cable was urgently needed by the Empire, a complete and exhaustive survey should be undertaken to prove the practicability of laying a cable over the route suggested. After considerable pressure had been brought on the Government, these surveys were commenced, and proved that the depth in no case exceeded 3,200 fathoms, while the average depth was more nearly 2,700 fathoms. An interesting range of submerged mountains was found

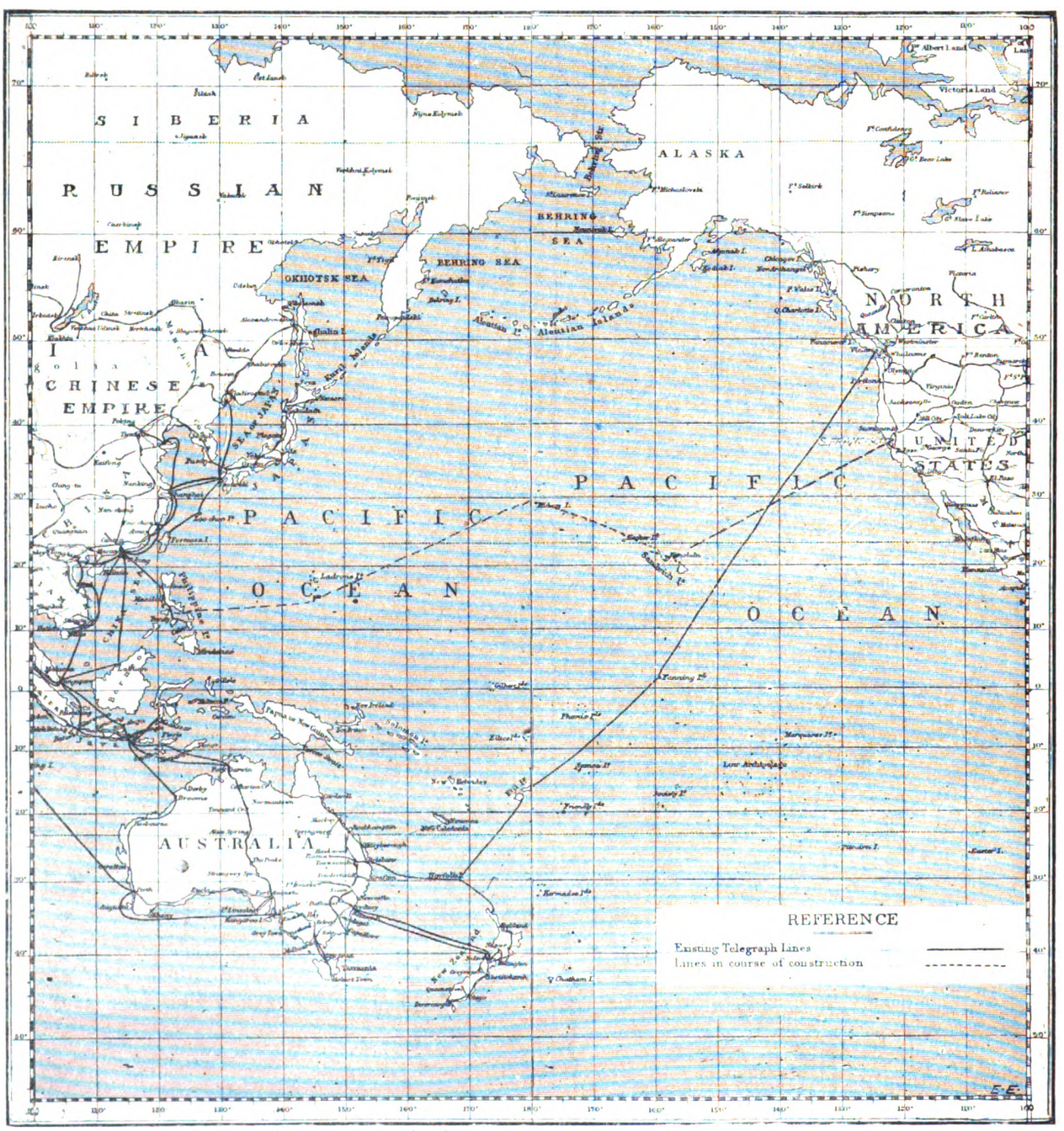

FIG. 1.—Map of the Pacific, showing the all-British Cable by a full line and the American Cable by a dotted line.

in the course of this survey, rising out of the sea bottom between Australia and Norfolk Island These were found to be quite 12,000ft. high, and to have such precipitous sides as would have rendered the laying of a cable over them impracticable. A detour had accordingly to be made to avoid these peaks, which were christened the Britannia Mountains. Tenders were invited for the laying of the cable in 1894, but the first real step towards the completion of a scheme was made by the appointment in 1895 by Mr. Chamberlain of a Pacific Cable Commission. This commission commenced to sit in June, 1896, and heard expert evidence from representatives of the large cable-making firms of this country. A report was made by this commission in January, 1897, but was not made public. The cable companies that year offered to lay an all-British cable to Australia *vid* the Cape for an annual subsidy of £25,000 for 20 years. The preference of the Admiralty for the suggested route, which would have touched at Gibraltar, Sierra Leone, Ascension, St Helena, Cape Town, Durban, Mauritius, Rodriguez, and Cocos Island, led to the further hanging up of the Pacific scheme. In 1898 the various Governments interested came to an agreement as to the proportions in which they would bear the cost of the work. Queensland, New South Wales, Victoria, and New Zealand each agreed to divide one-ninth of the whole, Canada and England to provide the rest. The commissioners' report was then issued, and was found to advocate the route on which the cable had actually been laid. Again trouble arose over the question of the proportion in which annual deficits were to be borne. The English Government was this time to blame, but after a further conference all matters were settled. Great Britain agreed to bear five-eighteenths of the cost of construction and maintenance, while British Columbia offered to find two eighteenths in addition to five-eighteenths provided by Canada. A permanent board of control was then formed of the following eight gentlemen representing the various countries indicated: Sir Spencer Walpole (chairman), Mr.

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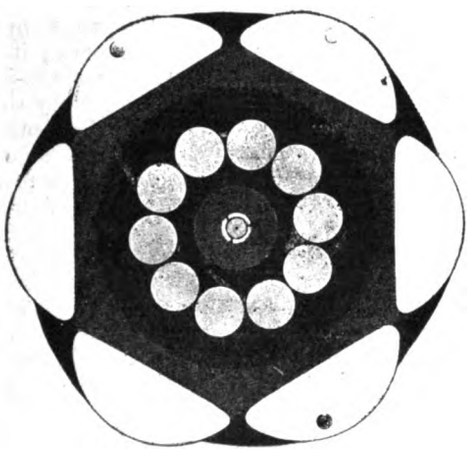
G. E. Y. Gleadowe, and Mr. Hepworth Mercer for the Imperial Government; Lord Strathcona and Mr. Alexander Lang for Canada; while New South Wales was represented by the Hon. Henry Copeland, Victoria and Queensland by Lieut.-General Sir Andrew Clarke, and New Zealand by the Hon. W. Pember Reeves. The Board appointed Mr. C. H. Reynolds, late director-general of telegraphs in India, as their general manager. Previous to the appointment of the Board, however, the Colonial Office announced that the tender of the Telegraph Construction and Maintenance Company had been accepted for the cable, the price being £1,795,000. Through the courtesy of this company we are able to give the accompanying map of the route and also the sections of shore end and deep-sea cable employed.



Section of the Shore End of the Pacific Cable.

These sections indicate the general construction of the cable, but not its actual dimensions. The lengths of the various sections are as follows :

	Length of cable in knots.	Length of route.
Brisbane to Norfolk Island	835	778
Doubtless Bay (New Zealand) to Norfolk Island	519	481
Norfolk Island to Fiji	981	883
Fiji to Fanning Island	2,043	1,906
Fanning Island to Vancouver	3,458	3,221
Total	7,836	7,269

From this it will be seen that about 7·8 per cent. of slack was used on the average when laying the cable.

The longest single length of submarine cable previously laid was that from Cape Cod to Brest, owned by the French Cable Company; the length of this is 3,173 knots, so that it is only 285 knots shorter than the length from Fanning Island to Vancouver. The consulting engineers for the work have been Messrs Clark, Ford, and Taylor, who have been so intimately connected with submarine

Deep-Sea Cable.

cable work from its earliest days. The satisfaction derived from the completion of this cable, from an engineering point of view, is great. Commercial interests, however, would be better pleased if they knew that the cable was to be worked independently of the companies which have, from the commencement, opposed its construction. It is not enough that the cable from its all-British character should be of supreme value in time of war: we require it to be worked to its utmost limit to improve the Imperial trade in times of peace.

On the same map we show by dotted lines the route of the American Pacific cable. The contracts for the laying of this are in the hands of English firms. Thus the length from San Francisco to Honolulu is being laid by the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown. The other sections of this cable to connect up to the Philippines are to be laid next year by the Telegraph Construction and Maintenance Company.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

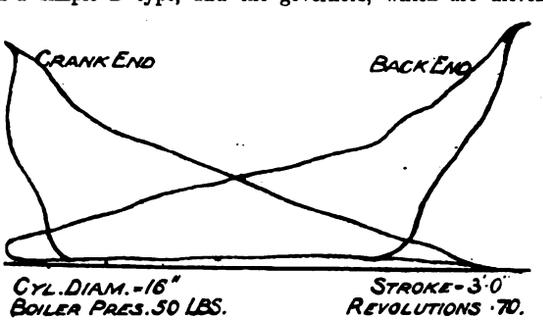
QUESTIONS.

531. How can you connect up a three-phase machine as a single-phase machine, and what is the ratio of the powers you can get from it in the two cases?—J. C. R.

532. How would you determine the amount of steam used by an injector?—C. M.

ANSWERS.

Question No. 525.—The accompanying diagrams were taken from a horizontal non-condensing engine cylinder, 3ft. stroke and 16in. diameter. The boiler pressure is 50lb. per square inch, the indicator spring used $\frac{1}{8}$, and number of revolutions per minute 70. The coal consumption is naturally high, working out to about 20lb. per indicated horse-power per hour. The slide valve is a simple D type, and the governors, which are driven by



bevel gearing from the crankshaft, actuate an ordinary double-beat valve inserted in the steam main. State defects and possible remedies for same.

Best Answer to No. 525 (*awarded* 10*s.*).—This is an uncommon diagram, and one rather difficult to interpret correctly, and at the best one can only indicate the lines upon which possible remedies may be found. To do this the diagram must be compared with a practically perfect diagram, and its defects noted. The diagram has been reproduced approximately correctly in Fig. 1, and a practically perfect diagram is shown in Fig. 2, with the nomenclature adopted here for the various parts of the curve, and each curve has been divided into 10 parts to facilitate comparison. It is at once seen that at the back end the following defects are present in Fig. 1: The steam line is not level, but shows excessive wire-drawing. Cut-off appears to occur at about three-tenths of the stroke. The expansion line is bad; instead of being part of a hyperbolic curve, it is composed of two almost straight lines, A B, B C, of different slopes This is the part of the diagram the causes of whose defects are most difficult to define. Release occurs at C, the end of the stroke, instead of at a point about one-tenth or one-twelveth from the end. The exhaust seems free, the slight rise in the back pressure being negligible. Compression begins too early. It commences at about the third division instead of about the first. The admission line is bad, which indicates too great a lead on the steam-port, whereby the initial pressure is almost attained before the piston has reached the end of its stroke, and in consequence the little hook is formed. At the crank end similar defects are observable, except that the cut-off and release are earlier,

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whilst compression is later. The waviness of the diagram generally is probably due to the stickiness or other shortcomings of the indicator. Thus the deviations from the model diagram are fairly easily discerned, but their causes and remedies are not so apparent. There is, however, one point which seems fairly clear. It will be noticed that the deviations are not the same at both ends. At the back end the cut-off and release were characterised as "late," and the compression as "early," whilst the characteristics of the crank end were the opposite. This seems to indicate that the value is wrongly set on its spindle. The suggestion is that it be moved backwards on its spindle a distance equal to about one-eighth of its stroke; but if a paper rubbing of the valve face and ports be taken, and the position of the valve at the beginning and end of its stroke be noted, the displacement can be very quickly and easily detected.

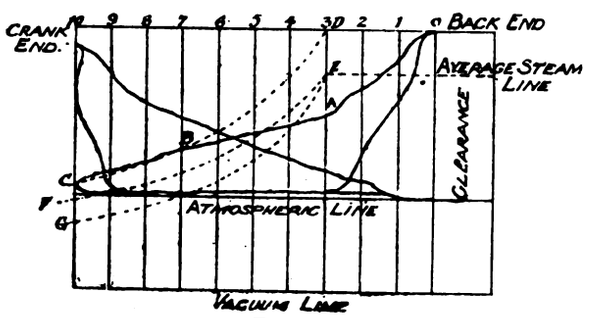

FIG. 1.

The correction of the setting of the value will probably also correct the inequalities in the initial pressure; in fact, so far as the points of cut-off, release, and compression are concerned, they should then be similar at both ends, and their periods should accord more with the diagram of Fig. 2, but the mis-shapement of the expansion line is due to other causes, and requires other remedies. In Fig. 1 there are three theoretical curves plotted out with a view of showing more clearly how the expansion line differs from the theoretical, and to obtain, if possible, some clue to the causes of the variations. The curve D C, which almost coincides with that part, B C, of the expansion line is the theoretical curve which would be obtained if the initial pressure were maintained to the point of cut-off D, and there had been clearances equal to about one-sixth the capacity of the cylinder. The curve E F is the theoretical curve obtained assuming that the cut-off pressure had been equal to the mean pressure between the points of admission and cut-off,

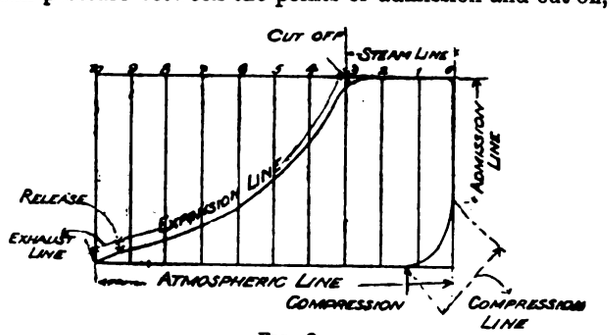

FIG. 2.

and clearances had again been equivalent to one-sixth the capacity of the cylinder. The curve E G is the theoretical curve obtained assuming the same cut-off pressure as for E F, but allowing nothing for clearances. It is seen incidentally that the effect of clearance is to raise the expansion line above the normal. Neither of these three curves fits the diagram. The curve D C fits the lower end of the expansion line, but that is an expansion line of a cut-off pressure much higher than is shown in the diagram; whilst the other two curves show that with an assumed average pressure at cut-off, which is higher than that in the diagram, the normal expansion line would fall below the atmospheric line, so that for at least one-fifth of the stroke the engine would not develop sufficient power to move its piston forward. This seems to indicate that with such a low initial pressure the ratio of expansion adopted is too great. If the initial pressure cannot be raised, then steam should be cut off later.

From these considerations it is apparent that the expansion line of the diagram does not agree with any regular curve. Hence the only conclusion is that something is occurring inside the cylinder to elevate that line as soon as steam is cut off. There are at least three things possible—viz. (1) large initial condensation with re-evaporation as soon as expansion begins; (2) excessive clearances; (3) leaky valves. It may be due to any one of these or a combination of them. The last can easily be detected by removing the cylinder cover when the engine is on its dead centre, or when steam is supposed to be cut off from, say, the back end. The clearances in cylinder and steam ports can be obtained by measurement. The condensation or wetness of the steam can be roughly gauged by opening the drain cocks If condensation be great, it may be counteracted to some extent by putting a steam-jacket on the cylinder. Clearances may be reduced by shortening the passage to the steam-ports, or the over-all length of the cylinder. In the latter clearance may be almost altogether dispensed with if the lead on the steam-port be made large. Leaky valves can, of course, probably be remedied by refacing them or replacing with a new set.

One other point to be noticed is the great loss of pressure between the boiler and cylinder. The initial pressure in the cylinder seems to be only about 27lb., showing a loss of 23lb. pressure. This may be due to the steam-pipes being too small, but more probably is due to wire-drawing at the double-beat valve. Replacement by a larger valve would overcome this to some extent.

Then, again, the wire-drawing in the cylinder is a further loss of pressure. Judging by the exhaust line in the diagram, the ports seem to have an ample sectional area; hence it is more than probable that the outside lap of the valve is too great, so that a piece should be chipped off. But in so doing the lead on the steam-port will probably be increased; hence the eccentric should be shifted back on its sleeve to reduce its angle of lead. To keep wire-drawing within reasonable limits the velocity of steam through the posts should not exceed 100ft. to 130ft. per second. The required area of port opening can be found from the formula:

$$O = \frac{A \times v}{V},$$

where O = area in square inches of port opening at the beginning of stroke;
A = sectional area of cylinder in square inches;
v = velocity of piston in feet per second;
V = velocity of steam permitted in feet per second.

Applying this formula to this case, where the cylinder area is 201 square inches, velocity of piston is 7ft. per second, and the permissible velocity of steam is 130ft. per second; the area of port opening at the beginning of the stroke works out at 10·8 square inches.

This seems to deal with all the points worthy of observation from the diagram. It certainly appears as though the engine were affected by almost all those complaints to which such machines are heirs, and it offers food for thought and scope for work for the engineer for some time to come in devising means for the application of the suggested remedies.

In conclusion, the indicator would probably work better, and more true diagrams obtained, if it were thoroughly cleaned and heated by blowing steam through it before being again used.—ALPHA.

Answer to No. 525 (*awarded* 7*s.* 6*d.*).—The defects of the diagram are: (*a*) early admission, shown by the upward admission line being inclined backward instead of vertical; (*b*) unequal setting of the valve, as shown by the unequal area of the two cards, and the above defect being more marked on the back end card; (*c*) excessive wire-drawing, almost obliterating the point of cut-off, as shown by the forward admission line sloping downward instead of continuing horizontal to the point of cut-off; (*d*) serious loss of pressure between boiler and engine cylinder. The extreme height of the diagram being $1\frac{1}{16}$in., with a 16 spring, denotes a maximum pressure of 27lb. available in the cylinder with a boiler pressure of 50lb., being a loss of nearly 50 per cent.

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To remedy the defects *a* and *b*, remove the steam-chest cover and adjust the slide valve on the spindle, until the amount of opening of each admission port is equal as the engine is rotated, then move the eccentric backward on the crankshaft until the steam-port is just opening as the crank commences to advance from the dead centre. If the eccentric is fixed with set screws, it may be found to have slipped forward, but if fastened with keyway, it should be

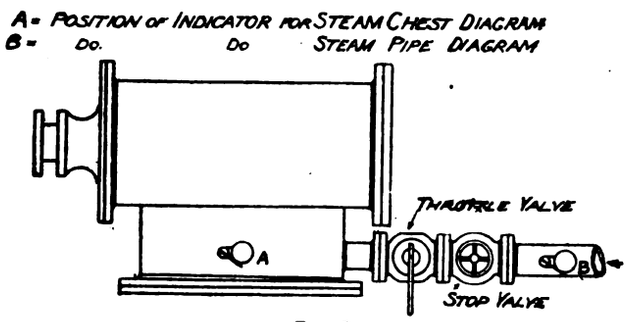


Fig. 1.

moved backward and fresh key fitted. The defects *c* and *d* are probably both due to the same cause, which may be inadequate sectional area of the steam-pipe, especially if this is of considerable length and contains many bends or restricted passages in the stop or throttle valve, probably the latter, as many of the old type of double-beat valves actuated by a crankshaft governor are most truly named *throttle* valves. The best method of ascertaining the cause

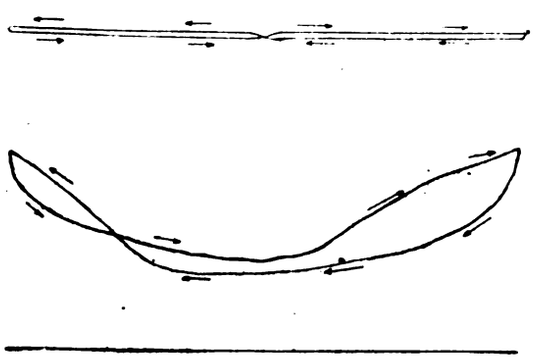


Fig. 2.

would be to take diagrams from the steam-chest, and also from the steam pipe on the boiler side of the stop valve, by fixing the indicator in the positions marked A and B respectively (Fig. 1). If the steam-pipe is of adequate sectional area the diagram given at B should be a straight line, and its height above the atmospheric line should measure by scale only a few pounds below the boiler pressure, any fluctuation of this line would show the steam-pipe to be too small.

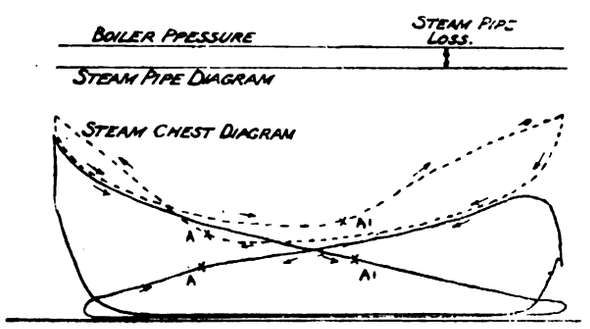
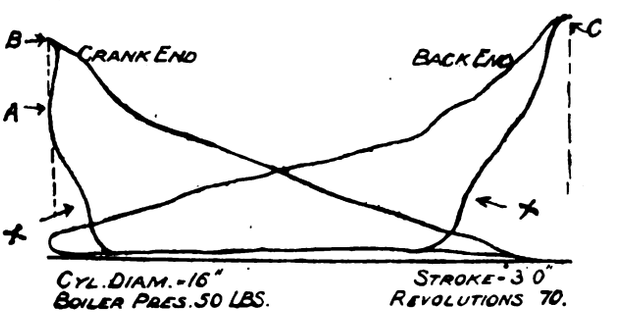


Fig. 3.

The steam-chest diagram should show very slight, if any, fluctuation, and at most should not exceed that shown in the upper diagram of Fig. 2, where it will be seen the pressure falls slightly on steam being admitted to the piston until the point of cut-off is reached at half stroke, when it rises again until steam is admitted at the other end of the cylinder, when the action is repeated. But from the appearance of the diagram given by "Baron," it will more probably be found that his steam-chest diagram will somewhat resemble the lower portion of Fig. 2, which is a card taken by the writer from the steam-chest of an engine with, among others, this similar defect of restricted steam passages in the throttle valve.

As an example of the loss caused by such a badly-designed throttle valve, a combined diagram taken from the steam-pipe, steam-chest, and cylinder of this engine is given in Fig. 3. It will be observed that the drooping pressure line of the steam-chest diagram follows closely the steam admission line of the cylinder diagrams until the point of cut-off is reached, which is entirely obliterated in the cylinder diagrams, but is revealed by the ascending curve of the steam-chest diagram at A and A_1. If the steam-chest diagram gives great fluctuation as above, the remedy is obviously to replace the double-beat valve with one having all steam passages of adequate sectional area. If the fluctuations are found in the steam-pipe diagram, a larger steam-pipe must be put in. If, however, both these diagrams are normal, the only remaining cause for this wire-drawing would be restricted port passages in the cylinder. The coal consumption is necessarily very high, owing to the heavy loss between the boiler pressure and the maximum pressure available in the cylinder, and also the defective setting of the valve and excessive wire-drawing referred to.—Stow.

Answer to No. 525 (*awarded* 5*s.*).—Before pointing out any defects in the steam distribution, or suggesting remedies for the same, it is usual to make sure that the indicator diagrams under consideration correctly record the action of the steam in the cylinder. It is evident, from an inspection of the cards submitted by "Baron," that they do *not* faithfully reproduce the pressure in the cylinder at



the respective points in the stroke of the engine. Referring to the point A, the engine has apparently reached the end of its stroke, the indicator drum having commenced to revolve in the opposite direction at this point, and after moving a short distance, its direction of rotation is again reversed until the point B is brought under the pencil.

Now, it is perfectly evident that the piston does not perform this evolution, the probability being that it is caused by the inertia of the drum and an elastic indicator cord. Confirmation is added to this view by the spur-like projections at B and C, this formation being a common result of "stretch" in the indicator cord. The same formation, however, is shown on the card where there is excessive lead, the pressure rising to that of the entering steam before the piston has reached the end of its stroke. The appearance of the admission line, however, hardly bears out the supposition that the lead is too great in this case. If, in the indicator which "Baron" is using, the spring in the paper barrel is adjustable, as is the case with Crosley, McInnes, Simplex, and all modern indicators, the tension on this spring should be increased, and a suitable indicator cord made use of. A specially woven cord may be obtained, and before being used it is as well to have it thoroughly stretched by suspending a heavy weight from one end of it for a day or two. Messrs. McInnes supply an unstretchable cord for this purpose, having a core of flexible, fine steel wire, which the writer can strongly recommend The cards have apparently been broken by connecting the indicator to the middle of a connecting pipe between the two ends of the cylinder. "Baron" is advised to make sure that this pipe is perfectly clean, if partially clogged up with grease, the best way to clean it is to put it through the fire. The indicator also should be well cleaned, and a slightly stronger spring, say $\frac{1}{10}$in., used. The diagram in

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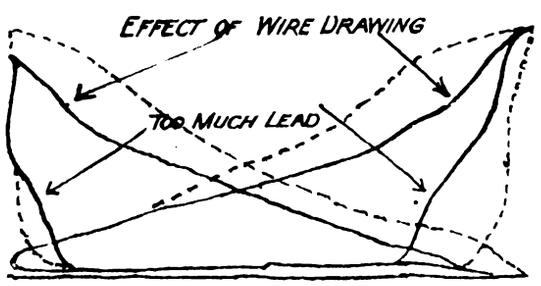
its present state looks anything but reliable. Assuming that these diagrams approximately represent the varying pressures in the cylinder, one of the most notable features is the excessive throttling of the steam during admission, and that this is not due to contracted port area is evident from the even exhaust line. The steam, therefore, is throttle, either (1) in the steam-pipes, or (2) through the throttle valve, or (3) the valve does not give enough opening to steam. It would be advisable to take diagrams from the steam-chest, and also, if possible, from the steam-pipe at the boiler side of the throttle valve. These diagrams should be taken with same spring as used for the cylinder, and should be plotted out to scale on the cards taken from the cylinder. In this way, the point at which the throttling takes place can be located. If it takes place at the throttle valve owing to the engine being lightly loaded (this is the most likely cause), the shape of the diagram may be improved by altering the value so as to give an earlier cut-off. From the appearance of the compression curve at X, either there is a lot of water in the cylinder or the piston is slack in the cylinder, and is allowing steam to leak past it. The latter seems to be the most likely cause. The cylinder cover should be removed, and, the cross-head being securely blocked, steam should be admitted at the front end of the cylinder. This is the only reliable test for piston tightness, and it is only by removing the cover that it can be determined whether the steam is leaking past the piston or through the valve.

In conclusion, the valve is unequally set, being nearer to the front end of the valve chest. Had the engine been more carefully indicated, and the points of cut-off stated, a fuller and more certain diagnosis could have been given.—C. L. B.

Answer to No. 525 (*awarded* 5*s.*).—In order to give a thorough explanation of the faults in the indicator diagrams accompanying this question, it would be a great help if one knew all the circumstances under which the cards were taken, and what the engine was working. Errors of no small percentage may arise in the indicator (as there are several poor indicators on the market), such as the means taken of driving the paper through defects in the parallel motion, faults may show in the spring itself, the vertical motion of the pencil may not be exactly proportional to the pressure in all positions

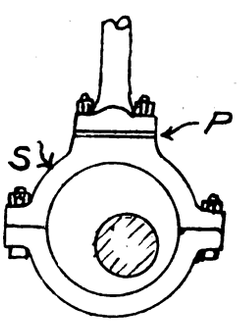
From the description we may take it that the cards have been taken with a first-class indicator, and that the engine was working under ordinary circumstances, such as a



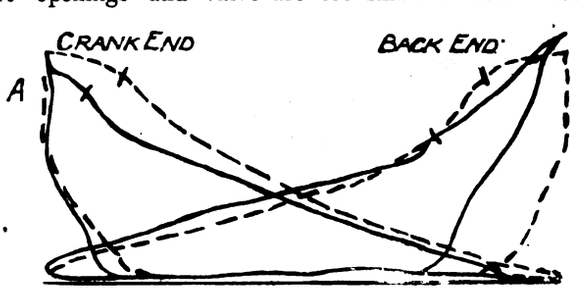
steady load, no superheated steam, and no feed heater in the exhaust likely to cause back pressure. Taking the crank end card, there appears to be a considerable amount of wire-drawing, there being no defined point of "cut off" shown, but an expansion line almost straight from the steam corner to the exhaust point. (The accompanying sketch shows with a dotted line over the original one the card one would expect to get with a properly designed valve.) The back end is similar in this respect, showing that the steam ports and passages are too small It is also evident that the exhaust passage is small, as the exhaust line for both cards is above the ordinary distance from the atmospheric line. Another very evident fault is that there is too much lead on the valve, as the steam line is seen sloping off to the steam corner. It also appears to have too much lap, and that the engine erector had purposely given it too much lead in order to make the cut-off later.

To remedy these defects, the best way would be to take off the steam-chest cover in order to get at the valve; then set the crankpin on dead centre, measure the lead or the amount the port is open to steam, bring round the crank-pin to the other centre, and again measure the lead. They should both be the same. As it is a horizontal engine, $\frac{1}{8}$in. lead should be allowed for this speed. The "cut off" will probably be one-third of the stroke, or 12in. from the commencement of the stroke, and should be the same for both ends. If you cannot get this "cut-off" without giving more than $\frac{1}{8}$in. lead, the only way to cure it will be to chip off a little of the cover or lap of the valve, and this will necessitate setting back the sheave of the eccentric in order to keep the lead correct. The amount of lap at each end of the valve will not be the same, on account of the obliquity of the connecting rod. The longer this rod the nearer the two sides agree.—H. BAKER.

Answer to No. 525 (*awarded* 5*s.*).—I quite believe "Baron" when he says the coal consumption is high. The engine, no doubt, is a fair age, and has needed its brasses letting together now and again. Now, what has happened is that when the eccentric straps were let together, a distance piece ought to have been put in between the foot of the eccentric rod and the strap, as shown at P, equal in thickness to the amount worn off the



strap, S. The valve travel is not given, but let it be T inches; then the thickness of the distance piece $P = \frac{3}{36} \times T$, or $\frac{1}{12}$ T. The $\frac{3}{36}$ is got as follows: In the original diagrams the compression at the crank and back ends take place 4in. and 10in. respectively from the end of the stroke. Half the difference is 3in., and as the stroke is 36in., hence the fraction $\frac{3}{36}$. By doing this a diagram similar to the dotted diagram may be expected. Other defects are too much wire-drawing, and the port openings and valve are too small. These defects



cannot be remedied without putting in another cylinder and valve. The inward curve shown on the diagram at A should not occur. It is due to using poor string to connect the indicator drum to the motion bar.—W. A. T.

Question No. 526.—A number of motor-type meters for tramway feeders are arranged in a horizontal row. It is found that the current in each meter has a slight effect on its neighbours, causing them to run a little faster. How can this effect be remedied without altering the position of the meters?

Best Answer to No. 526 (*awarded* 10*s.*).—Before considering the remedy to be adopted for the state of affairs described in the question, two points in the question and their bearing on its answer may be noted. It is stated that the meters are employed on tramway feeder circuits, and it may, therefore, be taken that the currents flowing through the meters are continuous ones. Further, it is stated that the interaction of the fields of the various meters upon each other causes the meters to run a little faster than they should do. We may, therefore, suppose that the series circuits of all, or nearly all, the meters are

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connected up in the same direction, so that the fields of the meters on either side of any one meter have the same direction and sense as the field of that particular meter. The fields of alternate meters will then have no neutralising effect upon each other, but will tend to accelerate the armature of the intermediate meter. This state of affairs may be diagrammatically represented as in Fig. 1.

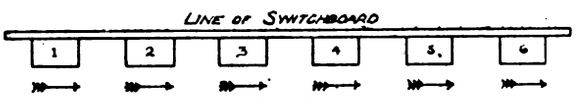

FIG. 1.

The first and simplest remedy that may be adopted—without altering the position of the meters—is to reverse the connections (both series and shunt connections so that the direction of rotation remains unchanged) of alternate pairs of meters. If there were six meters, as in Fig. 1, it would only be necessary to alter the connections of meters 3 and 4. The fields of the two nearest neighbours of any particular meter—so far as their effect on the intermediate meter is concerned—then tend to neutralise each other. This is diagrammatically represented in Fig. 2.

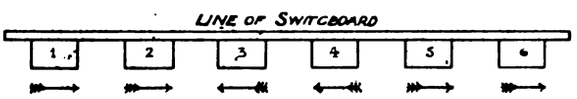

FIG. 2.

Meters 1 and 6 have other meters on one side only, but the effect of the alteration will, nevertheless, be beneficial, since the fields of 2 and 3—so far as their effect upon meter 1 is concerned—tend to neutralise each other, and so with meter 6. It is to be noted that the efficacy of this remedy depends upon the relative values of the currents in the separate meters: the more nearly these are equal the more perfect the remedy. Screening the meters by enclosing them in soft-iron cases is a doubtful remedy, since to render the screening effective the case would have to be so massive that it would in itself defeat the desired end by decreasing the magnetic reluctance of the field path in the meter which it surrounded, and so increasing the flux due to the field coil.

"M W. K.'s" question raises an important point, and leads one to anticipate that in the future all continuous-current meters designed for switchboard use will be of the astatic type.—LL. R. L.

Answer to No. 526 (*awarded* 5*s.*).—May I suggest that this effect on the meters is produced not so much by the meters themselves, but by the leads connecting them. A similar occurrence lately came under my notice, in which a new meter of this type could not be stopped rotating even though no current was passing through it. An investigation into the cause of this proved that it was due to the meter being fixed in front of a heavy 'bus bar behind the board, as it stopped rotating when the load on the 'bus bar was taken off. Under these circumstances it is useless to calibrate the meter to suit the conditions under which it works, as the stray field is not a constant quantity, and ought to be eliminated. This is best done by enclosing the meter in an iron box or case, which will absorb the lines of force due to external surroundings. It will probably be found sufficient if the front is left exposed so as to see the dial, provided the sides project well out. By these means a constant condition is obtained, and the meter can be recalibrated and correct results obtained. If on investigation the leads are found to be causing the error, it might be possible to rearrange them, taking them further away from the meters. Should this not be convenient, a cast-iron box, about $\frac{1}{4}$in. thick, fixed round the meter will put things right. It is rather strange that makers do not provide for these conditions, as I have known various makes of this type of meter act as above.—C. I. S.

Answer to No. 526 (*awarded* 5*s.*).—When a number of motor-type meters are arranged in a horizontal row, the effect of any meter on its neighbours should be very slight. If we assume that the current in each meter is concentrated in a circle of a inches radius (this assumption will be near enough to give us a fair idea of the magnitude of the effect), the ratio of the field at the centre to that at a distance, r, from the centre will be $\frac{2\pi}{a} / \frac{2\pi a^2}{r^3} = \frac{r^3}{a^3}$ (approx.), r being large compared with a.

The above formulæ may be found in most text-books on electricity. Now, the dimensions of the coils of motor-type meters are generally about equivalent to a circle of $1\frac{1}{2}$in. radius, and the minimum distance meters can conveniently be placed apart is about 15in. Substituting these figures in the above ratio, we get

$$\frac{\text{Field at centre of coil}}{\text{Field at a distance of 15in.}} = \frac{(1\frac{1}{2})^3}{15^3} = \cdot 001 \text{ (approx.)},$$

so that, if all the meters were equally loaded, each meter might register about one-fifth of 1 per cent. fast—an amount which is well within the latitude usually allowed. A remedy, however, which is good enough for all practical purposes, is very simple. It is only necessary to reverse both shunt and main coil connections in each alternate pair of meters, beginning with Nos. 2 and 3. If this is done it will be noticed that each meter, except the end ones, lies between two meters which will have opposite effects on it. The resultant effect will, therefore, be to a very large extent cancelled.—M. W. K.

Answer to No. 526 (*awarded* 5*s.*).—It is possible to remedy this effect by shifting the positions of the mains connected to the meters. If a Thomson-Houston tramway meter with a capacity of 800 amperes at 550 volts read correctly when the two mains connected to the ampere coil are brought up vertically to the terminals at the back of the meter, then it will read about 3 per cent. fast or slow if these mains are brought to the meter horizontally. This large error is due to the fact that the ampere coil consists of only one turn of solid copper, and so the field due to the mains is comparable with the field due to the coil. It is obvious, then, that by adjusting the relative positions of the mains at the back of the switchboard it would be possible to make two meters read correctly. It would, however, be extremely difficult to do this accurately by the method of "trial and error" if there were more than two meters. Since *all* the meters are reading fast, it might possibly be remedied by a symmetrical displacement of all the cables leading to the meters.—J. C. R.

FORTHCOMING EVENTS.

TUESDAY, NOV. 11.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "Electric Tramways," by Messrs. Chas. Hopkinson, B. Hopkinson, and E. Talbot.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., opening meeting. Inaugural address of Mr. Henry A. Mavor, chairman.

THURSDAY, NOV. 13.

Institution of Electrical Engineers.—At 8 p.m., opening meeting of the session. Inaugural address of Mr. James Swinburne, president.

FRIDAY, NOV. 14.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "The Theory of the Aluminium Electrode," by Dr. W. W. Taylor and Mr. J. K. H. Inglis; "The Determination and the Ratio of the Specific Heats at Constant Pressure and at Constant Volume for Air and Steel," by Mr. W. Makower.

Electrical Engineers' Volunteers.—At 7.45 p.m., smoking concert at headquarters, Regency-street, Westminster, S.W.

North-East Coast Institution General meeting at Newcastle.

SATURDAY, NOV. 15.

Institution of Junior Engineers.—Visit to the new shipbuilding and marine engineering works of Messrs. Yarrow and Co.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Diesel Engine."

BOOK RECEIVED.—We have received from Messrs. Crosby Lockwood and Son a copy of "Factory Accounts, their Principles and Practice," by Messrs. Emile Garcke and J. M. Fells. It is intended as a handbook for accountants and manufacturers. This is the fifth edition, revised and extended, and is priced at 7s. 6d.

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CONTENTS.

Notes	649	Portsmouth Accounts	672
Leeds Electricity Works	654	Legal Intelligence	673
The Pacific Cable	659	Companies' Meetings and Reports	673
Questions and Answers	661	New Companies Registered	674
Forthcoming Events	665	New Committees	674
Conferences and Cables	666	Contracts for Electrical Supplies	674
The Application of Electric Power in the Iron and Steel Industries	667	Lighting Notes	675
Trade Notices and Novelties	670	Traction Notes	679
Physical Society	671	Provisional Patents, 1902	682
Appointments Vacant	671	Companies' Stock and Share List	683
Keighley Accounts	671	Traffic Returns	684
Cardiff Accounts	672		

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CONFERENCES AND CABLES.

Within the last week the completion of the Pacific cable has been the cause of universal congratulations within those parts of the British Empire affected by the same. It is curious that at about the same time the papers relating to the conference between Mr. Joseph Chamberlain, as Secretary of State for the Colonies, and the Prime Ministers of our self-governing Colonies should be issued. This conference, which was not unlike in composition that which took place in the Diamond Jubilee year of our late Queen, was eminently a business one. In the papers concerning it which have been issued a vast amount of useful information is given, and this without bringing forward unduly the individual expressions of those attending the conference. The value of these meetings between the Premiers of our Colonies and the Secretary of State for the Colonies cannot be over-estimated, but it largely depends on the skill with which the deliberations have been directed towards practical rather than controversial ends. For instance, in the few meetings which took place during the months of June, July, and August last resolutions were passed which, when ratified by the respective Governments represented, will ensure that similar conferences will be held in the future at regular intervals. At these, as at the one held this year, opportunities for reviewing the general policy of the Empire will be given to those so nearly interested in the same. Mr. Chamberlain in his opening speech to the conference this year divided the subjects for consideration into three heads—political, commercial, and questions arising out of Imperial defence. The first of these is rather outside our range of subjects, but it is satisfactory to note that our Colonies are likely to be consulted in future in connection with treaties with foreign Powers. In the same way it is worthy of note that the Premiers were all agreed that their Colonies should contribute more largely in the future to the Imperial defence. In most cases the contribution of these Colonies was actually arranged as to amount at the same time. It is with the second class of subject which we have particularly to deal—*i.e.*, with the commercial union between the various component parts of the Empire. Mr. Chamberlain pointed out that the Empire might be self-sustaining. "It is so wide, its products are so various, its climate so different, that there is absolutely nothing which is necessary to our existence, hardly anything which is desirable as a luxury which cannot be produced within the borders of the Empire itself." He proceeded to point out that the greater part of the necessaries of life consumed in England came from foreign countries, and that we exported the bulk of our surplus product also to foreign countries. This is not a satisfactory state of things, and could be improved by a free interchange between all parts of the Empire. As a move towards this, a number of resolutions were passed as to preferential systems of trading between our Colonies and the Mother Country, which in many cases took a definite form. Besides these and resolutions connected with Government contracts, shipping subsidies, etc, there was one resolution passed which is of supreme interest in connection with the State-owned Pacific cable recently completed. This resolution reads: "That it is desirable that in future agreements as to cable communications a clause should, wherever practicable, be inserted reserving to the Government or Governments concerned the right of purchasing on equitable terms, and after due notice all or any of the cables to which the agreements relate." The information contained in Appendix 12 of the papers, contributed by Sir Sanford Fleming on the Pacific cable and the telegraphic service of the Empire, contains the reasons for the above resolution, which should be generally adopted. The Pacific cable was originally

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intended to be merely a link in an all-British cable, which would encircle the globe and give communication with practically every important British possession. The essential feature of this system would have been that the cable should not land on any foreign soil, nor should it be laid in shallow seas near any country likely to prove unfriendly. Immediately this scheme was propounded the opposition of the associated cable companies took a most active form. They have already laid one section of the proposed cable—*i.e.*, that between Natal, Mauritius, and Australia. Their next step was to enter into an agreement with the Government of New South Wales granting reductions of rates to that colony in return for concessions which will greatly hamper the working of the Pacific cable. It is to be regretted that this agreement should have been signed by the Government of New South Wales without the consent of the other Australian Colonies, which only a few weeks previously had agreed to bear their proportion of the cost of the recently completed cable. This want of united action on a subject of public and commercial importance would have been avoided if the matter had been brought before a conference of all parties interested. There is no need here to decry the cable companies for the steps they have taken to retain the monopoly of submarine communications, but where the Imperial defence and commercial prosperity are concerned our Governments should not be in the hands of private financiers, who may transfer their undertakings to foreign investors from countries with whom we may be at variance. The Pacific Cable Board have before them great opportunities of using the new cable for the advancement of Imperial interests, and we trust that they will not enter into working arrangements with their rivals which will prevent the great advantages of the new cable from being realised.

THE APPLICATION OF ELECTRIC POWER IN THE IRON AND STEEL INDUSTRIES.*

BY D. SELBY-BIGGE.

In the year 1894 the author had the honour of reading before this institute two papers dealing with the subject of electric power transmission, having regard especially to the driving of works machinery by means of electricity. At that time the subject was a comparatively new one to the owners of works in Great Britain. The papers read were purely of a technical nature, and dealt with the methods the author then thought most suitable to be employed in driving works electrically. Since that date a great number of papers have been read by well-known authorities on this subject. In bringing another communication before this institute it is now the author's endeavour to read a paper on somewhat different lines, and one which will prove not only of interest but of actual use to works owners and managers in England. The paper, therefore, will deal chiefly with actual facts and figures, and with data of a practical nature, collected from a great number of different sources.

During the past 12 years the author has been almost exclusively engaged in the remodelling of the driving arrangements in engineering works, iron and steel works, shipyards, factories, and mining operations from steam to electricity, and he has almost invariably been met with the question, Can you show us by any facts or figures actual savings which can be directly attributable to the change from one system to the other? It has not, however, been possible for him to deal with this matter in the form of a paper until the present time, as in the early days no data were available, and even in subsequent years accurate data have been most difficult to obtain The following cases and figures may, however, prove interesting to the members of this institute.

* Paper read before the Iron and Steel Institute.

Savings Effected in Works.

For the Hamburg quayside cranes the total working expenses were as follows: wages for cranesmen, coal or electric current, cleaning and oil (excluding, however, repairs), per 10-hour run per crane, taking the average during the year:

	Cost per 10-hour run.	
1. Brown single steam-crane	10s.	
2. Steam winch crane	8s.	1893-94.
3. Steam-crane driven through pipes from steam plant	12s.	
4. Electric crane	7s.	1898.

The steam-cranes are stoked with cinders only, which in 1893-94 cost about 11d. per cwt. The electric cranes take current from the public supply at about 2d. per kilowatt-hour. Nos. 1 and 2 have a boiler on the crane itself. No. 3 takes steam from a larger steam plant through pipes (about 20 are thus supplied). In 1901 the working cost of 182 Brown's cranes came to 11s. 4d. per crane per 10-hour run, whereas that of the electric cranes was the same as in 1898—viz., 7s. In 1898 the steam cranes lifted 1,825,880 tons in 315,083 hours, the working costs amounting to £20,516. 4s., so that the cost per hour, inclusive of repairs, amounted to 410,324/315,083 = 1·302s., or about 1s. 4d. per working hour. The cost per ton lifted would be 0·2247s., or nearly 2¾d. The electric cranes lifted, from Jan. 1, 1898, to Sept. 30, 1898, 77,697 tons in 10,190 working hours, the costs being 2,664 shillings for current, 2d. per kilowatt-hour, and 4,462 for wages, etc. Thus for one ton of goods lifted the cost is nearly 1d.

Taking next the case of the Westinghouse Air Brake Company, Wilmerding, Penn., U.S.A., the boilers in this shop were formerly driven in groups, 30 steam engines, aggregating 1,375 h.p., being used for the purpose. The engines were supplied with steam from the central boiler plant. For this system was substituted an alternating-current system, the generators supplying induction motors driven by Parsons steam-turbines; the shafting used was divided into shorter lengths, and the 30 engines were replaced by 57 motors, aggregating 1,065 h.p. In order to have an accurate comparison of the two systems, several tests were made, extending over some days, with the following results: the reduction in steam consumption was found to be 40 per cent., and the reduction in coal consumption $32\frac{2}{10}$ per cent. Before a meeting of the Franklin Institute in 1901 Mr. Samuel Vauclain, superintendent of the Baldwin Locomotive Works at Philadelphia, U.S.A., stated that if electric driving in their works should be abandoned, the manufactured product would cost 20 to 25 per cent. more for labour, and the floor space would have to be increased 40 per cent. to maintain the present output.

In an excellent article written by Mr. Alexander Richardson, upon Messrs. Vickers, Sons, and Maxim's works at Barrow-in-Furness, and published in the July number of *Traction and Transmission*, he says: "No special data have been taken as to the cost of running this station separately, but it may be noted that the cost per unit generated during 1901 at the engineering works station was 0·77d., which includes coal, wages, water, repairs, and all works costs. The economy resulting from the substitution of electric power for steam is shown by the fact that the average monthly coal consumption for three winter months in 1898, when only steam power was used in the shipyard, was 476 tons, whereas for the corresponding period in 1899, after electric power was adopted, the average coal consumption was 232 tons, being almost exactly half the total required for steam power. This, too, notwithstanding the fact that many new machines had in the interval been added in the platers' shed, and that the amount of lighting done had been more than doubled. The true saving is probably nearer 60 per cent. than 50 per cent. if this extra load be taken into account."

At a large colliery in South Durham the pumps were originally of the spear-rod type, worked from bank, and the pumps delivered about 1,000 gallons per minute against a head of 400ft. Owing to the room which these pumps occupied in the shaft, and it being desired to put in another cage, which could not be done with the pumps in the shaft, the pumps were removed, and in

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COMPARATIVE COST OF WORKING HYDRAULIC AND ELECTRIC LIFTS.

Type of lift.	Load, cwt.	Source of power.	Travel in feet.	Cost of average round trip up and down, in pence.	Number of trips per penny.	Remarks.
Electric	7	Manchester Corporation	50	·159	6·3	Observed. Conditions unfavourable. Current at 2½d.
Hyd. suspended H.P.	7	Manchester Corporation	50	·29	3·45	Calculated from published scale.
Hyd. suspended L.P.	7	Manchester Corporation	50	·445	2·2	Calculated at 6d. per 1,000 gallons. Pressure 50lb.
Electric	9	Private supply	50	·066	15·0	Observed. Conditions ordinary. Calculated at 2½d.
Hyd. suspended H.P.	9	London Hyd. Power Co.	50	·277	3·6	Calculated from published scale.
Electric	9	Glasgow Corporation	50	·061	16·4	Observed. Current at 2½d.
Hyd. suspended H.P.	9	Glasgow Corporation	50	212	4·7	Calculated from published scale.
Hyd. suspended H P.	12	London Hyd. Power Co.	50	·35	2 86	Observed.
Hyd. suspended H.P.	9	London Hyd. Power Co.	50	·287	3·5	Observed.
Hydraulic ram H.P.	12	London Hyd. Power Co.	50	·42	2·4	Observed.

their place was substituted a horizontal compound coupled engine of 400 h.p., one 250-kw. dynamo arranged to drive the two pumps at present installed, also an additional pump, and the coal-cutting machines. This machinery was placed at a colliery where they were able to utilise coke-oven gas. The colliery being 1,000 yards from the shaft where the pumps were originally installed, the current was carried overhead by cables and down the shaft to two sets of 11 by 18 three-throw pumps, each delivering 500 gallons per minute against a head of 400ft. It is estimated that the saving in fuel alone is over £1,500 per annum. In addition to this, the shaft can now be used for winding, and the output of the colliery very considerably increased.

In one of the collieries in Northumberland the workings were pumped by means of seven single-barrel pumps, each set delivering about 100 gallons per minute, these pumps being driven by an endless wire rope from two hauling engines, steam being supplied by locomotive boilers underground. This plant was taken out, and in its place was substituted a horizontal engine with automatic triple-expansion gear driven on to a dynamo, and the existing pumps were utilised, the pumps being driven through machine-cut worm gear by 6-h p. motors, and in all eight sets were so arranged. The total cost of the electric plant, exclusive of erection, was a little over £3,000, and the annual saving was from £1,500 to £1,800.

At a colliery in Scotland in which the workings were originally drained by means of (*a*) a spear-rod pump to the shaft bottom; (*b* and *c*) two duplex pumps underground with steam-pipes, the furthest pump being about 800 yards in-bye. It required seven men to attend to the pumps, and the consumption of coal was about 14 tons per day. This plant was taken out, and in its place there was installed a horizontal compound coupled engine of 250 h.p., 130-kw. dynamo, one set of three-throw pumps 11 × 18, delivering 500 gallons per minute against a head of 600ft, and one 150-h.p. motor for driving same. The work with the new plant was done in eight hours per day, the consumption of coal was 2¼ tons per day, and the whole installation was looked after by three men. It was estimated that the annual saving exceeded £3,000, so that the total cost of the plant, including erection and everything, would be paid for in less than two years.

With electrical driving of hauling gear at the Ewald Colliery, Germany, it has been found that, not taking into account depreciation, discharging one ton-kilometre of coal from the mine costs about 3·39 pfennigs (⅓d.). A balance-sheet for July, 1895, shows a clear saving in cost against that of July, 1894, of 5,512 marks, the economy being effected by the electric hauling gear. The quantity of coal discharged up to July, 1894, for 25 working days amounted to 107,000 truck kilometres at 0·6 of a ton per truck, 50 horses being at work, so that the monthly work of each horse amounted to 107,000/50 = approximately 2,140 truck kilometres, or 2,140 × 0·6 = 1,284 ton-kilometres without counting trucks carrying bricks, wood, or lime, or running empty. The daily work of each horse was 2,140/50 = 85 6 trucks per kilometre, or 1,284/25 = 51·36 ton-kilometres. The monthly cost per horse is as follows: 100 marks paid for hiring; 54 marks, wages for driver, proportion of expenses for stable boys, etc., together, 154 marks for 50 horses; therefore = 7,700 marks, not counting six marks per horse, or 300 marks per month for 50 horses for shoeing, water, and amortisation of the underground stables. If, therefore, the daily work of the horses is 85·6 trucks per kilometre, there would be 51·5 horses necessary for the month of July, 1895, for the whole transport of 118,962 truck kilometres in 27 working days, which would mean a cost of 51·5 × 154 = 7,930 marks. Exclusive of amortisation of the capital the cost of the mechanical hauling gear is as follows:

		Marks.
1	foreman	190·00
2	day attendants	197·75
4	night attendants	473·45
3½	men for rope repairs	328·07
175	different amounts for extra work, etc.	562·15
	Total of wages	1,751·42
	Extra expenses	145·82
	(320 volts, 110 amperes = 35·2 kw.) for the steam-engine 35·2/0·7 = 50·3 h.p.	521·51
	(1 horse-power hour = 0·024 mark monthly, 27 days × 16 hours × 50·3 × 0·24 = 521·51 marks.)	
	Total working costs	2,418·75

Not taking into account depreciation and interest, in the month of July, 1895, there would be a saving of 7,931 marks - 2,419 marks = 5,512 marks against the same month of the year before. That amounts to $\frac{7,700·0}{107,000 \times 0·6} = 12$ pfennigs (1·2d.) per ton-kilometre if worked by horses, and for the mechanical hauling gear $\frac{2,418·73}{118,962 \times 06.} = 3·39$ pfennigs (⅓d.). The costs of amortisation will no doubt be balanced on account of the saving of 51·5 × 12 = 618 cubic metres of fresh air per minute for nine horses, because of the reduction in costs for repairs, etc., and, above all, on account of the greater regularity of working. If, therefore, it is desired to fix the working cost at, say, 150,000 marks for running expenses, inclusive of reserves, 2,250 marks per month, 18 per cent. for amortisation and interest would have to be taken into account and thus raise the total cost for the mechanical working to 2,419 + 2,250 = 4,669 marks per month; or, in other words, a ton-kilometre would cost $\frac{4,669·0}{713·772} = 6·54$ pfennigs (a little more than one halfpenny), amounting only to half the cost of working by horses. A good example of the great difference in cost of working will be found in the statement that the total cost of transporting one ton 3,280ft. if electricity is used amounts to only 0·3d, whereas if horses are used the cost amounts to 1·2d. The majority of us do not realise the great losses in driving shafting with all its bearings, pulleys, gears, and ropes; it amounts to several millions of horse-power every hour in the year.

In a Portland cement factory in Westphalia it has been found that of the 400 h p. of the steam-engine, 70 h.p. were used for driving shafting alone with no load, and since this factory is working day and night, we may say that during a year of 300 working days, 300 × 24 × 70 = 504,000, or more than half a million horse-power hours are wasted, meaning to say ⅓d. per horse-power hour, a sum of £1,050 per annum. For driving a ventilator in a cement factory, 15 h.p. were transmitted a distance of 263ft. Two shafts, a reducing gear, and four belts were used, and exact measurements showed that 8·1 h.p. were

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absorbed by shafting and belts. Since the ventilator had to work day and night, this small transmission caused a yearly loss of 8·1 × 24 × 300 (working days per annum) = 58,320 horse-power hours.

It has been found that belts of $\frac{3}{16}$in. thickness, at a speed of about 20ft. per second, and the usual pulley diameter waste about 2lb. per $\frac{3}{4}$in. of belt width. Simple cast tooth gears work with an efficiency rarely over 90 per cent., and worm gears hardly ever attain an efficiency of 50 per cent. If we take works driven by steam power we find that the losses in shafting alone are very considerable. In the case of a wagon works this was found to vary from 22 per cent. to 57 per cent., and in the case of an engine works it was found to vary from 25 per cent. to 70 per cent., the average being 42 per cent. At another engine works, where fairly long lines of shafting and comparatively a small number of tools were used, the loss was 75·6 per cent.

Given below in tabulated form are some particulars of the shafting losses in different works, from which it will be seen that the loss varies from 39 to 77 per cent. It is obvious that, other things being equal, the greater the average distances of the machine from the driving engine the greater is the loss in shafting.

Nature of work.	Total H.P.	Per cent. to drive shafting.	State of load.	H.P. per 100ft. shafting.	H.P. per 100lb. shafting.	H.P. per bearing.	H.P. per belt.
Wire-drawing and polishing.	400	39	½	14	·58	·37	1·76
Steel stamping and polishing.	74	77	½	9·8	·35	·84	2·4
Boiler and machine work.	38	65	¾	4·77	·21	·55	·48
Heavy machine work	112	57	1	5·7	·23	·58	·45
Light machine work..	74	54	1	8	·4	·69	·12
Manufacture of small tools.	47	52	1	2·5	·23	·24	·11
Ditto	190	57	1	4·36	·43	·39	·21
Screw machines and screws.	241	47	1	6·33	·38	·63	·23

Cost of Production.

The author has frequently been asked another very obvious and reasonable question—viz., what is the cost of production should we adopt an electric plant in our works? In answer to this the author has drawn upon a number of cases of different kinds and in different parts of the country showing the rate at which the works owner can generate his own electricity. These figures are taken from actual examples of everyday working, and are not in any way test figures taken for the purpose of this paper. Taking these figures as a basis, it is an easy matter for a works owner, once having ascertained the total horse-power which will be involved in the driving and lighting of the entire works, to see for himself at what expenditure per annum he can run his works upon the new system.

The author is indebted to Messrs. Richardson, Westgarth, and Co, Limited, West Hartlepool, for the following information on the subject of the economy effected by the introduction of electric driving into their works. The following is a rough summary of the changes which have been effected. These works were formerly driven by about 13 small and uneconomical steam-engines scattered about in different places, the maximum aggregated indicated horse-power of which would approximately be, say, 300 to 400. Steam for these engines was furnished by a battery of 12 boilers, and the coal consumption for the driving of the works was approximately 100 tons of coal per week. Five years ago the driving arrangement of the works was remodelled by the substitution of electric motors for the various engines—a power-house being built in a central position, and equipped with two boilers, each 15in. by 10in., two dynamos each of about 400 i.h.p., and one small machine of about 120 h.p. The tools throughout the works are now giving an output at least of 30 per cent. in excess of what it used to be, and are burning 50 to 60 tons of coal per week in the generating station boilers. The above facts speak for themselves with regard to the economies which have been brought about by the introduction of electric driving into the works. The machinery throughout was constructed by Brown, Boveri, and Co., and is of the three-phase alternating-current type. The cost of renewal and repairs over the period during which the machinery has been running (five years) has been extremely small, certainly not 1 per cent. of the value of the installation.

Cost of Electricity delivered on Switchboard.

Test of 139½ hours, Nov. 17 to 23, 1901, Britannia Works.

Mean current (amperes)	3,464		
Mean pressure (volts)	125		
Mean power (watts)	433,000		
Mean electric horse-power	580·42		
Board of Trade units	60,403		
Weight of steam per Board of Trade unit	27·52lb.		
Weight of coal per Board of Trade unit	3·04lb.		
Cost per Board of Trade unit.	d.	Cost per week.	
Coal, 3·04lb. at 11s. 6d. per ton	0·187	£47	4 0
Water, 27·52lb. at 3½d. per 1,000 gallons	0·00963	2	8 6
Stores	0·00995	2	10 0
Wages	0·06625	16	13 3
Repairs*	0·0159	4	0 0
Superintendence	0·01192	3	0 0
Net cost per Board of Trade unit	0·30065d.	£75	15 9
Interest and depreciation on £15,000 at 10 per cent. per annum	0·099d per unit.		

* Includes labour of keeping 134 arc lamps in repair.

Cost per Electrical Horse-Power per Hour.

Coal, 2·27lb. at 11s. 6d. per ton	0·1395
Water, 20·53lb. at 3½d. per 1,000 gallons	0·00718
Stores	0·0074
Wages	0·0494
Repairs	0·01185
Superintendence	0·0089
	0 22423d.

Mean indicated horse-power at 75 per cent. efficiency, 773. Coal per indicated horse-power, 1·705lb. Water per indicated horse-power, 15·4lb.

The managing director of a large engine works informed the author that they are now running their works on 7½ tons of coal per day, and are employing 800 men. Their works consist of four distinct yards, all yards are driven from one central station, and in the old method a boiler would have to be placed in each department or else long lines of wasteful steam-pipe. Their cost of production, including interest and depreciation on capital, is 0·46d. per unit.

At a shipyard on the north-east coast, using only 112 h.p., the cost of production of electricity has been found to be only 0·6d. per electrical horse-power per hour, this figure including all charges, interest, and depreciation. At another shipyard on the north-east coast the saving effected by the substitution of electricity for steam driving shows a saving of 43½ per cent. per £ wages paid by the adoption of electric power. The figures are as follows:

Cost of Power per £ Wages Paid.

Coal and Gas.		Electricity.	
May 2, 1893, to April 24, 1894.		April 30, 1900, to April 30, 1901.	
Wages	£64,885	Wages	£126,700
Cost of power	2,337	Cost of power	2,578
=8·66d. per £ wages paid.		=4·88d. per £ wages paid.	

Taking the case of another shipyard which was previously driven by gas engines, the author has received the following particulars: "We have no hesitation in saying that we are getting at least 30 per cent. more power out of our machines since we adopted electric power instead of the gas-engines we used before. As far as the cost per Board of Trade unit goes, we have lately had readings taken, and find that last year's works out at about 0·8d.; this is taking into consideration the depreciation on our plant, interest on capital, repairs, and, in fact, everything which we can possibly put down against this account." The average output would not exceed 250 h.p. to 300 h.p.

The author is indebted to the managing director of another large shipyard in the North of England for the following statement: "Some years ago, just about the time when we first introduced electrically-driven machines, we put in new boilers in place of the old ones; and while it must be remembered that the new boilers are more efficient than the old ones, I would say in general terms that our coal consumption has been reduced by some 40 per cent., although the amount of machines driven electrically is now greater than those which were formerly

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driven by steam, and consequently the reduction may be even greater than the percentage I mention above."

In a letter the author has received from Colonel R. E. Crompton, he states: "In our own works, which are on a somewhat extended scale, the substitution of electric driving for the old shafting system has approximately halved our bill for power; in fact, the whole of the driving of the works and tools for about 1,300 men is practically supplied by one 120-kw. set fully loaded, and it is only when we are testing that we have to run two sets of this size, whereas by the old system we should have had to run two 200-h.p. engines continuously."

Another very interesting case, although not in full operation as yet, but one which shows conclusively the enormous advantages to be derived in driving works from their own central power station, is that of Messrs. Head, Wrightson, and Co., Limited, of Thornaby-on-Tees. In this case no fewer than 39 steam-engines and 20 boilers are being replaced by two combined plants, with one as a stand-by, and by two boilers. The whole plant is designed upon the most modern lines, and advantage has been taken of every known device to reduce the cost of production to the lowest possible limit. The actual working results of this installation should be available in the course of a few months' time.

In summarising the above cases, it is obvious that the greatest economy results in the substitution of electricity for steam in those cases where the units of power, both in engines and boilers, are the most subdivided. There are, however, enormous advantages to be derived, especially in the case of intermittently working machinery, where the load is of a very variable nature, and particularly so in all crane work, which plays such an important part in all our engineering industries.

(To be continued.)

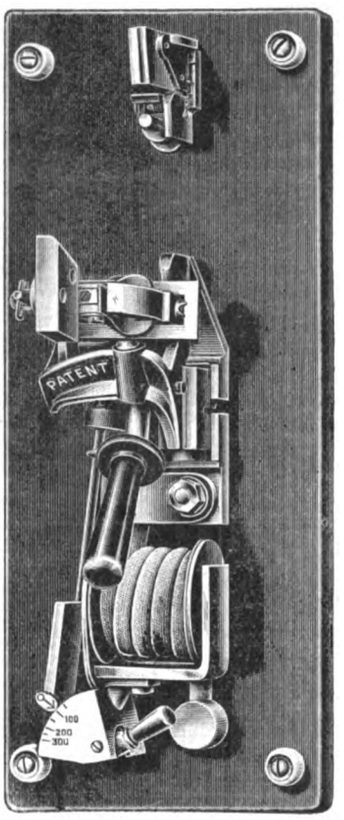
TRADE NOTICES AND NOVELTIES.

"Solvo."

With their customary enterprise the General Electric Company, Limited, Queen Victoria-street, London, E.C., have introduced a specially-prepared dry form of indiarubber, called "Solvo," with the object of overcoming the difficulty hitherto experienced in connection with the carriage of indiarubber solution. As our readers know, indiarubber solution plays an important part in making good the insulation of electric wires and cables at joints, and will continue to be a necessity so long as indiarubber is used for insulating cables and wires; but at the same time it is an article which comes very expensive if sent about the country or shipped abroad in small quantities, owing to the fact that the carriers classify it as inflammable. The minimum cost for carriage is, we understand, 5s., and for collection and delivery another 5s., thus making the total cost of 1lb. come to about 12s. "Solvo," the new material, being in a dry condition and containing no naphtha, can be carried at the ordinary rates. All that is necessary for the user to do is to fill up the tin of "Solvo" with coal-tar naphtha, which can be obtained cheaply everywhere locally, the tin containing such a quantity of prepared rubber that when the coal-tar naphtha is added the weight of indiarubber solution indicated on the tin will be formed by simply stirring and leaving 24 hours. The substance should be a boon to the electric wiring trade. Further particulars of "Solvo" are given in circular W 1,018, just issued by the General Electric Company, Limited, which also deals with other jointing materials for installation work.

New Switches.

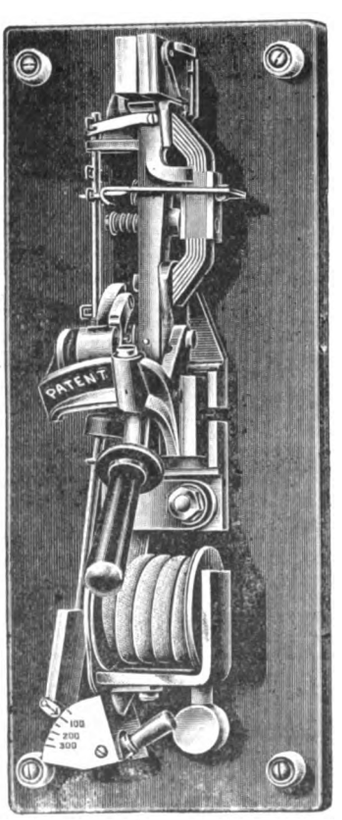
We illustrate herewith a new pattern edgewise grip-contact switch just introduced by Messrs. Dorman and Smith, Ordsal Station Electrical Works, Salford, Manchester. In this switch the switch blades are gripped on to the contacts by means of a toggle gripping arrangement, which is operated by a continued motion of the switch handle after the blades have reached their position on the contacts. On opening the switch the first movement operates the toggle, and so reduces the pressure on the contacts; at the same time a trigger is lifted, and the switch arm flies off, moving over the contacts with a light rubbing pressure. It is claimed that this arrangement ensures a quick, certain break, while the blades cannot stick on the contacts even if burnt, and in putting the switch on and off the light rubbing pressure is sufficient to keep the contacts clean. The main circuit-breaking switch is combined with an auxiliary switch, interlocked so that the main switch is closed first, then the circuit completed through the auxiliary switch, leaving the main switch quite free to be opened by any automatic device. This auxiliary switch cannot be opened



OPEN.

Edgewise Grip-Contact Switch, fitted with Automatic Overload Gear.

until after the main switch has been opened. The switch is claimed to be well adapted for generator or power circuits, and can be used as a hand-operated switch as well as



CLOSED.

Edgewise Grip-Contact Switch, fitted with Automatic Overload Gear.

an automatic switch. The automatic device on the overload or maximum switches presents several novel features, the advantages claimed being that it ensures absence of friction immediately the armature has started to move, and that power is

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secured at the end of the armature movement very greatly in excess of that required to lift the latch to open the switch, so that failure in this particular seems absolutely impossible. The standard patterns are being made to open circuits up to 500 volts for all currents up to 2,000 amperes, and they are made in the following patterns and combinations: "overload" or "maximum current," "minimum current," "reversed current," "maximum and reversed combined," or "maximum and minimum combined." We may add that the makers have a sample of the switch on view at their London office, 94, Charing Cross-road, W.C.

Calendar.

From Messrs. Blumann and Stern, Limited, Plough Bridge, Deptford, London, S.E., we have received a copy of a useful calendar for 1903. Printed on the back of each tear-off slip are particulars relating to the firm's well-known lubricating oils and other specialities.

PHYSICAL SOCIETY.

At the meeting of the society held on the 31st ult., Prof. S. P. Thompson (president) in the chair,

A paper "**On the Existence of a Relationship between the Spectra of some Elements and the Squares of their Atomic Weights,**" by **Dr. W. M. Watts,** was read by Prof. Everett. The author has detected two kinds of relation between the spectra of some allied elements. In the first kind, which is illustrated by comparisons between zinc, cadmium, and mercury, and also between gallium and indium, the differences between the oscillation frequencies of certain lines of one element are to the differencies between the oscillation frequencies of the corresponding lines of another as the squares of their atomic weights. In the second kind the relation is not between two but between three spectra, and is illustrated by the trio potassium, rubidium, and cæsium, as well as by the trio calcium, strontium, and barium. The element of greater atomic weight has the smaller frequency; and, in comparing corresponding lines, one from each of the three spectra, the differences of frequency are proportional to the differences between the squares of the atomic weights. If each of the spectral lines in question is represented by a point whose co-ordinates are "frequency" and "square of atomic weight," the three points which represent three corresponding spectral lines will lie on one straight line in the diagram, and these straight lines will be parallel for all the components of a given set of corresponding groups. When a similar mode of plotting by points is employed to exhibit the first kind of relation, the joins of corresponding points meet in a point, which lies on the axis of frequencies—in other words, on the line of zero atomic weight. This relation was indicated by Rsmage about a year ago as holding for corresponding doublets and triplets.

Lord Kelvin expressed his interest in the paper.

Prof. Perry asked to what extent the points actually lay upon straight lines. He had worked with the spectra of potassium, rubidium, and cæsium, and knew that many relations which apparently held on careful examination were found not to be true on account of certain points falling slightly off the curves. He would like to compare the author's results with some of his own work.

A paper on "**The Size of Atoms**" was read by **Mr. H. V. Ridout.** This investigation deals with the size of dissociated atoms or ions, and the results obtained refer to a dissociated atom as the smallest quantity of matter which can take part in an electrolytic action The element chosen is hydrogen, and the author concludes that, in round numbers, 114½ million atoms are necessary to form a line 1cm. long. The method employed consists in finding a pair of spheres which would be charged by the quantity of electricity known to be necessary to electrolyse a given quantity of the body under examination—in this case water—to the known difference of potential of its ions. From this the size of the atom is deduced, subject to certain assumptions enumerated and discussed in the paper. The atoms are regarded as spherical and closely packed. To facilitate the calculations the packing is assumed to be such that the centre of any sphere is immediately above the centre of the sphere upon which it rests. Under these circumstances the total volume of spheres necessary to fill a given cube is equal to that of the single sphere about which the cube is described. The electrical capacities of isolated spheres being proportional to their diameters, it follows that the total capacity of any number of such spheres is equal to the capacity of a single sphere, the diameter of which is equal to the sum of the diameters of the small spheres. Using these two propositions, the size of the atoms is easily deduced from the pair of spheres already determined. The author points out that the method fixes both the superior and the inferior size of the atoms, and gives, therefore, the true value.

Lord Kelvin remarked that he had often concerned himself with the size of atoms, and pointed out that the value obtained by the author for the diameter of a hydrogen ion was almost exactly one-half of that which he had obtained for the diameter of a molecule of hydrogen. The fact, however, might be a coincidence. He had dealt with a sphere which would have the same effect as a double atom of hydrogen. While avoiding the assumption that atoms are hard and spherical, it was usual to treat them as such for purposes of calculation. The paper was an important one, but there were many assumptions which required looking into. Lord Kelvin said that in dealing with the subject of atoms it was necessary to consider the atoms of electricity. The atomic theory of electricity now almost universally accepted, had been thought of by Faraday and Clerk-Maxwell and definitely proposed by Helmholtz. The atoms of electricity were very much smaller than the atoms of matter, and permeated freely through the spaces occupied by these greater atoms and also freely through space not occupied by them. An atom of electricity in the interior of an atom of matter experienced electric force towards the centre of the atom. We were forced to conclude that every kind of matter had electricity in it, and Lorenz had named electricity as the moving thing in atomic vibrations. If the electrions, or atoms of electricity, succeeded in getting out of the atoms of matter, they proceeded with the velocity of light and the body was radioactive. It was therefore not surprising that some bodies showed radioactive properties, but rather surprising that such properties were not shown by all forms of matter. Our knowledge of this subject, which originated with the discovery of the Becquerel rays, had been greatly advanced by the experiments carried out at the Cavendish Laboratory, and he had no doubt that in the next two or three years much light would be thrown upon this important matter.

Prof. Everett asked why the author had taken the specific inductive capacity of water equal to 2.

The **Author** said that the latest determinations of the constant approximated to that number.

APPOINTMENTS VACANT.

Chief Clerk, Swindon Corporation Electricity Department, £100 per annum, Nov. 18. See advertisement.

Assistant Electrical Engineer, Swindon Corporation, £100 per annum, Nov. 18. See advertisement.

Cable Jointer, Swindon Corporation, 35s. per week, Nov. 18. See advertisement.

Shift Engineer, experience in running of direct-current three-wire generating station, 37s. 6d. per week, Nov. 11. See advertisement.

Junior Draughtsman, Croydon Electricity Works, constructional experience. See advertisement.

Head Storekeeper at large Lancashire electrical and engineering works. See advertisement.

Working Electrician, to take charge of D.C. factory plant. See advertisement.

Switchboard Attendant, for continuous L.P. system in Gloucestershire manufacturer's central power station, 25s. per 54-hour week (overtime). See advertisement.

KEIGHLEY ELECTRICITY WORKS.

Mr. J. M. Smyth, the borough electrical engineer of Keighley, has presented his committee with a long report on the working of the electricity department for the 12 months ended June 30 last. The amount expended to date on capital account is £46,473, which exceeds the total sum of the loans and value of land by £2,565. The revenue account is as follows:

Expenditure.	£	s.	d.
Coal	274	14	1
Oil, waste, water, etc.	29	6	10
Wages at station	359	5	7
Repairs and maintenance of machinery	23	5	10
Repairs and maintenance of mains	28	19	10
Attending to public lamps	101	10	4
Interest paid to gas department for land in part lieu of rent	256	9	10
Rates and taxes	190	2	3
Salaries of engineer	269	2	8
Clerks	95	0	0
Stationery and printing	14	0	9
General establishment charges	78	8	7
Law charges	67	19	11
Insurances	16	16	7
Coronation illuminations	85	7	5
	£1,870	11	6

Receipts.	£	s.	d.
By sale of current	724	15	3
Public lamps	480	0	0
Meter rents	49	1	0
Rent received from gas department	108	0	0
Sundries	47	8	3
	£1,409	4	6
Deficit	£461	7	0

In regard to the deficit of £461. 7s. shown on the past year's working the report draws attention to several items which appear to be an unusually heavy burden on the first year's working of an undertaking which has at present such a small revenue. These items include rent of site, £128; rates and taxes, £190; stamp duties, £58; law charges, £67; and Coronation illuminations, £85—making a total of £528. The items of rates and taxes alone, it is shown, swallow up about 22·6 per cent. of the total revenue. The number of units sold in the past year was 90,737. The total works costs amounted to £817. 3s. 6½d., and the cost per unit sold 2·16d., or, exclusive of public lamps, 1·89d. The financial result for the year under review may be summarised as follows: loss on working, £461. 7s.; interest on loans, £1,047. 3s. 11d.;

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amount transferred to sinking fund, £885. 17s. 3d.; and amount transferred to land sinking fund, £125. 0s. 11d.—total loss for the year, £2,519. 9s. 1d. This deficit has to be met out of the rates. The total number of 8-c.p. lamps connected on June 30 last, including private supply and public lamps, was 5,707. The total number of consumers was 440, and the maximum supply demanded 131 kw. The total amount of plant at the station is 440 kw., and, allowing 25 per cent. spare plant, this leaves 330 kw. available for supply. There is a continual increase in the demand, and it is anticipated that the plant will be loaded to about half its maximum capacity this winter. The average price obtained per unit is—private lighting, 4·59d.; motors, 1·81d.; and public lighting, 2·91d. From these figures, it will be seen, says the report, that the prices charged are too low to make the undertaking self-supporting until the output is considerably increased, but the engineer does not recommend the adoption of higher rates. He thinks, however, judging from the increase in the demand during the current year, the undertaking may become self-supporting at the end of the fourth year of working, or sooner if the tramways require power next year.

PORTSMOUTH ELECTRICITY ACCOUNTS.

From the accounts of the Portsmouth Corporation electricity works for the year ended March 31, 1902, it appears that the total expenditure on capital account to date amounts to £202,061. The revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith.

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£ s. d.
Coal or other fuel	£8,554 15 1	
Oil, waste, water, and stores	888 5 0	
Wages at generating station	1,331 11 2	
Repairs and maintenance, etc.	935 6 10	
	11,751 19 9	
Less received for old material	61 6 7	
		11,690 13 2
	Distribution of Electricity.	
Repairs, maintenance, etc., of mains	120 2 4	
Repairs, etc., of transformers, etc.	1,261 10 7	
		1,381 12 11
	Public Lamps.	
Attending and repairs	1,287 16 1	
Renewal of lamps	93 4 6	
		1,381 0 7
Rents, rates, and taxes		986 19 7
	Management Expenses.	
Salaries—engineer's staff	997 0 4	
Accountant and clerical staff	365 5 10	
Salary of collector	119 11 8	
Stationery and printing	124 16 8	
General establishment charges	294 13 0	
		1,901 7 6
Special charges		257 4 0
Total expenditure		17,598 17 9
Amount carried to net revenue account		13,255 7 4
Carried forward for new workshop and bad debts		1,441 6 6
		£32,295 11 7

Cr.	£ s. d.
Sale of current, less allowances	24,868 7 8
Sale under contract	84 0 0
Public lighting	5,047 18 9
Rental of meters and other apparatus	1,201 12 2
Sale and repairs of lamps	121 15 0
Sale and repairs of other apparatus	103 8 5
Rents receivable	94 19 11
Miscellaneous receipts	773 9 8
	£32,295 11 7

GENERAL BALANCE SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received, less repaid	153,561 8 11
Sundry creditors	2,181 7 0
Balance at credit of reserve fund account	4,725 0 0
Amount due to treasurer on revenue account	4,261 10 1
Amount due to treasurer on capital account	38,042 7 4
Amounts deposited	334 17 6
Balance at credit of revenue account	1,441 6 6
Amount due on redemption account	10,457 19 1
	£215,005 16 5

Cr. Assets.	£ s. d.
Capital account—amount expended	202,061 15 4
Stores and motors on hand	2,995 10 9
Sundry debtors for current supplied	9,772 2 2
Other debtors and unexpired insurances	176 8 2
	£215,005 16 5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		2,235,647
Quantity sold: Public lamps	439,376	
Quantity sold: By contract	1,580	
Quantity sold: Private consumers by meter	1,406,834	1,847,790
Quantity used on works		100 525
Quantity used for magnetising current		198,499
Quantity used for motor-generators		80,926
Total quantity accounted for		2,227,740
Quantity not accounted for		7,907
Total maximum supply demanded (kilowatts)		1,713

Number of public lamps: 264 arcs, 106 incandescents.

CARDIFF ELECTRICITY ACCOUNTS.

From the accounts of the county borough of Cardiff electricity works, just issued, it appears that the total expenditure on capital account to March 31, 1902, amounted to £119,566. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£ s. d.
Coal or other fuel	£2,808 15 4	
Oil, waste, and stores	692 14 9	
Wages at generating stations	1,404 16 8	
Repairs and maintenance of plant, etc.	786 5 8	
Sundry other expenses	170 8 8	
		5,863 1 1
	Distribution of Electricity.	
Wages to linesmen, fitters, etc.	36 19 4	
Repairs, maintenance, etc., of mains	75 12 8	
Repairs, etc, of transformers, etc	88 14 0	
Repairs, etc., of apparatus, etc.	53 16 3	
		255 2 3
	Public Lamps.	
Attending and repairs	316 3 8	
Renewals of lamps	143 19 8	
		460 3 4
Rents, rates, and taxes		820 15 9
	Management Expenses.	
Salaries—Engineer's department	423 11 5	
Clerical staff	293 12 2	
Auditor	25 0 0	
Collector	130 16 7	
Printing and stationery	145 14 4	
General establishment charges	126 8 1	
		1,145 2 7
Law and parliamentary charges		66 19 0
Special charges—insurances, etc.		94 8 10
Total expenditure		8,705 12 10
Amount carried to net revenue account		6,809 15 6
		£15,515 8 4

Cr.	£ s. d.
Sale of current per meter	13,115 9 11
Sale under contracts	140 19 2
Public street-lighting	1,936 18 1
Rental of meters and other apparatus	322 1 2
	£15,515 8 4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	80,107 16 4
Sundry creditors	6,219 19 11
Amount due to treasurer	36,381 13 8
Amount due to Cardiff urban authority account	1,223 11 11
Amount due to Corporation waterworks account	171 14 3
Sinking fund—loan instalments repaid	8,537 18 2
Balance of proceeds of action Corporation *v.* Ferranti	886 6 4
Balance at credit of net revenue account	2,256 3 10
	£135,785 4 5

Cr. Assets.	£ s. d.
Capital account—amount expended for works	120,585 16 11
Stores on hand	1,551 16 0
Sundry debtors for current supplied	4,846 2 9
Other debtors	163 17 8
Amount due from borough fund account	243 14 9
Amount due from Cardiff tramways account	955 10 10
Cash in hands of engineer	40 0 0
Investments, etc., for redemption of stock	7,398 5 6
	£135,785 4 5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,287,795
Quantity sold: Public lamps	159,823	
Quantity sold: By contract	8,459	
Quantity sold: Private consumers by meter	837,481	1,005,763
Quantity used on works and offices		46,846
Total quantity accounted for		1,052,609
Quantity not accounted for		235,186
Total maximum supply demanded (kilowatts)		951

Number of public lamps: arcs, 84; incandescents, 349.

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LEGAL INTELLIGENCE.

HASTINGS TRAMWAYS.

On the 30th ult., in the Chancery Division of the High Court, Mr. Justice Buckley gave judgment in the case of the Attorney-General and John Bray *v.* the Mayor, etc., of Hastings, Wm. M. Murphy, and the Hastings Tramways Company. The action was brought at the instance of Mr. Bray, a ratepayer of Hastings, to set aside an agreement between the defendants with respect to the rights of Mr. Murphy and the tramways company to construct a line of electric tramways along the front at Hastings, the contention of the plaintiff being that the agreement was *ultra vires*. The facts of the case appear sufficiently from the judgment of the Court.

Mr. Justice Buckley, in giving judgment, said this was an information laid by a ratepayer that a certain agreement of June 1, 1901, was illegal and *ultra vires*, and was to be held null and void. The action came on for trial before him last May as a non-witness action, and was discussed at considerable length, but as it proceeded it was found impossible to go on with the case as the Court was then constituted. The agreement of June 1, 1901, was an agreement between the Hastings Tramway Company of the first part, the Corporation of Hastings of the second part, and Mr. Murphy of the third part. The only defendant to the action was the Corporation of Hastings, so it was impossible to set the agreement aside in the absence of other parties to it. Accordingly the action was ordered to stand over for the purpose of adding the defendants Mr. Murphy and the tramway company, and as it was suggested that some of the added parties might desire to call witnesses, it was made a witness action. As a matter of fact, no *viva voce* evidence had been taken. In May last there was a long argument from plaintiffs that the agreement of June 1 was not duly executed by the Corporation, and that it had never come before the mayor and burgesses in Council assembled. That had now been abandoned, and it was admitted by plaintiffs that the agreement was duly executed, and in that his lordship concurred. The only point he now had to determine was whether the agreement was *ultra vires*, and on what ground, if any, it was not binding on the Corporation. The arrangement with Mr. Murphy was as to a scheme of tramways, part of which was to be authorised then, and also the possible construction of a further line along the front in the future. The argument of the plaintiffs was that the Corporation had no power to enter into an agreement for this purpose on two grounds. The first was that because the Act of 1900 authorised certain things, it, by implication, forbade certain others. In his opinion, that argument failed, as Section 2 of the Act dealt purely with matters authorised in the Act, and could not apply to matters not dealt with in the Act. The second point was that the Corporation had no power to bind their successors. The principle at law was this: A municipal corporation had, *prima facie*, an absolute right of contract for any purpose for which it existed, but that *prima facie* right did not exist where the Corporation was expressly or impliedly prohibited from making any such contract. What was the object of the incorporation of this Corporation for the purposes relevant to this matter? It existed to control the highways and to see that they were properly administered for the benefit of the public. There was nothing either expressed or implied which could prevent the Corporation from having the power to say they would agree to anyone constructing trams, or that, in consideration of such construction, they would give a prior right of construction to the same person in another place. It was, on the contrary, a right and proper agreement to make. Upon these grounds, he was of opinion that the agreement which the Corporation entered into on June 1, 1901, was one that it was competent for them to enter into, and was binding on the Corporation. The action, under these circumstances, failed altogether, and in dismissing it he would dismiss it with costs.

Judgment accordingly.

ELECTRIC RAILWAYS COMPANY.

Before Mr. Justice Byrne in the Winding-up Court on Tuesday the petition of H. A. Nepean Fyers and another was heard. Mr. George Henderson, for the company and certain creditors, asked that the petition should stand over to await the result of certain negotiations with the managing director of the Great Western Railway Company. Mr. Eve, K.C., in support of the petition, maintained that the company was insolvent; the hopes expressed of the Bill going through with the Parliamentary Committee were not yet realised, inasmuch as it appeared on affidavit that there was not sufficient evidence to satisfy the Joint Committee that the necessary money would be forthcoming. His Lordship directed the petition to stand over for a week.

HIRAM MAXIM LAMP COMPANY.

In the Chancery Division of the High Court, on Tuesday, Mr. Justice Byrne had before him the affairs of the above company on an originating summons by the liquidator in the voluntary winding-up of the company against shareholders for a balance order, or order to pay calls made on them before the company went into voluntary liquidation. Before the winding up commenced the company sued the shareholders for the calls, and applied for judgment, and an order was made that on payment into court of the difference between the amount of the calls and the amount of a debt pleaded, by way of set-off, as due from the company to the shareholders, the latter should have leave to defend. On that they set up the plea of set-off. Before judgment was given the company went into liquidation, and the liquidator now took out a summons for payment of what the company had sued for but not recovered before the winding up. It was contended on behalf of the shareholders that they were still entitled to their set-off.

Mr. Justice Byrne, in giving judgment, said it was conceded that, if there had been no action and no plea of set-off, it was plain on the face of the authorities that the respondents could not rely on a set-off against an application for a balance order, but it was contended that, having regard to the previous plea, the original debt was gone. His lordship could not accept this view. In truth, the plea of set-off was a plea proper, and until judgment there remained two debts, and, where no judgment was given, there seemed to be no reason why the ordinary rule should not prevail, or why the liquidator should not be entitled to receive the amount of the call without the deduction sued for but not recovered by the shareholders. His Lordship gave the shareholders leave to appeal.

CLAIM FOR ELECTRIC LIGHT.

In the West London Police Court an adjourned summons was heard against Elizabeth King, of Earl's Court, at the instance of the Brompton and Kensington Electric Supply Company, who claimed the sum of £10. 18s. for electric light. The husband had died, and the question was how many units were consumed prior to the death of Mr. King. Mr Lane, K.C., went into the particulars of the consumption, and altered the amount claimed by the company to £6. 10s., but he allowed the defendant £1. 1s. costs on the ground that the representatives were not prepared on the last occasion the case was before the Court to prove the case.

COMPANIES' MEETINGS AND REPORTS

BROCKIE-PELL ARC LAMP.

On Wednesday the ordinary general meeting of this Company was held at the offices, Worship-street, Lord Suffield presiding.

The **Chairman,** in moving the adoption of the report, remarked that it was more satisfactory than that which had ever previously been issued by the directors, and he hoped that the dividend (3 per cent.) was an indication of the commencement of better times. The business was steadily expanding, as was shown by the increase of 40 per cent. in the sales; and although the competition, owing to the "cutting" of prices by English and foreign manufacturers, had been very keen, the number of new orders, as well as the many repeat orders which had been received by the Company, proved that the Brockie-Pell lamp maintained its reputation. Exceptional dulness in trade prevailed from the end of March to the end of July, but the orders which were received by them during September and October had been very encouraging. The most important contract undertaken by the Company during the year was that for lighting the Glasgow Exhibition, and the result had been an unqualified success. About 950 of their lamps had been placed in the streets of Westminster. One of the most recent orders they received was for lamps to be used at the forthcoming durbar at Delhi. Several very satisfactory orders had been received from South Africa since the termination of the war. For the current year the Company's prospects were very hopeful.

Sir F. D. Dixon-Hartland, M.P., seconded the motion, which was adopted.

MONTEVIDEO TELEPHONE.

The annual meeting of the shareholders in this Company was held on the 30th ult. at Winchester House, Mr. Frank W. Jones presiding,

The **Chairman,** in moving the adoption of the report, stated that since last year's meeting the position and prospects of the Company had somewhat improved. Their receipts and the net results for the year ended July 31 last had been larger than for any previous year, and the latest reports from their manager in Montevideo showed that continued, if not rapid, progress might be expected in the future. At their last meeting he indicated the probability of very considerable capital expenditure to be expected from new conditions in telephony and from increasing business, and emphasised the necessity for preparing in advance for such demands. Fortunately, the Company had not been called upon to incur any extraordinary outlay in the past year. Every effort had been made to husband their resources for the time when they would be absolutely needed and could be most advantageously expended. They now had practically in cash a substantial reserve, and for many years all payments on account of capital expenditure had been made from this fund. It was intended to continue to build up the reserve. The improvement for the year in net revenue was £823. The Board proposed to pay the full dividend on the preferred shares, the usual dividend on the ordinary share capital, to place £5,000 to reserve, and to carry forward the same amount as last year.

Mr. J. G. Le Marchant seconded the motion.

After some discussion the motion was unanimously adopted.

W. R. SYKES INTERLOCKING SIGNAL.

The ordinary general meeting of this Company was held on Friday at Winchester House, Major-General C. S. Hutchinson presiding.

In moving the adoption of the report, the **Chairman** said that the affairs of the Company had gone on satisfactorily during the period under review. A steady business had been done, and their works had been fully occupied. With regard to the question of electrical and other power signalling, he stated that Mr. Sykes had given great attention to it, and had perfected a system which compared favourably with other inventions both as to first cost and expense of maintenance.

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The Company were also manufacturing an insulated joint and bond at the joint, which were matters intimately connected with automatic block signalling, now being adopted by a number of railway companies. They had already received large orders for this joint and bond. Another thing which had been receiving attention was the safe-guarding of diamond crossings. During the past year the Company had done work for 16 railway companies, and they now had orders on hand to the amount of about £7,000. The profit for the year was £3,824, to which had to be added the balance of £527 brought forward. It was proposed to pay a dividend at the rate of 6 per cent. on the 65,000 shares with 15s. paid and a dividend of 2½ per cent. on the fully-paid shares allotted to the vendor, leaving £800 to be carried forward.

Mr. A. A. Brand seconded the motion, and it was adopted.

NEW COMPANIES REGISTERED.

General International Wireless Telegraph and Telephone Company, Limited.—Capital, £175,000. Objects: to adopt an agreement with J. T. Armstrong to use, develop, grant licenses in respect of and otherwise turn to account the patents, inventions, and rights referred to therein, and to carry on the business of electricians, mechanical engineers, suppliers of electric light, heat, and power, telephone and telegraph constructors and owners, etc.

Romapac Tramway Construction Company, Limited.—Capital, £10,000. Objects: to carry on the business of tramway and railway constructors and owners, etc.; proprietors, electrical and other works and conveniences, etc., and to work any tramways by horse, steam, electrical, or other power.

Tram Seat Improvement Company, Limited.—Capital, £4,000. Object: to acquire from H. S. Haigh and T. Taylor the benefit of certain existing inventions relating to improvements in tram seats and the like, and to carry on the business of tram seat manufacturers, engineers, metal workers, timber merchants, etc.

NEW COMMITTEES.

The following committees have been selected:

LIVERPOOL.—*Tramways* (18 members)—S. W. Higginbottom, M.P. (chairman), Frederick Smith (deputy-chairman), A. T. Salvidge, jun., W. H. Williams, J. S. H. Banner, R. H. Bullen, E. Burns, W. Houlding, Joseph Hunter, S. M. Hutchinson, R. Kelly, E. L. Lloyd, G. J. Lynskey, J. Brunskill, W. Denton, W. W. Walker, J. L. Eills, J. T. Wood, and C. Petrie. *Electric Power and Lighting* (19 members)—R. Dart (chairman), W. W. Walker (deputy-chairman), W. Bartlett, H. Campbell, H. M'Cubbin, F. Smith, W. H. Williams, J. Brunskill, W. Muirhead, J. Daly, W. H. Edwardes, S. W. Higginbottom, M.P., J. Harrison Jones, J. B. Light, H. Miles, J. Roby, J. Pickthall, A. L. Rathbone, and J. Jacobs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bristol.—The Electrical Committee invite tenders for arc cables. Tenders by Nov. 14. See advertisement.

Midland Railway Company.—The Directors invite tenders for various annual stores. Tenders by Nov. 11. See advertisement.

Erith.—The Urban District Council invite tenders for the supply of meters (single and three phase) and cut-outs. Tenders by Nov. 12. See advertisement.

Salford.—The Electricity Committee invite tenders for the supply and delivery of 1,500 yards of lead-covered pilot wire. Tenders by Nov. 12. See advertisement.

Lowestoft.—The Corporation invite tenders for overhead line equipment, poles, etc., and underground feeder cables, etc. Tenders by Nov. 26. See advertisement.

Aberdeen.—The Tramway Committee invite tenders for one electrically-driven tower wagon for overhead equipment repairs. Tenders by Nov. 25. See advertisement.

Warrington.—The Electricity Committee invite tenders for a 12 months' supply of paper-insulated cables. Specification, etc., can be obtained on application to the Borough Electrical Engineer, Howley, Warrington.

Sunderland.—The Corporation invite tenders for one steam-driven three-phase generator, motor-generators, and static transformers, and high and low tension switchboards. Tenders by Nov. 28. See advertisement.

Eastbourne.—The Corporation invite tenders for motor-omnibuses to accommodate not less than 16 passengers. Particulars can be obtained from Mr. H. W. Fovargue, town clerk, Town Hall, Eastbourne. Tenders by Nov. 29.

Radcliffe.—The Urban District Council invite tenders for the supply and erection of steam-engines and dynamos, boilers, superheaters, and economisers, and jet condenser and feed pumps. Tenders by Nov. 14. See advertisement.

Southampton.—The Corporation invite tenders for the supply of car bodies and electrical equipment, and trucks for 12 motor carriages. Specification, etc., can be obtained from Mr. H. F. Street, borough electrical engineer. Tenders by Nov. 18.

Caen (Calvados, France).—The Prefect at this place requires tenders for the concession and working of a light railway between Trouville and Honfleur, a distance of about 10 miles, for goods and passenger traffic. Electric traction preferred. Tenders by Jan. 1, 1903.

Halifax.—The Tramways and Electricity Committee invite tenders for the supply and erection of a new 750-kw. steam dynamo complete, with condenser. Specifications, etc., can be obtained from Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders by Nov. 20.

Barrow-in-Furness.—The Corporation invite tenders for an electric motor and pump to be erected in a shed adjoining the corn mill, Devonshire Dock. Specifications, etc., may be obtained at the office of the Borough Engineer and Surveyor, Town Hall. Tenders by 12 noon on 12th inst.

Pontypridd.—The Urban District Council invite tenders for tramways permanent way, traveller, and storage battery. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on 22nd inst.

Manchester.—The Tramways Committee invite tenders for the supply of span-wire brackets for tramway poles. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by 1 p.m. on Nov. 15.

Pemberton (Lancs.).—The Urban District Council invite tenders for the reconstruction of the Ormskirk-road tramway, from Adams's Bridge, Newtown, to the terminus at Lamberhead Green. Specification, etc., may be seen at the offices of Messrs. Heaton, Ralph, and Heaton, Victoria-buildings, King-street, Wigan. Tenders by 19th inst.

La Valette.—The Municipality invite tenders for the establishment and working for 99 years of a tramway between La Valette and Senglea Cospiena, Vettoriosa and Casal Zebbug. Deposit £300. Tenders by Nov. 25 to Wm. Casolani, receiver-general and director of contracts, La Valette. Plans and particulars will be ready by March 1, 1903.

London, W.—The Hammersmith Borough Council invite propositions from manufacturers for the fitting up of a boiler at their electricity works to burn oil fuel. Full particulars, etc., can be obtained from Mr. G. G. Bell, engineer and manager, Electricity Works, 57, Fulham Palace-road, Hammersmith, W., and propositions to be sent in by 15th inst.

Newcastle-upon-Tyne.—The Tramways Committee invite tenders for the supply and erection complete of a new triple-expansion direct-coupled engine, of 3,000 h.p., at the power station, Newcastle-upon-Tyne. Specification, etc., may be obtained from the general manager and engineer, Mr. A. E. Le Rossignol, M.I.E.E., Manors Power Station, Newcastle-upon-Tyne. Tenders by Nov. 8.

Dumfries (Scotland).—The Town Council invite tenders from companies as follows—viz.: (1) for the burgh's electric light provisional order, and alternately (2) for light and traction combined; (3) for a supply of electricity to drive the cars, if the Council resolve to conduct the traction; (4) if the Council construct the works, tenders for a lease of each. Tenders by Dec. 1. See advertisement.

London.—The County Council invite tenders for the supply and delivery of one 50-ton electric power overhead travelling crane, with auxiliary two-ton hoist, and for the erection of the same in the Council's electricity generating station at Greenwich. Delivery and erection of this plant at Greenwich is required as soon as the buildings are ready to receive it, which, it is anticipated, will be within about 15 months. Specification, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by Nov. 18.

Durban (Natal).—Tenders are invited for the following in connection with the new municipal telephone system: a complete exchange equipment for an ultimate capacity of 7,200 lines, the present contract to make immediate provision for 2,520 lines. The equipment comprises all distribution and switchroom boards, power plant, and wiring. The contract also includes the work of erection in Durban and maintenance for three months; and underground dry-core air-space cables, comprising approximately 15,000ft. 200 pair, 12,000ft. 150 pair, 25,000ft. 100 pair, 6,000ft. 75 pair, 7,000ft. 50 pair, 12,000ft. 25 pair. Tenders by Dec. 5. See advertisement.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

London.—The County Council invite tenders for the roadwork and platelaying required for the reconstruction on the conduit system for electrical traction of the tramways (a) from the Elephant and Castle, *via* New and Old Kent Roads, to East Greenwich, and (b) from the Elephant and Castle, *via* Walworth-road, Camberwell Green, Church-street, Peckham-road, and Queen's-road, to New Cross-gate. The contractor will be required to use the track rails and fastenings, the slot rails and conductor tees, which will be furnished by the Council under another contract; but all the remaining metal work and other

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materials, and all the special work at junctions, crossings, cross-overs, car-shed entrances, etc., beyond the track and slot rails and the conductor tees, will be included in this contract. Specifications, etc., can be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Nov. 18.

RESULTS OF TENDERS.

Burnley.—Dick, Kerr, and Co., Limited, have sub-contracted with Belliss and Morcom, Limited, Birmingham, for a 360-h.p. engine.

Montrose.—The Guardians have accepted the offer of the Angus Electric Lighting and Power Company for the electric lighting of the infirmary.

Ladysmith.—Willans and Robinson, Limited, Rugby, have received an order for two 100-h.p. engines intended for coupling to dynamos for the electric lighting of the town.

King Williamstown. — The Electric Construction Company, Limited, have sub-contracted with Belliss and Morcom, Limited, Birmingham, for four of their engines.

South Wales.—Willans and Robinson, Limited, Rugby, have received an extension order from the South Wales Electrical Power Distribution Company for four 360-h.p. engines.

Rotherham.—The Town Council have accepted the following tenders: Babcock and Wilcox, extension pipework, £1,716; Kelvin and White, Glasgow, extension of switchboard, £843.

War Office.—Messrs. D. Bruce Peebles and Co., Edinburgh, have sublet the order for the engines to Messrs. Browett, Lindley, and Co., Patricroft, for driving the dynamos ordered by the War Office Ordnance Department for Waltham Abbey.

Ashford (Middlesex).—The Managers of the West London School District have received the following tenders in connection with the electric lighting of their schools at Ashford. (Contract No. 1) dynamos, boosters, storage battery, switchboard, etc.; (2) feeders and wiring. Mr. T. J. Digby, 32, Shaftesbury-avenue, W., consulting electrical engineer:

Contract No. 1.—Tenders strictly in accordance with the specification

	Scheme No. 1.	Scheme No. 2.
J. G. Statter and Co.	£1,380 10 0	£1,514 0 0
Electric Construction Company	802 10 0	1,002 10 0
Johnson and Phillips	785 0 0	868 0 0
C. Cooper and Co.	1,195 0 0	1,430 0 0
Tamplin and Makovski	885 0 0	1,160 0 0
F. J. Coleby and Co.	1,023 5 0	1,208 0 0
Donnison, Berlyn, and Sillem	900 0 0	1,170 0 0
National Electric Wiring Company	884 10 0	1,015 11 0
H. South	900 0 0	1,100 0 0
Robb and Mitchel	908 10 0	1,112 0 0
G. Weston and Co.	807 18 3	999 0 0
F. A. Glover and Co.	780 0 0	938 0 0
H. G. Woods and Co.	740 0 0	970 0 0
D Firth and Son	854 0 0	1,047 0 0
R. Dawson and Co., Stalybridge*	739 0 0	911 0 0
Blackburn, Starling, and Co.	765 10 0	941 0 0

Tenders subject to special conditions as per covering letters, or with alterations or additions to the specification.

D. Bruce Peebles and Co.	1,115 0 0	1,308 0 0
Crompton and Co.	836 0 0	1,073 0 0
T. Parker, Limited	802 0 0	978 0 0
P. R. Jackson and Co.	770 0 0	922 0 0
Holmes and McCallum	698 0 0	852 0 0
Mather and Platt	626 0 0	840 0 0
General Electric Company	745 3 0	787 5 0
Troup, Curtis, and Co.	1,868 18 6	2,032 17 6
Scott, Mountain, and Co.	995 0 0	1,199 0 0
Brush Electrical Engineering Company	887 0 0	1,067 0 0
Ward Bros.	921 11 0	1,139 3 0
Thames Electrical Engineering Company	679 14 0	856 5 5
Sunderland Forge, etc., Company	939 0 0	1,094 0 0
Lea and Warren	735 0 0	920 0 0
Nicholson and Co.	739 15 0	881 15 0

Contract No. 2.—Tenders strictly in accordance with the specification.

Manchester Electric Power and Lighting Company	£1,250 0 0
C. Mackrill and Sons	1,148 11 3
C. Cooper and Co.	1,045 0 0
Tamplin and Makovski	1,131 15 3
F. J. Coleby and Co.	1,175 10 0
Donnison, Berlyn, and Sillem	800 0 0
National Electric Wiring Company	895 18 0
H. South	800 0 0
Robb and Mitchel	772 18 0
G. Weston and Co.	830 0 0
F. A. Glover and Co.	876 0 0
H. G. Woods and Co.	790 0 0
D. Firth and Son	583 0 0
R. Dawson and Co.*	655 0 0
Blackburn, Starling, and Co.	648 0 0

Tenders subject to special condition as per covering letters, or with alterations or additions to the specification.

Troup, Curtis, and Co.	2,032 17 6
Scott, Mountain, and Co.	1,177 0 0
Brush Electrical Engineering Company	1,275 0 0
Ward Bros.	1,084 0 0
Thames Electrical Engineering Company	1,183 18 0
Sunderland Forge, etc., Company	705 0 0
Lea and Warren	600 0 0
Nicholson and Co.	596 10 0

* Accepted for Contract No. 1 (Scheme No. 2) and Contract No. 2.

Bury.—The Town Council have accepted the following tenders: Askham Bros. and Wilson, Sheffield, cast-steel points and crossings, etc.; Forest City Electric Company, Manchester, copper bonds.

Insulating Compound.—The National Telephone Company have again accepted the tender of Rowland Carr and Co., of 6 and 8, Lime-street-square, London, E.C., for the supply of insulating compound required by the company for a further six months in addition to this year's supply.

Leicester.—The Corporation have accepted the following tenders: North-Eastern Steel Company, Limited, Middlesbrough, for the supply of 4,800 tons of steel rails and 175 tons of fishplates, at £32,325. 19s.; Hadfield's Steel Foundry Company, Limited, Sheffield, for the manufacture, supply, and delivery of points, crossings, etc., and for the construction of special track work, at £13,041. 10s.

Transvaal.—Messrs. C. A. Parsons and Co. have, through their agents, Messrs. Reunert and Lenz, of Johannesburg, secured an order from G. A. Denny, Esq., of Johannesburg, for the construction of a turbine-driven air compressor for the George Goch mine. This machine will deliver 4,000 cubic feet of air per minute at a pressure of 80lb. per square inch, and will consist of a steam turbine driving an air turbine.

Sydney (N.S.W.).—Messrs. C. A. Parsons and Co., of Heaton Works, Newcastle-on-Tyne, have secured an order from the Agent-General of New South Wales for two sets of turbo pumping engines for the Sydney waterworks. Each set will consist of a compound steam turbine, with surface consenser and air pumps, direct coupled to three centrifugal pumps capable of arrangement either in series or parallel. No. 1 set will deliver either 1,040 gallons of water per minute against a head of 720ft., or 3,120 gallons per minute against a head of 240ft. No. 2 will deliver either 2,300 gallons per minute against a head of 240ft., or 6,900 gallons per minute against a head of 80ft. C. W. Darley, Esq., is the inspecting and consulting engineer to the New South Wales Government.

Hammersmith.—The Borough Council have received the following tenders for a special transformer to enable a supply to be given to the King's Theatre, Hammersmith-road:

Witting Bros.	£217 0 0
R. Jackson and Co.	220 0 0
Fuller Electrical Manufacturing Company	225 0 0
F. A. Glover and Co.	235 7 0
Bruce and Co.	243 0 0
General Electric Company	244 0 0
Electric Construction Company	251 0 0
Geipel and Lange	252 0 0
Geipel and Lange (alternative)	260 0 0
Johnson and Phillips	260 0 0
Lancashire Electric Motor Company	267 0 0
Lancashire Electric Motor Company (alternative)	309 0 0
Laurence, Scott, and Co.	255 0 0
E. Scott and Mountain	268 0 0

BUSINESS NOTES.

LIGHTING AND GENERAL.

Gloucester.—A main is to be laid in the Victoria-street district at a cost of £180.

Nuneaton.—The electric cables are to be extended to Attleborough Hall at a cost of £130.

Tin Electro Smelting Co.—The directors have declared an interim dividend of 7s. per share.

Holyhead.—The question of the electric light scheme is once more being raised at Holyhead.

Mangotsfield.—The Council are taking steps to procure an electric lighting provisional order.

Cuba.—The Cuban Congress has given the American National Telephone Company a monopoly for 50 years.

West Hartlepool.—The Postmaster-General has agreed to grant a telephone license within the West Hartlepool area.

Worthing.—Sanction has been received to the borrowing by the Corporation of £8,846 for electric lighting purposes.

Wath-upon-Dearne.—The Urban District Council's electric lighting provisional order has been extended for one year.

Bakewell.—The Cressbrook Cotton Mills have obtained permission to place electric light lamps along the highway in the vicinity of Cressbrook.

Deal.—The cost of the opposition to the Kent Electric Power Bill amounted to £326. 17s. 10d., of which the Council's proportion came to £3. 7s. 6d.

Oldham.—The salary of Mr. Newington, borough electrical engineer, has been increased from £275 to £400 per annum by annual increments of £25.

Kingswear.—The question of renewing negotiations with the electric light company at Dartmouth for the electric lighting of the parish is being revived.

Wakefield.—The Guardians have obtained sanction to the expenditure of a sum not exceeding £1,850 for the installation of electric light at the workhouse.

Wrexham.—The process of changing the system, after the laying of the new cables for the lighting of the town, was carried out between Saturday night last and Monday.

Lye and Wollescote.—The Board of Trade appear inclined to consider the expediency of delaying the revocation of the Council's electric lighting order for one year.

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Irvine.—The Town Council are about to promote a provisional order for the laying down of a municipal electric power generating station for the supplying of the town.

Bermondsey.—The Corporation intend to apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to extend their area of supply, etc.

Honley.—The last minutes of the Gas and Electric Lighting Committee contain recommendations that the manager prepare specifications and estimates for the electric lighting of the district.

Tadcaster.—The electricity company have given notice of their intention to apply to the Board of Trade to extend their undertaking to Bramham, Boston Spa, Clifford, and part of Thorparch.

Dunblane.—The Board of Trade have revoked the Dunblane Electric Lighting Order, 1900, as confirmed by the Electric Lighting Orders Confirmation (No. 8) Act, 1900, as from Oct. 24, 1902.

Smoking Concert.—Major R. S. Erskine, O.C.E.E.R.E.(V.), will preside at a smoking concert to be held at the headquarters of the corps, Regency-street, Westminster, on Nov. 14, at 7.45 p.m.

Personal.—We are informed that Mr. Eadley Stanley, of the British Prism Globe Electrical Company, who has been in California for some months for his health, has returned, and reopened his old offices at 57, Chancery-lane.

Cookham.—Holy Trinity Church is to be lighted by electricity at the beginning of November, in accordance with a faculty already obtained. The cost of the installation—£200—has been practically met by voluntary contributions.

Branksome.—The first of a course of 10 illustrated lectures on "Electricity, and its Practical Application," was given by the Rev. H. Gibbons, of Poole, on Friday evening, in the technical schools. There is every prospect of a successful class.

Drayton-in-Holes.—The Market Drayton Electric Light and Power Company, Limited, are applying for a provisional order to produce and supply electricity for motive power and all public and private purposes within the rural district and parish.

Pontypridd.—It appears that the route along which the South Wales Electric Power Company propose to lay down cables in the Council's area clashes with the Council's arrangements, and the matter has been referred to the Council's consulting engineer.

Hampstead.—Mains for the supply of electric current to private consumers are to be laid in portions of Briardale-gardens, Broadhurst-gardens, Perrin's-court, and West End-lane at an estimated cost of £391, and in Belsize-mews at an estimated cost of £32.

Stock Exchange.—Application has been made to the Stock Exchange Committee to allow the following to be quoted in the official list: Havana Electric Railway Company's 7,500,000dol. 5 per cent. consolidated mortgage 50-year gold bonds of 1,000dol. each.

Belfast.—The current supplied during the last quarter shows an increase of 60 per cent. on the previous quarter, and Messrs. Harland and Woolf, Limited, are now taking a very large supply for their important works, for which they pay the same rates as other consumers.

Maesteg.—The Urban District Council propose to apply to the Board of Trade for a provisional order, under the Electric Lighting Acts, 1882 and 1888, to authorise the Council to generate and supply electricity for all public and private purposes within the urban district of Maesteg.

Electrical Organ.—The grand electric orchestral organ was used for the first time in Dover Town Hall on Wednesday. There were two recitals, and both attracted crowded audiences. The instrument is the gift of Dr. E. F. Astley, J.P., an active member of the Dover Choral Union.

Kingston-on-Thames.—The Corporation, after discussing a letter from the Kingston Municipal Society as to the appointment of an expert, referred to in our last issue, decided to direct attention to the resolution adopted at the last meeting adjourning the consideration of the question for six months.

Gorton.—The Urban District Council have asked the Manchester Corporation to put into writing the best terms upon which they would be prepared to supply the Gorton district with electricity for lighting and power purposes, and to pay all expenses incurred by the Council in obtaining its electric lighting order.

Hull.—The Corporation Telephones Committee on Tuesday appointed a sub-committee to consider a proposal to adapt the Trippett Baths to the purposes of the proposed municipal telephone exchange. A motion to seek power to borrow £47,350 for the provision of municipal telephones was referred to the Finance Committee.

Batley.—The specification for cooling tower for the generating station has been approved, and instructions given for furnishing an office for the clerk of works at the generating station. Tenders for the accumulators for the generating plant have been handed to the engineers, with instructions to submit a summary thereof and report thereon.

Greenock Aluminium Works.—The works in Dillingburn-street, Greenock, belonging to the Scottish Aluminium, Limited, in liquidation, have been purchased at the upset price of £18,000 by Mr. Patten (of Messrs. Patten and Prentice, Greenock) for a client. The property includes rolling mills, foundry, goodwill, ground, buildings, plant, and machinery.

Sandal.—The Urban District Council have resolved that no application be made at present for a provisional lighting order; but that the Council reserve the right to withhold their consent to the order proposed by the Provincial Electric Supply Company, being of opinion that at some future date it may be advisable for the Council to apply for an order.

Leek.—At the last meeting of the Urban District Council the Electricity Committee recommended that specifications of the proposed works be obtained. The Local Government Board have sanctioned the loan, and the law clerk pointed out that the period mentioned in the order had already expired, and unless the Council went on with the work another company might step in.

Electricity Supply Company for Spain.—The first drawing of these debentures for redemption at par on Jan. 1, 1903, will take place at the registered office of the company, College-hill-chambers, College-hill, London, E.C., on Wednesday, Nov. 19, 1902, at 2.30 p.m. The registered holders of these debentures, or their legal personal representatives, are entitled to attend at this drawing.

Stepney.—The Borough Council have decided to borrow the following sums: street-lighting purposes, £1,037; electric lighting—installation in Whitechapel district (balance of £24,570), £4,570; purchase of electric light meters, £3,000; extension of electrical mains in Cobb-street and Short-street, £380; extension of electrical mains throughout the borough (part of £18,703), £10,000.

Accidents.—At the inquest recently held at Warrington respecting the death of a man employed in the erection of the electrical overhead equipment of the tramway, the jury returned a verdict of "Accidental death," adding a rider that better protection ought to be provided on the tower wagon to prevent workmen from falling over. Minor electric light failures are reported from Barnes and Peterborough.

Bridgend.—The South Wales Electrical Power Company have promised to supply the town with electric light by Christmas. The building of the generating station is practically complete. Holloway Bros., of London, are the contractors. The company have now served the statutory notices of their intention to lay further mains, and these will at once be laid, southward to Ewenny and northward to Tondu.

Inverness.—The Town Council having received an application from a London electric light company stating that they intended applying for parliamentary powers to introduce the electric light into Inverness, a proposal that the Council dispose of their provisional order to the company was withdrawn, pending negotiations with the Canal Commissioners as to the obtaining of water power from the Caledonian Canal.

Anglo-French Telephone.—A Reuter's telegram says that a Bill has just been submitted to the Chamber providing for the approval of the convention concluded at Paris on July 29 last between Great Britain and France for the regulation of telephonic communication between the two countries. Another Bill was also introduced for the approval of the commercial convention of Aug. 19 between France and England relative to Jamaica.

Mischief.—Seven little boys were charged with extinguishing public lamps at Crewe last Tuesday. The evidence showed that the boys climbed lamp-posts in the West-end and tried to attach a piece of rubber to the wires communicating with the cable, their object being, as they put it, to get an electric shock. Their action plunged half the town in darkness, extinguishing 300 lamps. Five were fined 2s. 6d. and costs, and the others were discharged.

German Electrical Progress.—According to a report of E. L. Harris, the United States Consular Agent at Eibenstock, Germany, mentioned in the *Financial Times*, there are 80 electrical engineering joint-stock companies in that country with a total capital of 125,000,000dol. In 1901 those companies exported to other countries 10,068 tons of electrical apparatus with a value of 3,831,690dol., over 1,000,000dol. being shipped to Russia. Three of the companies employ nearly 30,000 persons.

Heathman's Tower Wagons.—We are informed that improvements effected recently by Mr. Heathman in his telescopic tower wagons leads him to think he has eclipsed the American Trenton pattern for ease and efficiency with which the sliding section can be raised and lowered. He naturally, like a good many others, does not like to see so many American-made wagons brought over to this country, and therefore has given special attention towards improving upon the Trenton wagon.

Windmills.—In Germany electricity, among other curious results, has rehabilitated the discarded windmill. The *Hamburger Nachrichten* mentions several instances of the windmill revived to subserve the purposes of an electric power station. At Nershum a windmill supplies power for 36 incandescent lamps that light a large paint factory. Another in Schleswig-Holstein keeps up a steady current of 30 volts. At Düsseldorf a windmill winds up a heavy weight, of which the descent works a powerful dynamo.

Oswestry.—The electric light has recently been installed at St. Oswald's parish church at a cost of about £300. The electric light is also installed in the following churches of the town: Trinity Church, Zion Church, Primitive Methodist Church, and the English Wesleyan Church. We are informed that all these installations have been carried out by Mr. E. M. Evans, Manchester and Oswestry, who is just completing an installation of about 700 lights at the new St. Mary's Hospital, Oxford-street, Manchester.

Belfast.—The output of the Corporation's electric lighting department for the September quarter was 278,298 units, as against 171,053 in the corresponding quarter in 1901, 120,795 in 1900, and 83,120 in 1899. The output during the past quarter was equal to an increase of 62·6 per cent. over the corresponding quarter last year. The Guardians have decided to apply for sanction to a loan of £550 for the purpose of laying main electric cables from the town main to the new nurses' home and infirmary extension at the union workhouse.

Davos Platz.—There is a scheme in consideration to heat the town by means of electricity. It is proposed to erect an extensive electric plant at the confluence of two large mountain torrents, whose united waters will supply the necessary motive force. The first cost of installation is estimated at £340,000. The idea is to do away with all contamination of the air by the use of

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fuel. Electricity is already extensively used for lighting and motive power, and is adopted in many villas for cooking and heating, and in one of the largest bakeries.

St. Annes.—The electrical engineer's last report states that the works continue to make satisfactory progress, and applications for current still come in freely. Eleven applications for current have been sent in since his last report for the equivalent of 552 8-c.p. lamps. The figures are appended: units sold to date, 49,994, against 32,554 in 1901; equivalent to 8-c.p. lamps connected, 8,727, against 4,287; units sold per lamp connected, 5·72, against 7·6; units sold during September, 12,681, against 7,077; total number of consumers, 136, against 49; average approximate cost of production, 2·4d., against 3d.

Cheshire Power Scheme.—A syndicate has been formed for the promotion of a scheme of electrical supply covering Cheshire, North Staffordshire, and the part of the county of Derby not already covered under the Derby and Notts Power Act. The capital of the new company is fixed at a million and a half, and power will be taken to issue debentures to the extent of half a million more A Bill will, therefore, be promoted by the Cheshire and North Staffordshire Electric and Power Syndicate, the object aimed at being the manufacture of power gas and its distribution, and the use of such gas for the production and distribution of electricity.

Southwark.—The Electric Lighting Committee in their last report state that their efforts to obtain powers for the extension of the municipal electric lighting system over the whole of the borough had not yet been rewarded by success, and the undertaking had therefore been deprived of an opportunity for growth that would have tended to its greater financial success. They could congratulate themselves, however, that there was a steadily increasing demand for the municipal electric light in the Newington district, and those who had worked hardest in this branch of their labours were the most confident of its early financial success.

Wandsworth.—The Borough Council have decided to object to the draft order proposed by the London Electric Supply Corporation, Limited, for the supply of electric light in the borough. The company was prepared to introduce additional provisions providing for the charging of 5d. per unit for the first 4,000 used each year, with 4d. per unit for all over that number; basement lighting to be by separate meter, and charged at the rate of 3d. per unit for the first 4,000 in each year, and 2d. per unit for all taken in excess of that number, and current for motive power and similar purposes to be 3d. per unit under the maximum demand system for the first hour and a half, and 2d. per unit for current taken in excess.

Award.—Elmore's German and Austro-Hungarian Metal Company, Limited, have received the highest award for their exhibit at Düsseldorf Exhibition—viz., the gold medal. In addition to the exhibition gold medal, they have been awarded one of the great golden State medals. There is a certain difference between the medals given by the exhibition and those granted by the Government. The exhibition medals are given solely for results obtained at the exhibition: the State, on the other hand, also recognises achievements in former periods and other fields. The Government have granted 30 golden State medals. Besides these 90 silver and 170 bronze State medals are announced, the list of which has, however, not yet been finally decided upon.

Bootle.—Alderman Brewster, at a recent Council, in moving the proceedings of Electric Lighting Committee, called attention to a great deal of misrepresentation which had been made. When they started the undertaking in 1890 they had 1,289 gas lamps, giving a candle-power of 13,130, to light the whole borough. In 1902 they had 1,072 gas lamps, practically the same number as in 1890, 166 arc lamps and 306 incandescent electric lamps, giving a total candle-power of 190,550. He might mention, to show what a success the private lighting had been, that since 1891 the increase had been 85 per cent. He could substantially say that electricity was cheaper to him than gas, and those people who grumbled at a dear quarter never mentioned it when they had one which was very cheap.

Colne.—The amount of last year's working of the electricity works have just been issued. The works, however, only commenced to supply current in September The total quantity of electricity generated to March 31 was 12,387 Board of Trade units, of which 10,803 was sold by meter to private consumers, 504 was used on works, and 1,080 not accounted for. The total working expenses amounted to £560. 16s. 5d., and the income to £660. 10s. 3d., which left a balance of £99. 13s. 10d. to be carried to net revenue account, out of which to pay interest and sinking fund instalment, but as the interest on loans was £249. 0s. 5d., and the sinking fund instalment £538. 9s. 6d., together £787. 9s. 11d., there remained a deficit of £687. 16s. 1d.

Royal Aquarium.—The bioscope is still going it, and the present programme contains the naval review, the Shah's visit to Woolwich, review of Colonials by the Queen on the Horse Guards Parade, Lord Roberts reviewing the boys of the Duke of York's School, Lord Kitchener's arrival at Southampton, Lord Kitchener's reception in London, the procession of the King and Queen on Oct. 25, the procession to the abbey in August, etc. Incidentally we notice that before the place is to be given over to its new avocation there will be various shows of cage birds, pigeons, cats and dogs, chrysanthemums, also a table tennis tournament for the championship of All England. Doubtless many will pay a last visit to this popular place of amusement to revive old associations before it becomes a memory of the past.

Portsmouth.—Mr. Price, the manager of the electric light works, has presented a most favourable balance-sheet. While there was a deficiency of £867 last year, the department has now wiped off this deficit and show a profit, after the payment of all expenses, of £4,300. For the first few months of the beginning of the year they had still to pay a high price for coal, otherwise the profit would have been another £1,000. All other costs at the station were originally 1·24d. per unit. This has gone down to 1d., and now the cost is only a little over ¾d. per unit. This decidedly shows an economical management. The profit made on meters amounted to about £1,500 a year. In reply to some criticism, the Chairman said that had they been a company they could have paid 5 per cent. after putting aside their percentage for depreciation.

Tunbridge Wells.—At Wednesday's meeting of the Town Council a proposal was submitted for handing over to the National Telephone Company the municipal telephone undertaking in view of the latter's present unsatisfactory financial condition. It is proposed that the Telephone Company shall reimburse the Council the £25,000 spent upon it, and take over the whole of the liabilities and plant. The company will give an unlimited service for £6 a year, and pay to the Corporation 2s. 6d. per subscriber, who now pays £5. 17s. 6d. At the present moment there are about 1,800 users of the telephone, of which 1,000 belong to the National, as against 450 when the Corporation commenced its system 18 months ago. After discussion the proposal was deferred for a week. The majority of the Council are in favour of the proposition.

Swansea.—The work of erecting additional plant at the electric lighting station is proceeding rapidly, and it is hoped that before December an engine and dynamo will be fitted capable of supplying an extra service of 25,000 8-c.p. lamps. The electric light account shows a total capital expenditure up to March 31, 1902, of £60,230. 15s. 9d., composed of £52,046 borrowed from the Bank of England and since converted into stock, and £8,184. 15s. 9d. borrowed from the treasurer. The revenue account up to March 31, 1901, showed a loss of £642. 4s. 9d., after providing for sinking fund and interest. The revenue account for the present year shows a profit of £292. 14s. 11d., thus reducing the above debit balance to £349. 9s. 10d., but no provision has been made this year for sinking fund. The Telephones Committee have asked Mr. R. Martin to interview the Local Government Board with a view to expedite the report of the local enquiry and the proposed loan.

London Fire Brigade.—The Fire Brigade Committee of the London County Council in their last report state that for rather more than two years Marconi's Wireless Telegraph and Signal Company had provided and maintained, in consideration of an annual payment of £50, the necessary electric instruments to enable communication by means of wireless telegraphy to be maintained between the street station at Streatham-green and the temporary sub-station in Mitcham-lane, and it has been arranged that the installation shall be retained until the completion of the permanent Streatham station next September. As the installation referred to has resulted in the saving of time in the turning out of appliances at the temporary sub-station, the committee share the chief officer's opinion that the apparatus should be retained until the permanent station is ready. The Council will be asked to pay £75 a year for the continuance of the convenience in view of the cost of upkeep, which is greater than was anticipated.

Hammersmith.—Some time ago the London County Council enquired from the Borough Council whether they were willing to supply current on the "penny-in-the-slot" system to various quarters at the fire stations. The Council advertised for tenders, and Mr. Bell on Wednesday reported that in his opinion there is not a satisfactory meter on the prepaid system in the market, and it was recommended that the London County Council be informed that the Borough Council is not in a position to supply meters, but would be prepared to supply the County Council in bulk if it would be prepared to supply the meters and distribute the current to its employés. Manufacturers of meters will, no doubt, be highly pleased with this report unless they happen to be of a somewhat different opinion with regard to their manufactures. The Council are willing to put up electric lamps on Brook Green and Shepherd's Bush Green providing the London County Council will share the cost of them.

Three-Phase Electrical Equipment of Mines.—The United National Colliery Company, of Wattstown, have placed an order with Messrs. D. Bruce Peebles and Co. for an electric pumping and hauling equipment at their pit. The installation will comprise one 100-h.p. three-throw direct-driven pump for raising water from the pit bottom to the surface and one 150-h.p. hauling gear capable of drawing 40 loaded trams from the face of the workings to the pit bottom, a distance of about 2,000 yards. The motors will be of their three-phase type, 2,000 volts, 25 periods. The haulage is main and tail, and the hauling motors will accordingly be fitted with their patent starting and reversing switch, which is specially designed for this class of work. The electric power is to be taken from the mains of the South Wales Electrical Power Distribution Company, who are now commencing to run their Rhondda mains from Pontypridd to Wattstown in the one valley and to Llwynpia in the other valley. Messrs. Bruce Peebles and Co. are providing cables down to the pit bottom large enough to carry 1,000 h.p., as the colliery company intend later on to convert the whole of their plant to electric driving.

Croydon.—Application is to be made for sanction to borrow £45,406, in consequence of the adoption of the following estimate for extension requirements, which has been presented by the borough electrical engineer: Plant—two water-tube boilers with pipework and valves, £3,500; mechanical stokers, £850; buildings and foundations, £400; pipe covering and connecting, £250; 600-kw. engine and dynamo set, £7,000; pipework and valves, £400; foundations, £400; switchboard cables, shunts, etc., £300; cooling and storage pond, air pumps, and pipework, £1,200; surface condenser and circulating pumps, £5,181; buildings, foundations, and trench work, £1,200; water-purifying plant, £440; Ados flue-gas recorder, £40; atmospheric exhaust valve, £80; total on plant, £21,241. Mains—direct-current mains (laid), £1,810; direct-current mains (extensions), £2,000; additional consumers, say, at £10 per consumer, £8,000; sundry small extensions, transformers, etc., £8,000; total on mains,

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£19,810. Screen round cooling pond, £250. Summary—plant, £21,241, add 10 per cent. for contingencies, £23,365; mains, £19,810, add 10 per cent. for contingencies, £21,791; screen, £250; total, £45,406.

Bradford.—The recent builders' strike interfered greatly with the erection of the new electricity station in Valley-parade, and delayed the starting of the two new engines, one of which was started on the 30th ult. by Mr. J. B. Moorhouse, chairman of the Electricity Committee. The engine, made by Messrs. Cole, Marchant, and Morley, of Bradford, has 2,000 h.p., and is of the slow-speed type, of the inverted vertical form, compound and condensing, having two cranks. It is arranged for driving direct a 1,000-kw. multipolar British Westinghouse dynamo, at 85 revolutions per minute, with a pressure of 165lb. per square inch at the engine stop valve. To start the engine, a small barring engine, made by Messrs. Thornton and Crebbin, of Bradford, is provided. The engine has an independent condensing plant, consisting of surface condenser, two air-pumps, and two return water-pumps. The cost of the engine and dynamo is about £13,000. The Electricity Committee's last report states that the total number of consumers is 1,560, being an increase of 155, equal to 10 per cent. Tramway traction is a big draw upon the generating station. A year ago a maximum of 1,400 h.p. was sufficient, but at present a maximum of 2,800 h p. is required. The output of units per week is now 114,000, as against 42,000 last year.

Brighton.—Application is to be made for sanction to the borrowing of £375 for the illumination of the entrance of the Aquarium. The Council have confirmed the terms provisionally arranged at the interview between Mr. Simpson, Mr. Wright, and Mr. Talbot with regard to the electricity works at Southwick, which were as follows: (1) the contract price of £15,978 to be increased by a further sum of £750; (2) the Corporation to pay them by Oct. 31 the balance of 80 per cent. of the value of the steelwork already delivered and lying on the ground at Southwick; (3) the period for completion of the work to be six months from this date. The Corporation are making arrangements for and would use their best endeavours to secure the clearance of the north end of the site with a view to their having the unrestricted use of the same within a month. Messrs. Redpath, Brown, and Co. have formally accepted the terms. It has also been resolved, as to the proposal to supply electricity outside the borough, that the resolution already approved by the Council, defining the limits of supply, should be amended by including therein the parish of Preston Rural. The borough surveyor is to report upon the improvement of the lighting of various streets, and incandescent electric lamps are to be substituted for the gas burners in the lamps in the path leading to St. Nicholas Church from North-street.

Newark.—In connection with the electric light controversy the *Newark Herald* publishes an interesting balance-sheet of the first year's working of the electric installation at Messrs. Ransome and Co.'s Stanley Works and some notes by Mr. E. Overell, their electrician. The Board of Trade units generated were 171,175. The fuel consumed consisted of 238 tons 15cwt. 1qr. of coal, at 30s. 4d. per ton, and 18 tons of coke, at 11s. 6d. per ton (£372. 9s. 6d.). Other expenses were: 290 gallons of oil, £29; 2½cwt. of waste, £3. 3s. 9d.; water and sundries, £17. 16s. 3d. (£50).; wages of stoker, driver, and electrician, £287. 16s. 2½d.; repairs, £50; depreciation (5 per cent. on £3,000), £150; capital (5 per cent. on plant and land estimated value £3,500), £175—total, £1,085. 5s. 8½d. The total cost, analysed, is as follows: cost of fuel per Board of Trade unit, ·52d.; cost of oil, etc., ·07d.; working expenses, ·38d.; cost of repairs, ·07d.; depreciation, ·21d.; capital, ·24d.; being 1·49d. per Board of Trade unit, or slightly under 1½d. per unit. The draft agreement with the Notts and Derby Electric Power Company for the supply of power to the Corporation has been agreed upon in committee. A special meeting is to be held on Friday to consider the agreement, and decide whether the Corporation would agree to delegate their powers to the company, or proceed with the scheme which Mr. Vesey Brown, their engineer, had drawn up for the lighting of the borough.

Penrith.—Messrs. Quin and Speight, Westminster, in their report upon the electric lighting scheme, mentioned in our last issue, give a number of details for a water-power scheme, £14,810, with £1,888 annual expenses of working: and for a steam-power scheme, £10,110, and £2,361 working expenses per annum. In order to adapt Southwaite Green mill it will be necessary to make considerable alterations to the premises, and widen the race from 6ft. to 26ft. After discussing the relative merits of overhead wires and underground cables they recommend the latter. Messrs. Quin and Speight add: "Taking all things into consideration, there is only one system of supply which can economically be adopted for Penrith, and that is continuous current at 460 volts pressure on the three-wire system. All our calculations are based upon this, and with a water-power scheme, continuous current, in order to ensure reliability, must be adopted. In this summary we are including only for the water-power scheme, as the figures given render possible only one conclusion—viz., that it is advisable for you to use the power of the River Eamont for the generation of your electricity supply. The amount previously given for the installation, including the generating station and sub-station, was £13,020; to which has to be added the cost of the distributing and feeder systems, £1,700; services, etc., £1,000; engineers' commission, 5 per cent., £578; contingencies, 10 per cent., £1,629—making a total of £17,927.

Ealing.—The business manager of the electric lighting undertaking (Mr. Albert Lewis) in his last report states that the September quarter's readings showed that 89,348 units had been consumed at an average price of 5·58d. per unit; this represented an increase in the output over the corresponding quarter of last year of over 31 per cent., the total revenue for the quarter, inclusive of meter rent, being £2,247. 18s. 10d. The sales for the September quarters of the last three years were as follows: 1900, 37,741 units, producing £1,160. 2s. 11d.; 1901, 67,937 units, producing £1,746. 12s. 9d.; 1902, 89,348 units, producing £2,247. 18s. 10d. The business of the undertaking continued to make excellent progress. The Highways Committee have reported that the question of the lights being out on Spring Bridge and Haven Green on Saturday and Sunday evenings was discussed, and the borough surveyor reported that the lamps in question were lighted at the usual time on Saturday night. An hour after lighting they went out, but one of the lighters, who was passing, lighted them again from the switch. Subsequently the switch "shorted" and burnt out, the circuit being out in consequence for the rest of the night. As the switch could not be repaired in time for the lighting on Sunday evening, a temporary connection with the mains was made, and the lamps were lighted at about eight o'clock on Sunday evening. This temporary connection was again made on Monday evening, but the switch had now been repaired and all was in order.

Croydon Fire.—Shortly after 8.15 p.m. on Friday last a fire was discovered in the testroom of the Borough Council's electricity works, which is situated close to the switchboard of the alternating-current system. This was extinguished by means of buckets of sand, but a few minutes afterwards the cables under the switchboard were found all ablaze. An attempt was made to extinguish this by sand also, but the inflammable nature of the insulation caused the fire to develop so quickly that the machinery had to be shut down, and the water hose played on this end of the engine-room. Although every cable in connection with this supply was ruined, new cables supplied by Messrs. Callender's were run and coupled up, and the supply resumed in about 24 hours after the fire took place. It had been anticipated that several days would elapse before this could be done. We are informed that it was due to the splendid manner in which every man on the staff worked that the supply was resumed so quickly. It had already been decided to overhaul this cable chamber next spring, it being found impossible to do so before. Mr. Scott, who himself only took over the management of these works in May last, with a staff of more than half new men, has already carried out the change over to direct current of the centre of the town, and this, together with the traction supply, was not interfered with. The fire was got under by the time the brigade arrived by the works staff, who did extremely well under the trying circumstances, the whole place being filled with dense fumes of burning rubber and bitumen. Up to the present the cause of the fire has not been discovered.

Islington.—New electric lighting mains are to be laid at a cost of £453. An application from the Postmaster-General, under the powers contained in the Telegraph Acts, 1863 to 1892, and in pursuance of the Telegraph (Telephonic Communication, etc.) Act of 1899, for permission to take up a number of footways and carriageways of the streets in the borough for the purpose of laying 3in. cast-iron pipes and also for the provision of jointing chambers at intervals of 150 yards or thereabouts to give access to the pipes, has been postponed pending the result of the deputation which is to wait upon him in conection with the matter. Should the result prove unsatisfactory, or should the Postmaster-General insist upon his rights, the Electric Lighting Committee propose to consent, subject to the conditions for the protection of the Council's interests being agreed to by the Postmaster-General, as follows: (1) That the conduits be laid only along those portions of the footways adjoining the houses, and in vertical sets of three (one under the other), instead of side by side as proposed; (2) that the ducts be laid so that no part shall be less than 3ft. from the surface of the carriageway or 2ft. below the surface of the footway, and that the iron pipes be laid so that no part shall be less than 2ft. below the surface of the carriageway or less than 14in. below the surface of the footway; (3) that there shall be a depth of not less than 6in. between the top of the roof of the manhole or the walls thereof, and the surface where these are constructed under the footway paving, and a depth of not less than 1ft. where they are constructed under the carriageway; (4) that no manhole chamber, joint pit, or any duct or other work be placed in any position where it will interfere with any drain, sewer, gully pit, chamber, or other property of the Council; (5) that the expenses incurred by the Council in superintending the work be paid by the Post Office authorities.

London County Council.—The Establishment Committee have presented a report upon telephones at the Council's central offices, making the following recommendations: "(*a*) That the resolutions of the Council, dated July 29, 1902, authorising an expenditure of £210 in fitting-up a call-room off the hall and adapting a building as an office exchange in the yard, and sanctioning the employment of a telephone attendant at the wages not exceeding 25s. a week, be rescinded. (*b*) That an expenditure not exceeding £300 be authorised for providing cabinets and screens, and for other work connected with the removal of the switchboard, etc., and fitting-up the entrance hall and the room adjoining it. (*c*) That the offer, dated Oct. 23, 1902, of the National Telephone Company, amounting to £327. 15s., for providing, *inter alia*, five additional 'exchange' lines, a new switchboard, and connecting the existing 42 lines, and for providing 116 additional telephones and lines, and operating the whole of the lines during certain hours daily to the satisfaction of the Council's engineer, and subject to a proportionate reduction in the amount of the offer until the full number of the lines required are ordered by the Council and are provided and working, be accepted; that the arrangement be for five years; that the solicitor be instructed to prepare the necessary agreement; and that the seal of the Council be affixed to such agreement when ready. (*d*) That authority be given for the employment of a boy messenger at wages not exceeding 14s. a week." Notices under Electric Lighting Acts and Orders have been agreed to as follows: the Metropolitan Electric Supply Company, of intention to lay high-tension mains along a portion of Elgin-avenue and along Norfolk-mews; the St. Pancras Borough Council, to lay mains along Berkeley-road, and along Redhill-street and a portion of Cumberland-market. A notice was also served under an order granted to a local authority from the Battersea Borough Council of intention to lay mains along Spencer-road.

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TRACTION.

Newport.—The work of relaying the Newport tramways for electric traction was commenced this week.

Middlesex.—In connection with the County Council's light railway scheme the Great North-road is to be widened where necessary to 40ft.

Worthing.—The Corporation purpose proceeding by parliamentary Bill with the application for powers to construct tramways in the town.

Cheshire.—A Bill will be introduced next session to construct an electric tramway from Chester to Birkenhead, a distance of about 13 miles.

Halifax.—The tramway from Stump Cross to Hipperholme, which has been constructed by the Corporation, is to be officially opened to-day.

Burnley.—The tramways report for the 13 months just ended shows that the receipts have amounted to £18,601 and expenditure to £13,901.

Leeds.—It is proposed to increase the salary of Mr. Arnold G. Livesay, assistant tramway electrical engineer, of Leeds, from £200 to £250 per annum.

Bridlington.—At their last meeting the Town Council decided to take steps to obtain powers to construct and work an electric tramway between the quay and the old town.

Sunderland.—The Tramways Committee are in communication with the Postmaster-General with a view of introducing the system of carrying letter-boxes on the tramcars.

Beckenham.—The Urban District Council agreed at their last meeting to promote a Bill in the next session of Parliament for the construction of tramways in the district.

Light Railways in the Peak District.—The Chapel-en-le-Frith Rural District Council have unanimously agreed to support the scheme for a light railway from Buxton to Chinley.

Crewe.—The Town Council have received several proposals for the laying down of light railways in the borough. Full particulars of the schemes, however, have yet to be submitted.

Egham.—It is the intention of the London United Tramways Company to apply in the coming session of Parliament for the extension of their system through Staines and Egham.

Chester.—Mr. A. A. G. Malet has held an enquiry into an application by the Town Council to borrow £5,924 for purposes connected with the supply of electric energy for the tramways.

Kirkcaldy.—A consignment of five of the Corporation tramcars has arrived. The builders are George Milne and Co. The tramways are expected to be opened in about three months' time.

Bournemouth.—An amicable settlement of the tramway dispute between the Bournemouth Corporation and the British Electric Traction Company is reported to be under consideration.

Levenshulme.—The District Council are obtaining the money required for the reconstruction of the tramways in the district from the Manchester Corporation at £3. 7s. 6d. per cent. per annum.

Macclesfield.—The support of the Town Council is solicited to the scheme for the construction of a light railway from the Cat and Fiddle to join the Macclesfield proposed tramways in Buxton-road.

Steyning West.—The Rural District Council have signed the agreement with the Brighton and Shoreham Tramways Company consenting to their constructing a tramway through Kingston-by-Sea and Lancing.

Yarmouth.—On Wednesday the Corporation held a special meeting to consider the proposed tramway extensions, at a total cost of £56,200. After discussion the meeting was adjourned till next Tuesday.

Glamorgan.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of light railways from Morriston to Pontardawe, in the county of Glamorgan.

East Preston.—The Rural District Council have passed a resolution declining at present to support the scheme of the British Electric Traction Company for an electric tramway along the coast from Worthing to Littlehampton.

Berlin.—A report reaches us to the effect that it is proposed to construct an underground railway in Berlin at a cost of £2,811,150. It will be a municipal undertaking, and four years are reckoned as the time in which it can be completed.

Manchester.—A deputation representing the local branches of the Tramways and Vehicle Workers' Union has waited upon the Tramways Committee with reference to the agitation for a reduction of working hours and an increase in wages.

Harrogate.—A special meeting of the Town Council was held yesterday week, when the proposal to include clauses in the Bill to be promoted next session for the construction of tramways in the borough was rejected. The motor-omnibus clause met with a similar fate.

Batley.—Terms are being arranged between the Corporation and the British Electric Traction Company for the supply of current to the company from the municipal power station. A draft agreement has been drawn up for the lease of the tramways to the company.

Darlington.—Prof Kennedy has delivered plans of the proposed tramways. It is hoped that the tenders will be let and the work completed within about 12 months. The Tramway Committee are considering the question of having double-decked or combination cars.

Aston.—Sir F. Bramwell has held an arbitration to determine the price to be paid by the Aston Manor Urban District Council to the Birmingham and Aston Tramways Company for their undertaking, partly under Act of Parliament and partly by agreement. The company's claim is for £80,000.

Stroud.—The light railway scheme for Stroud Valley is proceeding. The levels of various streets in the town of Stroud and of roads in the surrounding district, including Chalford, Nailsworth, and Stonehouse, have been taken by surveyors, and plans and sections are occupying the attention of a Stroud firm of architects.

London County Council.—The Council on Tuesday authorised an expenditure not exceeding £15 a week, until March 31 next, for the employment of clerks of works to supervise the erection of buildings in connection with the reconstruction for electrical traction of portions of the Council's southern system of tramways.

Bury.—In the provisional order for the Heywood-street to Market-street section of the tramways it is proposed to ask for powers to construct a line of tramways along Spring-street from Cecil-street to Frederick-street, and along Frederick-street to Market-street, for submission as an alternative scheme to Cecil-street.

Irthlingborough.—The electric traction company propose a deviation of the tramway route in this district so as to cross a proposed widening of the bridge. The matter has been brought to the notice of the Urban District Council, who suggest that the company should make the necessary alterations at their own expense.

Birkdale.—On Tuesday afternoon Major Drewitt, R.E., Board of Trade inspector, visited Birkdale and inspected the electric tramway between the corner of Aughton and York roads and the Crown Hotel. The inspection having been completed, and Major Drewitt having given his approval, the cars were at once started for public service.

Warrington.—The Wilderspool section of the Corporation tramways has been sanctioned by the Board of Trade. Messrs. Preece and Cardew are now preparing plans and estimates for the construction of the extension to Stockton Heath, the probable cost of which is £7,000. Trial trips over the Longford and Manchester-road routes have proved quite successful.

Liverpool.—The Lord Mayor of Liverpool on Tuesday evening entertained at dinner 700 inspectors, drivers, and conductors of the Corporation tramways. This was the second dinner of the men, the first 700 having been entertained on Monday evening. The men seemed to thoroughly enjoy themselves, both at the dinner and at the subsequent entertainment.

Pontypridd.—At a special meeting of the Urban District Council on Tuesday plenary powers were given to the chairman of the Tramways Committee to purchase property in Rhondda-road to carry out the tramway scheme of the Council This will enable the engineer to proceed with his plans without widening or in any way interfering with the Taff Vale Railway Bridge.

Alexandra Park.—The Light Railway Commissioners held an enquiry at the Alexandra Palace on Friday into the matter of the proposed further widening of roads in connection with the light railway scheme. The Chairman said that the Commissioners had come to the conclusion that a solid case had been made out for a 50ft. road, and therefore the order would stand.

Hull.—A special committee of the Corporation is to be appointed to consider and report "as to the allocation of the proportion of cost to be borne by the tramway undertaking of the sections of city improvement." Hitherto the trams have not been debited with any portion of the cost of street improvements which have been made in the interest of the tramway service.

Brighton.—A proposal to advertise for tenders for constructing tramways in London-road and Old-steine was referred to the Tramways Committee at the last meeting of the Town Council. The Tramways Committee recommend that application be made to Parliament in the proposed Bill for power for the Corporation to run motor or other omnibuses in connection with the tramway system.

North-Eastern Railway.—It is now stated that the directors of this company have decided to experiment with petrol motors for the propulsion of light and frequent trains on their local services. It is thought possible that these may afford a solution of the problem of meeting the competition of the electric trams, and meanwhile the question of electrifying the Tyneside lines will be postponed.

Stockport.—With regard to the electric tramways in the borough it was stated at the last Town Council meeting that the committee considered they were working satisfactorily. Since the accounts were made up in March the average receipts had more than doubled, and it was believed that when the accounts were submitted next year the Council would have no cause to be dissatisfied with the results.

Sheffield.—The extension of the Heeley section of tramways to Woodbank-crescent was opened on Saturday. The new section is three-quarters of a mile in length, half a mile being double track, and the remainder single with passing loops. The total rise from Heeley is 130ft., and the steepest gradient 1 in 16. This extension is a portion of the scheme for running cars right through to Woodseats.

Nottingham.—The first trial trip on the Wilford-road section of the Corporation electric tramways was made last week, and proved entirely satisfactory. The date of the Board of Trade inspection has not yet been fixed, but the opening of the line for traffic is not likely to be much longer delayed. When it does take place the whole of the original scheme of the Tramways Committee will have been completed.

South Shields.—The British Electric Traction Company have given notice of their intention to again apply in the ensuing session of Parliament for powers to construct an electric tramway between South Shields and Sunderland. A town's meeting held on Tuesday night approved the proposal of the Corporation to promote a Tramways Bill in the next session. The powers asked are for a little over £200,000.

Lewisham.—At the last meeting of the Borough Council a long discussion took place on the tramway question, a resolution having

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been adopted a short time against the introduction of tramways. A motion to rescind this resolution was eventually lost, as there was not a two-thirds majority in favour of it. The Council are holding out against a contribution towards the cost of the street widenings involved in the London County Council's scheme.

Croydon.—Purley car-shed is to be extended at an estimated cost of £3,500 in order to provide accommodation for an additional 15 cars. An extension of the tramway system is also proposed, and parliamentary powers will be sought in the next session authorising the following extensions—viz.: (1) from Morland-road to Wood-side, and continuing along Portland-road to High-street, South Norwood; (2) from the Thornton Heath terminus to the Gloucester, Whitehorse-road.

Prestwich.—Good progress has been made in connection with the construction of electric tramways at Prestwich. Lines through Prestwich village have already been laid, and the men engaged at the Salford boundary end of the undertaking have got the road up ready for laying the lines along Bury New-road opposite to the entrance to Prestwich Park. It is believed that in about a month's time the trams will be running from the Salford boundary into Prestwich village.

Bilston.—On Thursday last week Colonel von Tromp made an inspection of the new electric tramway laid down by the British Electric Traction Company from Willenhall through Bilston to Bradley, and also from Willenhall to the boundary of Wolverhampton, and afterwards from Willenhall to Darlaston. There was a large attendance of officials of public bodies in the cars, which travelled smoothly, and the trial is said to have given every satisfaction.

Dewsbury.—In reply to a resolution passed by the Dewsbury Tradesmen's Association respecting the necessity of a tramway between Dewsbury and Ossett, a letter has been received from the British Electric Traction Company stating that the company were unable to take any steps in this matter owing to the fact that the Ossett Corporation had agreed to support the application for powers to construct this line by the promoters of the Wakefield and district light railway.

Paddington.—At the Borough Council meeting on Tuesday the Special Tramways Committee recommended the Council to oppose the London County Council's projects (1) for constructing an electric tramway between Harrow-road and Edgware-road, *via* Sutherland-avenue, and (2) a similar tramway from Shepherd's Bush, *via* Richmond-road, Holland-park-avenue, High-street, Notting Hill, and Bayswater-road, to a point near Marble Arch. Both recommendations were adopted.

Exeter.—A special meeting of the City Council is convened for this evening to receive a report from the Electric Traction Committee, who, as the result of advice from a London expert, will recommend to the Council a series of alterations in the routes for the proposed electric trams previously decided upon. Some sections it will be proposed to abandon, and new ones will be introduced. The length of the tramways will be increased if the committee's recommendations, including an extension to Heavitree, be adopted

Hammersmith.—An interesting sidelight on the fiasco before the House of Commons Committee last month in connection with the Morgan and London United Tube Bills is the action which the Hammersmith Borough Council are recommended to take by their Law and Parliamentary Committee. The Council have been put to considerable expense in connection with the Bills, and they now propose to make a claim against the "promoters of the London Electric Railways" to recover payment of the costs incurred by them.

Longton.—Attention being called at the last Town Council meeting to an incident in connection with the tramways in High-street, when the brakes on the cars failed to act effectively, it was decided to call the attention of the Potteries Electric Traction Company to the matter, and request them to give instructions that the brakes of all the cars shall be thoroughly examined before the cars are sent out. It was also decided to again call the attention of the company to their promise to provide suitable lifeguards on the cars used on the lines in the borough.

Belfast.—The Belfast Street Tramways Company have decided to exercise the options reserved to them of purchasing the tramways of the Sydenham District Belfast Tramways Company and the Belfast and Ligoniel Tramways Company, and have asked the Belfast Corporation whether they will give their consent to the company converting to electric traction the lines of the Sydenham and Ligoniel Companies, and the lines in continuation thereof respectively, belonging to the Belfast Street Tramways Company, to the centre of the city.

Cardiff.—The Tramways Committee are in dispute with the old tramways company over a matter of a thousand pounds. Negotiations for the purchase by the Corporation of the old tramcar depôts have been dragging on for some months now, but without result. The company have reduced their price of £25,000 to £23,000, but the Tramways Committee have determined not to give more than £22,000. Unless one of the parties gives way the dispute will have to go to arbitration. The tramway terminating on the eastern side of the Clarence Bridge is not to be extended as originally proposed.

Manchester-to-Liverpool Monorail.—At a meeting of the promoters of the Manchester and Liverpool Electric Express Railway last week it was decided that a portion of the line shall be constructed immediately, seven miles in length, in the neighbourhood of Warrington. The Board of Trade, it is said, hesitate to sanction the carrying out of the complete plans without something more than theory to go upon. When this seven miles has been built, and the practicability of the monorail demonstrated, it may be expected that the construction of the remainder of the line will be undertaken at once.

Additional Traffic Returns.—Anglo-Argentine, £129 increase; Barcelona Ensanche y Gracia, £28 increase; Barcelona, £260 increase; Brisbane, £158 increase (month of September, £9,757, increase £994); Buenos Ayres and Belgrano Electric, £287 increase (month of October, £13,053, increase £183); Calcutta, £502 increase; Cape Town (month of August), receipts £15,450, expenditure £7,801; Isle of Thanet Electric, £4 increase; Mexico Electric (month of July), receipts £20,300, expenditure £12,600; Perth Electric, £272 increase; Port Elizabeth (month of August), receipts £4,014, expenditure £1,979.

Cheshunt Light Railway.—The order for the above railway has now been finally settled with the Board of Trade, and only waits confirmation. Application, however, has been made to the Board to delay its confirmation until the Waltham Cross and Enfield light railway order, promoted by the Middlesex County Council, is also ready for confirmation. The railways authorised by these orders will be in connection the one with the other, and it is, therefore, thought desirable that the times limited by the orders for the carrying out of the work should run together, and their construction be proceeded with concurrently.

Volk's Electric Railway.—The Brighton Corporation have granted permission to Magnus Volk, Limited, to extend their electric railway beyond the eastern boundary of the borough so as to make a connection with the intended station of the Brighton and Rottingdean Seashore Railway, subject to their constructing the extended portion of the line in accordance with plans and sections to be appoved by the committee, such extended portion of the line not to be the subject of compensation in the event of the Corporation taking over the remainder of the railway within the borough under the terms of their agreement with the lessees.

Walthamstow.—Sir Herbert Jekyll held an enquiry on Tuesday at the Board of Trade into the order promoted by the Walthamstow Urban District Council for the construction of light railways: (1) from Tottenham to Woodford; (2) from Chingford to Leyton; and (3) from Higham-hill to the Leyton boundary. Mr. Hutchinson's application to extend the borrowing powers from 40 to 50 years on the ground of the high rates, 9s. 7d. in the £, was refused, as was also a suggestion of the Hale End District Association of Ratepayers that the Council should be prohibited from acting as their own contractors, owing to their alleged extravagance and inexperience.

Finchley.—At last night's meeting of the Urban District Council the surveyor presented a report with reference to the construction of railways Nos. 3 and 4 of the Middlesex Light Railways Order, 1901, and on the street widenings involved in the scheme. The lines in question extend aleng the Great North-road from Highgate Archway to the junction of Totteridge-lane with the Great North-road. There is also a short branch line along the East End-road to a proposed generating station on a site adjacent to the Great Northern Railway. The report set out the provisions under which the County Council are required to carry out the construction of the lines, and dealt with the street widenings proposed. As to paving, the surveyor favoured the use of hardwood in preference to softwood blocks, as had been suggested.

Glasgow.—In giving judgment in favour of a cab proprietrix at Glasgow for £15 in respect of damage to a cab which was run into by an electric car in January last, Sheriff Strachan made the following cogent remarks: "The defenders seem to be under the impression that they have got a prior and preferable right to the use of the streets, and that it is the duty of the public to stand still whenever a car is seen approaching and allow it to rush along under the penalty of being knocked down or thrown out of the way. That, of course, was a most erroneous and dangerous assumption. While the public must use all reasonable care and caution so as to avoid coming into contact with the cars, the drivers of these vehicles were bound to observe at least three obvious precautions: (1) they must proceed at a safe and moderate rate of speed; (2) they must have a thorough knowledge of the mechanism of the cars, and have them entirely under their control; (3) they must keep a proper lookout, and be prepared to stop or reduce their speed when there was any danger of their coming in contact with a person or vehicle. These precautions were binding on drivers of all vehicles, and it was especially necessary that they should be observed by the drivers of electric cars, which were the most destructive of vehicles when not properly handled or controlled."

Tramway Municipalisation at Birmingham.—Mr. Arthur Chamberlain has written a further letter to the Birmingham and District Trades and Property Association, in which he sets forth reasons why the citizens should not approve the Bill now being promoted by the Birmingham City Council empowering them to municipalise the tramways undertaking. To quote from the letter: "In the game of negotiation a card in hand is quite as valuable as, sometimes more valuable than, a card on the table. The power to promote a Tramway Bill is a card that the Council has in its hand, but it is neither necessary nor desirable to play it until they can show us that it is impossible to lease the concession on satisfactory terms. As a matter of fact, without the powers now sought the Council entered into negotiations with the late owners of the tramways, and could have brought these to a successful issue if they had realised from the first what was the proper method of electrification and consolidation of all the lines. These negotiations therefore failed, not because the Council had not power to negotiate, but because they did not understand the tramway business, and with the best intentions varied their requirements from time to time. None of the members were sufficiently experienced in this very technical subject either thoroughly to understand or satisfactorily to solve the problem of a complete system covering the city and communicating with the outside districts, . . . The Bill in its present form is, in my opinion, bound to lead to extravagance, and it is a fresh incentive to corruption in public life, and it is desirable that every legitimate means should be used to defeat it." A resolution approving the Bill was carried amid cheering at a crowded town's meeting held on Wednesday night. A poll was demanded on behalf of the Birmingham Property Owners' Association.

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Company Notice.—The Barcelona Tramways Company announce that the sum of £4,000 has been paid for the option to purchase the business, which option was to be declared on Oct. 31, when a first instalment of the purchase money, making it up to £200,000, was to be paid, and a banker's guarantee provided for the balance; but at the request of the intending purchasers, and in consideration of their paying a further sum of £1,000, which they have paid, the Board have agreed to extend the time to Nov. 15. In all other respects the agreement stands.

Birmingham.—A pamphlet has been issued by the British Electric Traction Company on the tramway situation in Birmingham and district. The suggestion of the company is that the Birmingham tramways should be made an integral part of the comprehensive electric tramway scheme in the Black Country, affording through communication between the city and all the neighbouring districts as far as the lines extend at the lowest fares commercially possible. It is urged that only by single and uniform control is such a widely important public service possible.

Harrow.—The Middlesex County Council tramway scheme came before the Light Railway Commissioners, sitting at Harrow, again on Friday. After hearing witnesses for the promoters, the Commissioners threw out the scheme as far as it related to the Harrow district. The tramways were proposed to be run round the base of Harrow-hill, and Lord Spencer and Lord George Hamilton two of the governors of the school, had given in evidence that such a line would have a most prejudicial effect on the school. The tramcars would pass between two sections of the school cricket fields, and on Saturdays crowds of trippers would be drawn from London to watch the games.

Railway Electrification.—Lord Claud Hamilton (chairman of the Great Eastern Railway Company), with Mr. G. F. S. Gooday (general manager), and Mr. J. Holden (locomotive superintendent), inspected the track, equipment, and works of the Liverpool Overhead Railway on Friday. On Wednesday last week a number of the principal officials of the L. and Y. Railway Company visited Southport and inspected the power station at Chapel-street in connection with the scheme for constructing an electric railway between Southport and Liverpool. It appears the contracts have not yet been let for the new line, though an announcement on the subject is expected shortly.

Bushy Park.—It is officially stated that there has been no sale of any portion of Bushy Park to the London United Tramways Company for tramway purposes. The Office of Works is, however, disposed to entertain a proposal, which is strongly supported by the local authorities, for setting back the fence of Bushy Park for some distance along the tramway line where the road would be dangerously narrow. A piece of timbered land, of larger area than that to be thrown into the roadway, would be added to the park free of charge, a substantial permanent fence would be erected along the new frontage line of the park, and all structures would be reinstated free of expense to the Crown.

South London.—The transfer to the London County Council of the undertaking belonging to the South London Tramways Company has been postponed owing to legal difficulties. The date originally fixed was last Saturday, but the probability is that the actual transfer will not take place until the 14th or 21st of the month. The system which the Council will then acquire is something over 12 miles in extent, running from East-hill and North-street, Wandsworth, to the Borough and Westminster Bridge, with intersecting lines to Chelsea Bridge and Queen's-road. The work of electrification on the lines from Tooting to the bridges is proceeding apace, and it is confidently expected that the month of March next will witness the inauguration of the new service on the Tooting-to-Westminster section.

Barnsley.—The formal inspection of the tramways which have recently been completed in Barnsley was made on Friday by Colonel von Donop and Mr. Trotter, inspectors of the Board of Trade. They were accompanied by a large number of the officials of the owning company, the British Electric Traction Company. The inspectors found everything apparently in order, and arrangements have been made for the official opening of the service to-day. The line covered by the inspection runs from Old Mill to Worsborough Dale and Worsborough Bridge, a length of about three miles. There will be 10 cars at the outset, and the town will have a 10 minutes' service, with 20 minutes' service to the termini. Three penny stages have been arranged, and special workmen's cars will be run morning and evening. The overhead electric system is in use, and the Corporation will supply the motive power.

Torquay.—The Corporation have received a report from Mr. J. E. Waller, of the firm of Kincaid, Waller, and Manville, on the question of tramways for Torquay. In this report Mr. Waller recommends that the Corporation would be well advised to both own and work such an undertaking; but in any event, even if they should be disinclined to undertake the working of the tramways, he is satisfied that their ownership ought to be in the hands of the Corporation. There would be little or no difficulty in obtaining a reliable company to take a lease of the tramways on terms which would prove remunerative to the Corporation, who would thus be able to retain not only the construction, but also the maintenance and renewals of the tramways, thereby avoiding all interference with the streets by any outside body. In conclusion, Mr. Waller expresses the opinion that trams would prove of great public utility in Torquay, and that, under proper management, they should undoubtedly be financially successful.

Burton.—In reference to the proposal for a light railway from Burton to Ashby, a largely attended public meeting has unanimously decided in favour of the purchase clause being inserted in the order. A resolution deprecating the payment out of the rates of any part of the cost of the street improvements involved in the scheme was also passed. The Light Railway Commissioners held on the 30th ult. an enquiry into the application of the Midland Railway Company to construct the railway, which would go by Newhall, Swadlincote, and Woodville to Ashley. The proposed mileage is 11¼, divided into four sections. The gauge suggested is 3ft. 6in., the gauge upon which it is proposed to construct the Burton Corporation tramways. The overhead trolley system would be adopted. At the conclusion of the evidence, which raised the question of the insertion of the purchase clause in the order, the Earl of Jersey announced that the decision as to the purchase clause would be reserved. The Commissioners, however, would recommend that an order be issued.

Penarth.—A statement on behalf of the Penarth Tramway Syndicate, which has been formed for the purpose of obtaining a provisional order for the construction, equipment, and working of an electric tramway between Cardiff and Penarth, was laid before the District Council at their last meeting. It showed that the proposed tramway would be laid on the main road from Penarth to Cardiff, forming a junction with the Grangetown service of the Cardiff Corporation, and the route presented no engineering difficulties. Power might be supplied from the Penarth Electrical Supply Company, the South Wales Electrical Distribution Company, or the Cardiff Corporation works, or the syndicate might seek authority to erect generating stations. This matter would be subject to any suggestion of the Council, and full regard would be paid to the views and suggestions of the Council's engineer. The syndicate would run a service of trams every 10 minutes throughout the day, and the journey would not occupy more than 20 minutes, whilst the cars and appliances would be of the latest design. The syndicate has already received promises of capital to an amount beyond what would be required to construct, equip, and work the tramway. Upon receiving the consent of the Council steps would at once be taken to obtain a provisional order.

Gloucester.—With reference to the enquiry held by the Light Railway Commissioners at Gloucester in August last in respect of the applications made to them by the Corporation of Gloucester and by the Gloucestershire County Council for orders to authorise the construction of light railways in the district, the Commissioners have now decided to grant the respective applications: (*a*) of the Corporation, so far as it relates to the proposed light railways within the boundaries of the city of Gloucester, including powers to make such junction at the eastern boundary with the proposed light railways of the County Council as will allow a through service of cars to be worked; and (*b*) of the County Council. The Commissioners consider it desirable in the public interest that the Corporation and the County Council should come to an arrangement for working a through service at through rates upon the two lines, and if an agreement on the matter is arrived at between the authorities before the orders are finally settled and submitted to the Board of Trade, the Commissioners will make provision therein to carry the agreement into effect. If the authorities should in default of agreement join in requesting the Commissioners to deal with the matter, the Commissioners would be prepared after hearing the parties to determine the basis on which the working arrangement must be arrived at.

Finsbury Park Tube.—The builders of the new tube from Moorgate-street to Finsbury Park have been going on steadily with their works, and the greater section of the line is now practically completed. This section, which is three miles long, is from the City terminus to Drayton-park, with intermediate stations at Old-street and Essex-road, and it is only another half-mile from Drayton-park to the other terminus at Finsbury Park. It is a question now as to whether the finished portion shall be opened for traffic before the whole length of line is constructed. In the event of the directors deciding that it shall, it is likely that passenger trains will be running upon it very early in the New Year. The first complete train of seven coaches for the new tube railway has already been completed and dispatched from Loughborough to London. The coaches are, it is considered, the most luxurious ever constructed. The over-all length of each coach is 50ft., and each will accommodate 73 passengers. Each car, it is said, is practically a train in itself, and can run as a unit or in conjunction with other coaches. The approximate cost of these cars is about £1,000, independent of electrical equipment. The train of seven coaches has been manufactured by the Brush Electrical Engineering Company, and four similar trains are practically completed. Each train measures 350ft. in length.

Shipley.—Mr. Alfred Baker, general manager of the London County Council tramways, has given his award in connection with the matters in dispute between the Bradford City Council and the Shipley District Council regarding the tramways within the latter's district. There were several matters in dispute, including the cost of the tramways, the street improvements rendered necessary, and the cost of electricity. The award is as follows: (1) that the period of the lease shall be for 30 years; (2) that the Bradford Corporation shall pay to the District Council interest and sinking fund charges at the rate of £5. 14s. 6d. per cent. per annum for 30 years from May 17, 1902, on the sum of £27,614, expenditure in the construction of the Shipley tramways; (3) that the Corporation shall pay to the District Council interest and sinking fund charges at the rate of £4. 10s. 3d. per annum on the sum of £12,642 expended in street improvements; (4) that the District Council shall supply electrical energy for the proper working of the tramways at 1¾d. per Board of Trade unit (measured at the station), but that the price shall be subject to revision every five years; (5) that the District Council shall maintain the tramway—all except the overhead equipment, which is to be maintained by the Corporation—charging the Corporation at the rate of £100 per mile per annum for such maintenance. The Corporation shall then be relieved of all liability in respect of any accident arising from the defective condition of the tramway which has been maintained by the District Council.

Leicester and Anstey Light Railway.—As we briefly announced last week, the Light Railway Commissioners after enquiry decided to recommend the Board of Trade to grant an order for the construction of light railways between Leicester, Anstey, Groby, and Newtown

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Linford. In the course of the enquiry an important agreement was arrived at between the promoters and the Corporation of Leicester. The Corporation are the tramway authority in the district, and own the whole of the tramways in the borough, which they intend to electrify. The basis of the agreement arrived at was as follows: The Corporation to have the right to purchase so much of the railways as were within the borough within two years of their opening for traffic, upon the terms of the Corporation paying to the company the cost of construction, plus the cost of land acquired and used for the purposes of that portion, plus 10 per cent. on these costs, with a view of covering the proportion of capital expenditure attributable to that portion of the line. In view of their not exercising this right, the Corporation also to have the alternative right of purchasing so much of the railways as were within the borough, at the expiration of 21 years from the date of opening for traffic, or each successive period of seven years, upon the Corporation paying to the company a fair market value of that portion of their railway as a going concern, without any allowances for compulsory purchase. If the Corporation exercised either of the rights already referred to, they should agree to the lease of railway No. 2, together with running powers over so much of railway not within the Corporation boundary as should be necessary for them to work their traffic from No. 2 to their No. 1, for a period of 50 years, upon terms agreed or settled by arbitration, and the Corporation should agree, at the termination of the lease, to grant facilities for the purpose of forwarding such traffic as the company might agree to. On a clause to this effect being agreed to, the Commissioners agreed to recommend the granting of an order.

Tube Railways in London.—The Joint Committee of the London County Council appointed last week to consider at once the advisability of the Council promoting in the next session of Parliament a Bill on the subject of underground railways in London, reported on Tuesday that after consulting their officers they had arrived at the conclusion that, even if it were desirable, it was impossible within the time limited by the Standing Orders in Parliament for the Council to promote in the ensuing session any Bill which would require the deposit of plans and sections and a book of reference. After reviewing the general situation, the committee presented the following resolutions: (*a*) That in the opinion of the Council it will be detrimental to the interests of London if any Bill for the construction of a tube railway is proceeded with in Parliament until a full enquiry shall have been held and a report presented upon the following questions: (1) how far it is possible to adapt the provisions of the Light Railways Act, 1895, to underground railways in London as recommended by the Joint Select Committee of 1901; (2) whether it is possible and desirable to formulate some general scheme of underground railway accommodation capable of serving the requirements of London as a whole, and if so, what should be the main features of such general scheme; (3) whether a system of deep-level tube railways will afford the best results, or whether it will not be preferable to adopt either wholly or partially the system of underground locomotion in operation in Continental and American cities; (4) how and by whom such general scheme can best be carried out, having regard to the general traffic within London, the special need of supplying means of access to the suburbs, the housing problem, the need for cheap fares, the raising of necessary capital, and existing means of locomotion. (*b*) That with a view to obtaining such enquiry as above mentioned a deputation do wait upon the President of the Board of Trade and ask him to assist in obtaining the appointment of a commission to hold such enquiry, with power to consider all proposals that may be brought before them for the construction and supervision of underground railways in London, and to report as to the desirability of establishing some authority to prepare and issue provisional orders for confirmation by Parliament authorising the construction of such underground railways as such authority may be satisfied will be for the public benefit, and in the meantime to use his influence to obtain the suspension of any Bills that may be introduced into Parliament for the construction of tube railways in London. (*c*) That it be referred to the Parliamentary, Highways, Housing, and Finance Committees to jointly arrange for the proposed deputation, and to report again to the Council as to any further steps they may deem it advisable that the Council should take. In conclusion, the committee stated that in order that the Council might be in a position to lay full information before the commission, they had instructed the officers to prepare a complete scheme of locomotion for London, and in particular to report as to what proposals would be most likely to relieve congested and insanitary districts, provide the best means of opening up new areas, and afford the greatest convenience to the travelling public. After some discussion the report was received, and the consideration of the recommendations in it deferred until the next meeting of the Council.

Chatham.—An accident, attended by disastrous results, occurred on the Chatham and District Light Railway on Thursday last week. The scene of the mishap was at the foot of Westcourt-street, Old Brompton, very close to the main entrance to Chatham Dockyard. The gradient here is very steep, and running at right angles at the bottom is the brick wall of the dockyard. It will thus be seen that the curve of the line at this spot is very sharp, and the cars have to reduce their speed to practically nothing in order to make the turn successfully. The reports of the accident show that shortly after six o'clock on the Thursday morning a workmen's car, filled with mechanics and labourers going to work in the dockyard, was proceeding down the hill when the wheels skidded. The brakes failing to arrest its progress, the car dashed on at a high speed, and finally, leaving the rails at the curve above referred to, dashed into the wall at the bottom of the hill and overturned. The number of passengers on the car at the time is estimated at between 70 and 80, whereas it was only constructed to carry 50. The accident resulted in the death of two persons outright, and more or less serious injuries to 50 others, one of whom has since succumbed. In the course of the car down the hill many of the passengers jumped off, and the driver and conductor, it is reported, themselves leaped to the ground, thus avoiding serious injury. It appears that the Gillingham Urban District Council, in whose district the scene of the accident is situate, have entertained misgivings with regard to the line in Westcourt-street, owing to the steep gradient and the sharp curve at the bottom, but their objections were over-ruled, both the company and the Board of Trade inspector being of opinion that the powerful brakes with which the cars are fitted would afford complete control. As to the fact that the car was carrying 30 more passengers than its proper number, it is stated that the company have found it next to impossible to prevent overcrowding; the cars have been literally "stormed" in the mornings and evenings, the officials being set at defiance. At the opening of the inquest on Monday on the bodies of the three men who were killed, the conductor of the car said in evidence that it was impossible to keep men off. If he pushed one off others got on. He believed that the car travelled down the hill at the rate of 15 miles an hour. It was habitual for the early morning car to be overcrowded. It was not usual for a pilot to go on the first car down the hill. There was a pilot there sometimes, and if he was there at the top he took the car down. There were three brakes on the car, the power brake, the hand brake, and the slipper brake, and the driver used them all. The rails were very greasy down the hill that morning. He suggested that the driver had better go down alone, though the car was overcrowded. The hand brake was of no use, because the wheels locked. He could not tell whether any sand went on to the rails. He had no time to warn any of the passengers, and he did not hear the driver give any warning. Witness could not attribute the accident to the greasy state of the rails. He did not know any particulars of a previous accident at the bottom of the hill. He himself was not allowed to touch a brake unless he got a signal from the driver. Then he could use the slipper and hand brake. He received no signal from the driver on this occasion. John Coffey, a pilot in the employ of the company, said that it was his duty to take all cars down the hill. On this occasion witness was at the bottom of the hill when he saw the car coming down. He attributed the accident to the driver placing too much reliance on his hand brake. The Board of Trade enquiry into the disaster was opened by Major Pringle, R.E., on Tuesday. The proceedings were conducted in private.

PROVISIONAL PATENTS, 1902.

OCT. 27.

23319. Coin-freeing apparatus applicable to electric, gas, water meters, clocks, and other appropriate apparatus. John William Jones, 13, Dornton-road, Balham, London.

23323. Improvements in sparking plugs for use in connection with the electric ignition systems of internal-combustion engines. James Samuel Foley, 24, Temple-row, Birmingham.

23324. Improvements in automatic switches for use in connection with the electric lighting of railway carriages, and for analogous purposes. The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 21, Temple-row, Birmingham.

23328. Improvements in or connected with gearing. Wilfrid L. Spence and the British Electric Plant Company, Limited, Oakleigh, Alloa.

23333. Railway metal telegraphy. James Edgar, Nithsdale, Wrexham.

23344. Improved electrical billiard marker and indicator. James Malam, 11, The Pavement, New Cross, London.

23357. Electrically-driven surface planing and jointing machine. James Barr and the firm of John McDowall and Sons and Robert Anderson, Walkinshaw Foundry, Johnstone, Renfrewshire.

23371. Improvements in electric cables and in apparatus for the manufacture of same. Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, Surrey.

23372. Improvements in electric tremblers or contact breakers and means of actuating the same. William Spiers Freeman, Invicta Works, Otford, Kent.

23387. Improvements in and relating to main and branch electric switches. John William Ewart, Surrey House, Chiltern-road, Wendover, Bucks.

23389. An improved galvanic dry cell. Georges Schauli and Dolf Lowenstein, 173, Fleet-street, London.

23400. Improvements in electric conductors. Walter Victor Morten, 205, Sumatra-road, West Hampstead, London.

23420. Improvements in telegraphic cable relays. Alexander Muirhead, 323, High Holborn, London.

23421. Improvements relating to Rontgen-ray and like apparatus. Harry William Cox, 323, High Holborn, London.

23426. Improvements in and relating to electric accumulators. Lucien Garcin, 6, Lord-street, Liverpool.

23426. Improvements in incandescing bodies for electric lighting purposes. Ernest Schattner, 55, Chancery-lane, London.

23433. An improvement in electrodes for arc lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Gebrüder Siemens und Co., Germany.)

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23461. Improvements in magnetic apparatus for the distribution of current to electric tramways and railways by road contact. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Alfred Diatto, Italy.)

Oct. 28.

23491. Improvements in magnetic wheels. John Otto Heinze, jun., 62, St. Vincent-street, Glasgow. (Date applied for under Patents Act, 1901, Feb. 24, 1902, being date of application in United States.) (Complete specification.)

23492. Improvements in and relating to induction coils. John Otto Heinze, jun., 52, St. Vincent-street, Glasgow. Date applied for under Patents Act, 1901, July 11, 1902, being date of application in United States. (Complete specification.)

23494. Improvements relating to the electro-deposition of metals upon articles of china, earthenware, and the like. Gerald William Laybourn, 40, Stoke-road, Shelton, Stoke-on-Trent.

23507. Improvements in controllers for electric lifts. John Sanders Stevens, Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens, James Works, Queen's-road, Battersea, London.

23560. Improvements in trolley gear for electric traction. Frederick Bushell, 6, Lord-street, Liverpool.

23565. Improvements in and relating to electrically-actuated musical instruments. William Kennedy-Laurie Dickson, 18, Southampton-buildings, Chancery-lane, London.

Oct. 29.

23584. Improvements in electric switches or circuit breakers. Patrick Hamilton, 83, Cannon-street, London.

23594. D. Teers overhead life-guards for the protection of passengers from broken trolley wires on electric-driven tramcars. Daniel Teers, 90, Alexandra-road, Moss Side, Manchester.

23606. Improvements in electric arc lamps. Paul Högner, 40, Chancery-lane, London. (Complete specification.)

23619. Improvements in secondary batteries. Eduard Sandhagen and Joseph Lürgen, 81, High Holborn, London.

23622. Improvements in electro-reversible motors. Orazio Lugo, 16, St. Helen's-place, Bishopsgate, London.

23651. Improvements in electrical generators and motors. Walter Herbert Flood, 4, South-street, Finsbury, London.

23653. Improvements in and connected with electric ignition devices of internal-combustion engines and the like. John Alexander McMullen, 323, High Holborn, London.

23656. Improvements in and relating to the insulation of electric conductors. Edward Bergtheil, 1, Queen Victoria-street, London.

23657. A combined electrical switch and wall plug. John William Johnson, 18, Buckingham-street, Strand, London.

23660. A maximum-current registering indicator. Alexander Melville Clarke, 53, Chancery-lane, London. (Hartmann and Braun, Germany.)

Oct. 30.

23670. A device for automatically stopping electric generating plant when charging batteries. Walter Poynter Adams, 35, Queen Victoria-street, London.

23673. Improvements in and connected with the production of electrotypes. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 82, Victoria-street, London.

23677. Prepayment electricity meter. John Ellis, Keynsham, Station-road, Sandown, Isle of Wight.

23679. Improvements connected with trolley poles of electric cars or locomotives. John Samuel Rigby, 15, Water-street, Liverpool.

23695. Improvements in incandescent electric lamps. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

23734. Improved guiding device for the electric conductors of tram and like cars. John Addison Miller, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, Oct. 30, 1901, being date of application in United States.) (Complete specification.)

23738. Improvements in protecting hoods for telephone receivers to prevent the spread of contagious diseases. Edouard Bardac and Pierre Albert Martin, 1, Queen Victoria-street, London.

23742. Improvements in dynamo-electric machines. Dimitry Balachowsky and Philippe Caire, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 16, 1902, being date of application in France.) (Complete specification.)

23743. Improvements in the method of mounting electric incandescent lamps and apparatus connected therewith. Adolfo Miaja Eguren, 99, Cannon-street, London. (Complete specification.)

23753. Improvements in and relating to telephones. Isidore Bernard Birnbaum and Joseph Berliner, 322, High Holborn, London. (Complete specification.)

23754. Improvements in and relating to galvanic batteries. George Pearson and Lothar Fiedler, 70, Chancery-lane, London.

Oct. 31.

23778. Improvements in dynamo-electric machinery. James Atkinson, Benavie, Marple.

23797. Improvements in apparatus for composite systems of simultaneous telegraphy and telephony. John Merritt Fell, Fife House, Kingston-on-Thames.

23803. Improvements in and relating to the arrangement of incandescent electric lamps. Matthew Cranswick Greenhill and Stanley Edward Hammond, 27, Chancery-lane, London.

23842. Improvements in electric telegraphy. Frederick Edward Hesse and Ernest Sydney Heurtley, 24, Southampton-buildings, Chancery-lane, London.

23858. Improvements in thermo-electric batteries. James Yate Johnson, 47, Lincoln's-inn-fields, London. (A. Wolf, jun., and Co., Germany.)

Nov. 1.

23881. An improved trolley head or conductor for electric wires on railways, tramways, and the like. Jasper James Carter, 4, Vergemont Hall, Clonskeagh, co. Dublin.

23926. Improvements in means for regulating electric circuits. Henry Leitner and Richard Norman Lucas, Rose Villa, Byfleet, Surrey.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 20.

1901.

18030. Electrical apparatus for transmitting the speed of a rotating body to an indicator at a distance. Alcock.

21598. Mouthpieces for telephones and analogous instruments. Bergman. (Date applied for under International Convention, April 17, 1901.)

21646. Carbons for arc lights. Viertel and Pueschel.

23261. Automatic switch for switching off an electric motor used for pumping purposes. Drake and Drake and Gorham, Limited.

23398. Equipment of electrically-propelled cars. Siemens Bros. and Co., Limited. (Lydall.)

23637. Electromagnetic couplings. Imray. (Onken.)

23708. Intercommunication telephone systems. Byng and Bell.

22134. Electrical connections. Accles and de Veulle.

24797. Electrical motors. Burdon and Cavelier.

25380. Method and means for attaching the carriers of electric light shades to their standards or supports. Marshall.

26358. Circuit breakers for electric current circuits. Moy, Bastie, and Ernest F. Moy, Limited.

1902.

6485. Telephone systems. Cedergren. (Date applied for under International Convention, Oct. 26, 1901.)

10452 Wireless telegraphy and means therefor. Evans-Jackson De Forest Wireless Telegraph Company.

11508. Process for the preparation of electrodes for secondary batteries. Thompson. (Akkumulatoren-And Elektricitäts-Werke Akteingesellschaft vorm. W. A. Boese und Co.)

17260. Electric lighting and apparatus therefor. McGillivray.

17708. Signalling by electromagnetic waves. Fessenden.

18655. Automatic switch for electric pumps. Collings and Griscom.

18931. High-potential insulators. Dymond (Karlsbader Kaolin-Industrie Gesellschaft.)

19652. Ammeters and voltmeters. Nalder and Nalder Bros. and Thompson, Limited.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¼-⅜
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-⅜
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7¾-8¼
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	101-103
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	94-99
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15-16 xd
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2¼-2¾
—— 5 per cent. Debentures	100 ..	101-106 pc
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent, 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16½-17½
—— 4½ per cent. Preference	5	5½-5¾
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅜-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3½-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4½-5 xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9½-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £240 each	40	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12⅜-13½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12-12½
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	b	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5½
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2½-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4⅜-5½
—— 4 per cent. 1st Mortgage Debentures	100	100-103
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4½-5
—— 4 per cent. Debenture Stock	100	96-99
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref. } Within 1-82,500	10	11½-12
—— " " " " } Within 1-82,500	10	11½-12½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	106-108
—— " " Prov. Crts.	100	105-107
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11½-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8½-9
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	16s.	3/16
—— £250,000 " "	1	1
—— £2500,000 4½ per cent. Debenture Stock	80 p.c.	80 p.c

Electric Railways.—

Central London, Ordinary	100	108-111
—— 4 per cent. Pref.	100	107-110
—— " " deferred	100	108-111
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-119
City and South London, Consolidated Ordinary	100	72-74
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	92 95

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	105-108
Bournemouth and Poole, Ordinary	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	9½-10½
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	10½-10⅝
—— 7 per cent. Preference	5	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7-8
—— Nos. 20,001-50,000	5	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " £10 Ord.	6	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-109
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4½-5½
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5½-6
—— 4½ per cent. Debentures	100	108-112
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	13½-14½
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104-107
County of London and Brush Provincial, Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6-6½ xd
—— 6 per cent. Cum. Pref.	5	6-6½ xd
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3½-4½
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	6-6½
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10½
London Electric, Ordinary	3	1⅜-2½
—— 6 per cent. Pref.	5	4½-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	98-99
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	110-115
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6½-6¾
Notting Hill Electric Lighting	10	13½-14½
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oriental, 1879	1	—
—— £5 Shares	5	—
—— £4½ Shares, New	4½	—
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1⅜-2½
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2⅜-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8½-9½
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3½-4½
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3½-4½
Westminster, Ordinary	5	11½-12½
—— 5 per cent. Cum. Pref., 110,101-138,241	5	6-6½

Telephones.—

National Telephone, Preferred	100	92-94
—— Deferred Stock	100	56-58
—— 6 per cent. Cum. First Pref.	10	12½-13½
—— 6 per cent. Cum. Second Pref.	10	11½-12½
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent. Deb. Stock, Red.	100	102-105
Oriental Telephone and Electric Company	1	¾-1 xd

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 25	873	658	+ 214	+ 5,787	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	Nov. 1	5,198	4,792	+ 406	+14,605	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	Oct. 31	727	718	+ 9	+ 3,614	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	" 30	366	313	+ 53	+ 91	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	Nov. 1	258	248	+ 10	− 277	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 2	1,702	1,471	+ 231	+ 3,399	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	Oct. 26	3,208	1,090	+2,118	+82,937	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57[e]
Bristol Tramways Company	" 31	4,411	3,942	+ 469	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	" 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	Nov. 1	7,155	6,629	+ 526	+10,062*h*	12	12	" 31	335,086	41,188,389	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	" 2	3,284	2,111	+1,173	+18,275	12½	9½	" 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	Oct. 30	719	419	+ 300	+ 5,716	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	Nov. 1	201	197	+ 4	+ 52	4½	—	" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 2	109	88	− 21	+ 52*h*	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	Oct. 31	3,704	3,532	+ 172	} +1,718	46	46	" 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	" 31	768	766	+ 2											
Dundee City Tramways	" 26	764	618	+ 146	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	Nov. 1	12,759	13,194	− 435	−13,634	104	95	" 31	582,146*c*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	Oct. 22	1,139	1,028	+ 111	+ 2,225	27½	18½	Mar. 31	54,969	13,173,824	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	Nov. 1	1,029	882	+ 147	—	48	48	Sept. 30	29,061*h*	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	" 1	1,733	1,613	+ 120	+ 2,377	19	9½	" 30	72,331*h*	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	Oct. 25	9,919	9,170	+ 749	+32,511	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	Nov. 2	1,527	1,445	+ 82	+ 967	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Nov. 2	4,130	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	Oct. 30	964	835	+ 128	—	11	—	" 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	Nov. 5	1,060	1,023	+ 37	+ 2,699	19	17	" 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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NOTES.

Scientific Lectures.—In the matter of lectures on scientific subjects the Library Committee of the Battersea Borough Council are doing exceedingly good work. The question of continuing the university extension lectures during the spring term next year has come before them, and they have wisely decided to make the necessary arrangements for the prolongation of the course. In all probability the present lecturer, Mr. Frederick Womack, M.B., B.Sc., will be re-engaged for the spring term to give a course of 10 lectures on "Modern Applications of Electricity."

Electro-Harmonic Society.—At the ladies' night concert to-night in the Crown Room of the Holborn Restaurant a strong vocal and instrumental programme will be given. With Madame Clara Samuel as the contralto and Mr. George Stubbs as the tenor some very excellent singing may be expected. The list of vocalists also includes the name of Miss Annie McBridge. Mr. Alexander Prince is down for a couple of concertina solos, while the miscellaneous programme includes recitations by Mrs. Tobias Mathay, conjuring tricks from Mr. C. Lebert, and musical sketches by Mr. George Robins.

Royal Statistical Society.—The winter session of this society commences this month and ends in June next year, during which period eight ordinary meetings in all are arranged to be held. Among the papers of interest to the engineers to be read at these meetings are the following: "English Railway Statistics," by Mr. Wm. Mitchell Acworth; "A Census of the Empire," by Mr. J. A. Baines; "Financial Aspects of Federal Government for the United Kingdom," by the Hon. Thomas A. Brassey; "The Organisation of Local Statistics," by Mr. John Macdonald, C.B., LL.D.; and "Statistics of London Traffic," by Mr. E. J. Edgar.

Power Distribution in South Wales.—Such good progress is being made with the erection of the generating station of the South Wales Electrical Power Distribution Company at Bridgend that it is hoped supply will be commenced early next month. The structure itself is now practically finished, and the generating plant is being installed. Already the two asylums of the Glamorgan County Council have been connected to the mains, and besides taking current for lighting purposes, these institutions are contemplating the use of electrical power for driving the laundry machinery. The town of Bridgend will also be amongst the first customers of the power company, the Urban District Council having agreed to take supply in bulk for both private and public lighting.

Wireless Telegraphy in the Bahamas.—We are not aware that the Bahama Islands have as yet done much in the way of wireless telegraphy, but big things in this direction are evidently contemplated. The Governing Body of the islands has recently assented to the "Wireless Telegraphy Restriction Act, 1902," which provides that it shall be unlawful for any person in the Bahama Islands to transmit or receive messages across the seas by means of any wireless telegraphy whatsoever, unless the previous consent of the Colonial Secretary to the Governor-in-Council authorising the same is obtained. The penalty of non-compliance with this provision is laid at £200. From the expression "across the seas" it would seem that no restriction is placed on the interchange of wireless telegraphy in the islands themselves.

Institution Dinner.—The annual dinner of the Institution of Electrical Engineers has been fixed for Wednesday, Dec. 17, at the Hotel Cecil. It is proposed this year to arrange for a shorter toast-list, and to adjourn comparatively early in the evening to an adjoining room, where members will have a better opportunity for social intercourse than is usually possible at formal dinners. It is quite time that this departure was made, as the dinners of the Institution of late have been remarkable for the dreariness of the speeches on subjects which, being repeated year by year, make it exceedingly difficult for the speakers to say anything fresh. We are not told whether any musical entertainment is to be provided in the adjoining room. This would be a good feature, provided the programme was limited so as to leave ample time for conversation.

Electric Light Supply.—An inhabitant of Kingston Hill has recently asked the local Council if they have any objection to his supplying his neighbours with electric light from his private installation. The Council very properly decided to defer consideration of the matter, but the opinion appeared to be that neither consent nor refusal should be given. In this respect they were quite correct, because, as the conductors for connecting up the private plant in question on to the neighbours' wiring would not cross the public roads, the matter is out of the jurisdiction of the Council. Wayleaves and the use of the public roads form the sole advantages of an electric lighting provisional order. Quite a number of the electrical undertakings in the country started without any rights under the Electric Lighting Acts. That they have since obtained provisional orders may be explained on the ground that the expense was warranted in view of the certainty as to wayleaves thereby ensured.

Royal Society.—The list of those who have been recommended by the president and council of this society for election into the council for the year 1903, at the anniversary meeting on Dec. 1, is as follows: President, Sir William Huggins, D.C.L., LL.D.; treasurer, Alfred Bray Kempe, M.A.; secretaries, Sir Michael Foster, D.C.L., LL.D., and Joseph Larmor, M.A., D.Sc., LL.D.; foreign secretary, Thomas Edward Thorpe, C.B., Sc.D. Other members of the council: William Bateson, M.A.; William Thomas Blanford, LL.D.; Prof. Hugh Longbourne Callendar, M.A., LL.D.; Francis Darwin, M.A.; Prof. Harold Baily Dixon, M.A.; Prof. George Carey Foster, LL.D.; Sir John E. Gorst, M.A.; Prof. John Wesley Judd, C.B., LL.D.; Lord Lister; Prof. George Downing Liveing, M.A.; Prof Augustus Edward Hough Love, M.A.; Prof. Henry Alexander Miers, M.A.; Prof. Edward Albert Schäfer, LL.D.; Captain Thomas Henry Tizard, R.N., C.B.; Prof. Herbert Hall, Turner, M.A.; and Sir John Wolfe Barry, LL.D.

University College, Sheffield.—In consequence of great pressure on its space, a much-needed extension of the metallurgical department of the above college has just been completed. At a short distance from the metallurgical laboratory some new land was obtained, and on this a foundry and metallurgical furnaces have been erected. On the space set free by the removal of an old furnace, temporary accommodation for the electrical engineering classes is also being provided, and should be ready soon after the commencement of the new session. The permanent buildings for electrical engineering and for the extension of the engineering laboratories, will form part of a scheme which the governors of the college have in hand for extensive alterations to the old structure and the erection of new buildings. It is considered that the new scheme will meet most satisfactorily the needs of the college, and that when completed the city will possess an institution of higher education fully equal to the demands on it, and which will stand comparison with those of other cities.

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Conductivity of the Metals.—From the known electrical conductivities of metals at various temperatures, Mr. F. Streintz shows in a recent paper that in all cases the temperature coefficient is greater than 1/273. In the group of metals with high atomic weight, the temperature coefficient increases with the atomic weight. This applies also to metals the atomic weight of which lies between 100 and 120; for metals of lower atomic weight, it is only applicable to copper and zinc. Metals of high atomic weight have a negative temperature coefficient of heat conductivity. The ratio of the two conductivities is only proportional to the absolute temperature for metals of medium atomic weight. The temperature coefficient of the atomic heat is apparently connected with the temperature coefficient of the electrical conductivity, and the author draws the conclusion that for a metal of high atomic weight the smaller the displacement of the atoms compared with the distance between the atoms, the greater is the temperature coefficient of the electrical resistance.

Manchester Local Section.—The opening meeting of the new session of the above section of the Institution was held on Tuesday, when Mr. W. S. Goodrich presented a paper on "Electricity from Refuse—the Case for the Modern Destructor." The arrangements for other meetings during the session are as follows: Nov. 25, "High Temperature Electro-Chemistry," by Messrs. R. S. Hutton and J. E. Petavel; Dec. 16, "Electrical Haulage on Canals," by Dr. E. W. Marchant; Jan. 20, presidential address of Mr. Hardman A. Earle, chairman of the section; Feb. 3, "The Possible Development of Electrical Driving in Factories due to the Supply of Electricity at Cheap Rates by Large Power Companies," by Mr. J. S. Highfield; Feb. 17, "The Arrangement and Control of Long-Distance Transmission Lines," by Messrs. E. W. Cowan and L. Andrews; March 3, "Coal and Fuel Consumption at Central Stations," by Mr. G. F. Metzger: March 17, "Comparison between Steam and Electrically Driven Auxiliary Plants in Central Stations," by Messrs. C. D. Taite and R. S. Dawne; and April 7, "The Carriage of Goods on Electric Tramways," by Mr. A. H. Gibbings.

Electrification of Italian Railways —We gather that a number of schemes are in course of completion for the equipment of other lines in Italy for electrical working. Some half-dozen branches of the north, central, and southern lines are likely to be electrified, as is also the railway between Rome and Naples. On this latter high speeds are looked upon as being the great advantage to be derived from electrical working. Italy has a considerable advantage over this country, in that water power is often available for driving the electrical machinery. It is to be regretted, however, that more information is not to be had of those lines which have already been equipped electrically in Italy. We especially refer to the three-phase equipment of the Sondrio-Lecco line, which figured so prominently in the arbitration between the District and the Metropolitan Railways. The only fact which really is to be obtained seems to be that the line, although equipped for three-phase working, is only running one or two goods trains electrically. Whether the fault is in the equipment or in the management it is difficult to say, but an authoritative statement on the point should be made to the electrical world.

Deputations.—The system of sending corporation deputations on visits in order to view works which are likely to be of interest, and perhaps ultimately to be adopted within the municipal areas, is growing. We are surprised to find, however, that the limit of growth, so far as numbers are concerned, has been reached in Swansea, where the whole Corporation are invited to have a trip to Paris at the instance of a syndicate interested in a surface-contact system of electric traction. That the trip will be enjoyed by all members of the Corporation goes without saying, and we presume the inhabitants of Swansea should be satisfied, because the expenses are not to be borne by them. Looking at the matter from an engineering point of view, however, the trip is an absurd one, as not more than two or three councillors at the most will be at all qualified to judge of the merits of the system over other and rival schemes. The right way would have been for the Swansea Corporation to send their surveyor and electrical engineer, and perhaps the chairman of the Tramways Committee, at the expense of the borough, and thus avoid the stigma of having the whole of the Corporation "treated" by a would-be contractor.

Practical Medical Electricity.—The third edition of Dr. Dawson Turner's "Manual of Practical Medical Electricity" has just been published by Messrs. Baillière, Tindall, and Cox. In a short review of the new edition the *Lancet* states that until quite recently the practitioner who was known to adopt electricity to any extent in his practice was regarded, not exactly as a charlatan, but as one on whom the leaders of the profession, at any rate, might look askance. Happily, these views have become modified, and we have arrived at a stage when it is even possible to found a society for the study of electro-therapeutics. Nevertheless, the elaborate and expensive nature of the apparatus required for applying high-frequency and other forms of alternating current, static electricity, and X-rays, and the wider application of these in the treatment of cancer and various morbid conditions of the skin, have tended to place these methods of treatment in the hands of a few. There still, however, remain the simpler forms of electricity, which are applicable to many cases, and which any intelligent practitioner can use. To these our contemporary commends Dr. Turner's book. It is written by an author thoroughly in touch with his subject, and who writes in terse and, on the whole, intelligible language.

Electrical Apparatus for Coaling at Sea.—Mr. H. W. Leonard has recently taken out two patents in the States relating to a method of coaling at sea, which employs the well-known Ward-Leonard method of control. Rigged on one of the vessels is a sheave looped, in which is a carrying line whose two ends are secured to two drums on the other vessel. These drums are connected to two dynamo-electric machines, one of which operates as a motor when the other operates as a generator. The armatures of these machines are in parallel with the source of current supply, and the fields are separately excited. In operation the machine connected to the taking-up drum acts as a motor, and the machine connected to the drum paying out acts as a generator. When the tension on the cables varies the loads on the drums will vary accordingly, resulting in a corresponding variation of the counter E.M.F. of the machines, with the result that the machine operating as a motor will automatically take a greater or less amount of energy, producing a corresponding variation of torque and speed; while the machine driven as a generator by the moving cable will produce a greater or less amount of energy according to the speed of the cable, the result being that the drums pay out the cable faster or slower according to the variation in tension produced by the rolling or pitching of the vessels. By this arrangement a given tension may always be automatically maintained on the hauling line.

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The Electrical Industry in Germany.—It is difficult to find in the reports which most of the German electrical companies have now issued for the past financial year any signs of the early release of the electrical industry from the depression under which it has fallen in that country. The state of things as disclosed by the majority of these reports is certainly not very hopeful. To give an instance, the Watt Accumulator Works Company, of Berlin, has been so unsuccessful from the first that the shareholders have decided to wind up the concern in voluntary liquidation. It is believed that the Watt accumulator patents are of value, and that the battery is capable of development, but the company lacks the means of becoming prosperous. The accumulator, it is asserted, could only be converted into a profitable market product by large financial support. Of the successful concerns, the Electrical Investment Company, of Cologne, may be mentioned as having satisfactorily carried through the scheme of reconstruction agreed upon last year. The report for the past year's working shows a surplus of £12,920, which has been carried forward to the next account. Among other companies, Körting's Electricity Company, of Hanover, paid a dividend of 6 per cent. for the past year; the Westinghouse Electricity Company, of Berlin, incurred a loss of £9,396; while the Rheinish Schuckert Company, of Mannheim, paid a dividend of 4 per cent. for the same period.

Wiring Consumers' Premises in London.—It will be recalled that in its General Powers Bill of this year the London County Council sought powers, among other things, to enable the metropolitan borough councils having their own electrical undertakings to wire consumers' premises for the electric light, and to borrow money for this purpose. Clauses to this effect were inserted in the Bill at the request of a large majority of the local authorities in London, but owing to certain technical questions of procedure being raised the clauses were afterwards struck out of the Bill, and were not even considered in committee. That such facilities are greatly needed in London to enable the local authorities to make the best possible provision for electric lighting in their respective areas there is no doubt, and we are pleased to see that the County Council proposes to insert similar clauses in its General Powers Bill of next year to those which were dropped this session. Although objections may be raised to the principle, we should greatly like to see the borough councils empowered to supply the lamps as well as to wire and fit up the consumers' premises. In our opinion this is most desirable, because consumers where they have to buy them themselves often use inferior lamps, which bring the electric lighting undertaking into discredit. The success of this second application to Parliament must, to a very large extent, depend upon the co-operation of the local authorities, and we trust they will not fail to support the County Council in this matter.

An Electrically-Driven Tea Factory.—Natal, in South Africa, lays claim to the possession of the first tea factory to be driven by electricity, and it is possible that the actual drying of the tea itself by the same agent will shortly be attempted. The works are situate near the River Umhloti, and obtain the electrical energy from a power-house between three and four miles away. The whole question involved in the adoption of electric power for this industry was the cheapening of the cost of production, preparation, and transit, and it is promising to hear that the results so far have given every satisfaction. Water power for driving the generating machinery i obtained from the river, and the plant at present installed consists of one 100-kw. turbo-dynamo, which is sufficient for present needs. The dynamo develops 5,000 volts, three-phase, at 500 revolutions per minute, with a periodicity of 50. The power is transmitted at this pressure by three single-core cables carried overhead to the factory 3½ miles away, and also to the several dwelling-houses on the estate, including the mansion house of the head of the firm, Sir James L. Hulett, Speaker of the Natal Legislature. At the end of the transmission line the voltage is reduced by static transformers for the requisite power and lighting. In connection with the tea factory, the firm are laying down an electric railway some 24 miles long to a place called Mapunilo. It is anticipated that this line will favour the supply of labour from districts hitherto not easily accessible, and prove remunerative in the way of freight and point-to-point passenger traffic.

Institution of Junior Engineers.—This institution opens its winter session on the 21st inst. with the presidential address of Colonel Edward Raban, C.B., director of works of the navy. The subject of the address is "The Preparation of Engineering Projects." The good work which the institution is carrying on is shown in some particulars of recent progress we have received from the secretary, Mr. W. T. Dunn. Meetings are held during the winter months at monthly intervals for the reading and discussion of papers, and visits to engineering works and other places of interest are also made every month, alternating with the meetings, during this period. At other times of the year these visits are undertaken more often, about one a fortnight, and the summer excursion, occupying a week, is another excellent feature of the institution's programme. The advantages to be gained by visits to engineering works and the like cannot be over-rated, especially for young engineers, and the council of the institution are to be congratulated on the facilities they offer to the members for making such visits. The register now contains the names of about 700 members. Among the list of papers to be read in the forthcoming session we notice two which should prove of much interest to electrical engineers. They are entitled respectively: "Practical Notes on the Use and Maintenance of Electric Motors for Factory Purposes," by Mr. W. T. George, and "Greasy Condensation Water as Boiler Feed," by Mr. Wm. Paterson Applications for membership should be made to the secretary, Mr. W. T. Dunn, 39, Victoria-street, Westminster.

Ventilation of Factories.—A Blue-book has been issued containing the report of Dr. J. Scott Haldane, F.R.S., and Mr. E. H. Osborne, engineering adviser to the chief inspector of factories, to the committee which was appointed to enquire into the means of ventilation in factories and workshops, with special reference to the use of fans, and the use and construction of respirators for the protection of workpeople exposed to dust or dangerous fumes. The principal and most important recommendation which these gentlemen make to the committee is to the effect that such a standard of ventilation should be prescribed for all classes of factories and workshops not otherwise specially dealt with, that the proportion of carbonic acid in the air at about the breathing level shall not rise during daylight or after dark when only electric light is used beyond 12 volumes of carbonic acid per 10,000 of air, and that when gas or oil is used for lighting the proportion should not exceed 20 volumes after dark or before the first hour after daylight. The only exception to this rule is to be in cases where the extra carbonic acid is produced in other ways than by respiration or combustion. The duty of analysing the air will be undertaken by specially qualified persons appointed by the Home

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Office, and the samples will be collected by the inspectors of factories. If the ventilation is found defective, the owners of the factories will be given an opportunity of remedying the evil before legal proceedings are taken. Other recommendations are made with a view to empowering the factory inspectors to take samples of the atmosphere in factories and workshops at their discretion.

Electro-deposition of Copper. — An ingenious electrometallurgical method for the treatment of sulphide ore of copper is proposed by Mr. C. J. Tossizza, of Paris, and described by Mr. C. P. Townsend in the *Electrical World*. The copper in such ores is associated with iron, and the sulphate solutions obtained by treating the roasted ores with sulphuric acid are unsatisfactory electrolytes: for although copper is more readily deposited than iron, no separation of the metals is practicable with insoluble anodes. Such separation would involve the maintenance of the E.M.F. between terminals at a necessary minimum, whereas the polarisation of the anode quickly raises it to a point at which iron also separates. Mr. Tossizza introduces into the bath in the neighbourhood of the anodes the sulphur dioxide derived from the roasting, thereby reducing the potential difference to the theoretical figure of 0·2 volt, or under practical conditions to 0·6 volt. Obviously, the E.M.F. necessary for the separation of iron is reduced in similar proportion, but with effective depolarisation such intermediate values may be maintained as will permit the separation of the copper alone. The relation of this process to the prior art is somewhat peculiar. The method, that is to say, the use of reducing gases, and particularly sulphur dioxide for the depolarisation of insoluble anodes in the deposition of copper, was described in 1878 by Cobley. The realisation that thereby the purity of the separated metal might be controlled is due to Tossizza, who is, therefore, to be considered as the inventor of the method as applied to ferruginous solutions. On the practical side the process confronts the fact that no thoroughly satisfactory anode material for sulphate solutions is known.

Electrical Progress in South Africa.—South Africa is showing steady progress in matters electrical, although, perhaps, development in this direction is not so marked as might reasonably be expected. From the *British and South African Export Gazette* we learn that the first step in the realisation of the big scheme for the utilisation of the power of the Victoria Falls in the generation of electricity will be taken in the course of next year. The African Concessions, Limited, which has charge of the scheme, is under obligation to the Chartered Company to spend £10,000 on preliminary surveys and investigations during the next 14 months. The reason why more haste is not being shown in the carrying out of the scheme is said to be that the concessionaires are not desirous of pushing their operations ahead of other developments in progress, notably the completion of the Bulawayo-Waukie Railway. Another electric power scheme for supplying power and light to the mines and villages on the West Rand is projected by the Johannesburg Corporation. Presumably the generating plant would be driven by steam, as water power is not available in that locality. It is doubtful whether the Corporation would themselves carry out the scheme, and in all likelihood a private company will be invited to undertake the installation under agreement with the Municipality. An electric lighting scheme for Port Elizabeth is another visible sign of the progress South Africa is making in electrical development. This scheme, which has received the consent of the ratepayers, is estimated to cost about £100,000, although the initial outlay is not expected to exceed £60,000. It is curious that although electric tramways have been running in Port Elizabeth for some time, no part of the town has yet enjoyed the advantages of electric lighting.

Interurban Goods Traffic.—The tramways in South Lancs., when completed, are to undertake the prompt delivery and transport of goods throughout a wide area. It is interesting to see what has been done in this way in the States. In this respect the Detroit interurban roads have an excellent freight business, which has cut very heavily into the steam railway traffic. The reason for the success of this business is not so much the lower fares, but the frequency of service, which is far better on the trolley lines than on the heavier steam railways. Our contemporary, the *Street Railway Journal*, from which we obtain the following figures, expresses the opinion that the strength of the electric lines lies in their ability to deliver goods frequently and promptly between city and suburban points. It continues that to the unprejudiced observer it would seem that the present competition with steam railways must cease under a working arrangement, by which the local business would be done by the electric roads acting as feeders for the main-line traffic of the steam railways. The milk traffic on the Detroit Electric Railway has been well developed, no less than 13,700 milk cans being handled per month, with a revenue of £370. The rates are 5d. per can under 30 miles, and 6¼d. for any distance over 30 miles. This tariff is reduced for short journeys near the city. For the goods traffic a complete system of depôts has been established, on one side of which the company's trolley cars are drawn up, while from the other side the goods can be delivered on the carts of the local people. The dimensions of this class of traffic can be gathered from the fact that over the system there was carried in the month of July more than 5,900,000 tons of merchandise. We do not see mentioned that large factories along the route have their own sidings on to the system, but this is likely to be done, and it is made a special point of in the scheme for South Lancs.

Electric Irrigation Pumping Plant.—A most interesting case of irrigation, maintained by an electric power pumping plant, is described by Mr. C. W. Arthur in the *Electrical World*. Situate on the shores of Utah Lake, in the State of Utah, it is stated to be one of the largest pumping plants in the world, and probably the largest using electricity as the motive power. Utah Lake. is some 30 miles distant from the city of Salt Lake, and has an area of 93,000 acres. The several canal companies who furnish water for irrigation purposes in the valley have an agreement with the owners of the adjacent land, vesting them with the right to raise the lake level to a point 3ft. above the low-water mark. In its normal state it was found impossible to get a greater discharge than 75 cubic feet per second from the lake, which was quite insufficient for the demand in the summer months. In these circumstances the several canal companies have united and installed a pumping plant at the head of the Jordan River, for the purpose of lifting the waters of the lake into the river, and thence into the canals supplying water for irrigation purposes. At the outlet a dam has been built, and here upon a pile and timber foundation the pumps are placed. The plant consists of four 40in. special low-running double-suction centrifugal pumps of the Byron-Jackson type, weighing about 12 tons each. They are fed with a suction of 40in., terminating in a 48in. discharge. Each pump has a pumping capacity of 100 cubic feet per second under a head of 5ft. 5in., which is equivalent to a flow of about 65,000,000 gallons every 24 hours. Each pump is independently driven by a 100-h.p. Westinghouse induction motor, and is provided with an

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auto-starter. The power for the operation of the plant is transmitted over a distance of 12 miles from Salt Lake at a potential of 16,000 volts, and is delivered to the motors through three Westinghouse transformers of 175 kw. each. This method of using the water stored in a lake by pumping might be used in those lakes in Ireland where storage for summer use cannot be obtained by raising the lake level.

London Locomotion Problems.—From a statement made by the Prime Minister in the House of Commons on Tuesday, the Government will in all probability appoint a Royal Commission to enquire into the means of locomotion and transportation in London. The reference to such a commission would also include the problems of the better regulation of vehicular traffic, the possibility of appropriating certain thoroughfares to certain kinds of traffic, the means of facilitating the construction of electric tramways along or immediately beneath the streets, and the steps to be taken for creating a properly arranged and conveniently inter-connected system of deep-level electric railways. Mr. Balfour admitted that the subject was one of the very first importance, not merely for the Metropolis, but for the country at large. The only hesitation which he had in giving an affirmative reply to the proposal which had been made was lest a Royal Commission should have the effect of unduly delaying the steps that should be taken, but he would consider the matter, and he thought that in all probability the appointment of a Royal Commission would be the best course. It will be seen that although the Royal Commission, if appointed, would enquire generally into the locomotion problem in London, by the terms of the reference it would also consider the question of "tube" railways. An enquiry such as this is practically what the London County Council this week unanimously decided to ask the Government to grant, with the difference that they would also like the commission to have powers such as were held by the Rapid Transit Commission of New York. Such a commission, it is urged, should be vested with authority to consider all proposals that might be brought before them for the construction and supervision of underground railways in London, and to report as to the desirability of establishing some authority to prepare and issue provisional orders for confirmation by Parliament authorising the construction of underground railways as such authority might be satisfied would be for the public benefit.

The World's Supply of Timber.—The main subject of the inaugural address of Mr. J. C. Hawkshaw, M.A., at the opening meeting of the new session of the Institution of Civil Engineers on the 4th inst. dealt with the world's supply of timber. Engineers, he remarked, could not do without timber, and it was worth while considering whether the supply of that material was likely to continue to be equal to the demand. It was calculated that the number of timber sleepers on the railways of the whole world did not fall far short of 1,495 million, and a low estimate of their value was £180,000,000. This alone constituted a serious drain on the timber supplies of the world. The president next reviewed the measures which had been taken in other countries to secure the control of forests and their management on scientific principles, and expressed the hope that the labours of the committee recently appointed by the Board of Agriculture, and at present sitting, would result in removing from Great Britain the reproach of being the most backward country in respect to forestry. Turning to means of cheap transport, he suggested that the time was coming when the main roads should be placed under one management throughout the country, and become a national charge instead of a charge on the local rates. Good roads, with organised steam traction, would be more useful to farming than would light railways. Considering next the generation of power, the president remarked that water power possessed important advantages in its cheapness and also in its certainty, which was assured as regards the minimum supply; moreover, its cost was practically independent of the fluctuating cost of fuel and labour. Up to the present it was the electro chemical industries which had taken most advantage of cheap water power, and some of its applications in this direction were briefly alluded to. The difficulties connected with the utilisation of water power arose out of the necessity of storage for regulating the flow, a matter of little difficulty where lakes could be used for storage in uncultivated country, but entailing works of almost prohibitive cost where any alteration of the accustomed water-level led to interference with vested interests. The address concluded with some remarks on the relation of the biological sciences to the work of the engineer.

Electricity from the Tides.—A scheme has been proposed for obtaining electricity for use either at the central station or amongst a special class of consumers in the area of Dundee in connection with the docks of that town. The scheme in question is fully described in the issue of the *Dundee Advertiser* for last week. The name, however, of the author of the project is not given, but our contemporary states that its details have been carefully examined by a firm of electrical engineers and reported on favourably. It seems from the commencement of the article that the docks at Dundee are not extremely successful. If the scheme were adopted they would cease to exist as docks, and would simply become reservoirs, into or out of which the tidal water would flow, driving turbines on its way. The area of these docks and the heights below low water and high water will be presumably as given in the article, and the estimated cost of making use of the power is only £8,500. We should be inclined to doubt if the civil engineering work involved could be carried out for this, but our criticism of the scheme will not be on this score. The estimate states that for 16 hours per day 120 h.p. could be obtained from the water flowing into or out of King William Dock and 100 h.p. out of Earl Grey Dock. In estimating the revenue from the undertaking, the output is multiplied by 16 as the number of hours per day and by 365 as the number of working days per year. This gives the output available in Board of Trade units, which are reckoned to be sold at 4d. per unit. It must be remembered that the period each day during which power to be obtained varies with the state of the tide, and that it is most unlikely that any consumer of power could be found who would only require it during the 16 hours in question. If he did, it would have to be sold to him at less than 1d per unit in order to compete with steam plant installed for such a regular load each day. This reduction would at once bring the revenue down from £16,000 per annum to £4,000 per annum. We are afraid also that the intermittent use by other consumers would reduce even this £4,000 to below the author's estimate of cost, which is £1,670 per annum. Over and above this the docks would be quite useless for their present purpose, and we presume that the capital spent on them is hardly looked upon as wasted by the Dundee Harbour Board. The only chance for a scheme such as that proposed is where there is a large estuary available with a small tortuous inlet. In fact, the local conditions have to be so special that practically no successful tidal power station exists at the present day.

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TUNBRIDGE WELLS CORPORATION TELEPHONES.

AGREEMENT FOR SALE.

The Corporation of Tunbridge Wells took a prominent part in the agitation which ultimately resulted in the Telegraph Act of 1899 being passed, and they were the first to obtain a telephone license under the provisions of that Act. In our issue for Aug. 2, 1901, we gave a full description of the Corporation's system, which extends over 180 square miles of surrounding country, and provides telephonic communication to a large number of outlying villages, which previously were quite isolated from the town. At the opening ceremony it was already known that the National Telephone Company meant to fight the undertaking to the utmost, and that they had reduced their charge for an unlimited service to £4 per subscriber per annum. The Corporation charges were, and still are, £5. 17s. 6d. for unlimited service, or an annual rental of £3. 10s., plus ½d. for every outward call, or, again, £2. 10s. per annum, plus 1d. for every outward call. The present state of affairs is that the Corporation have now 853 subscribers, of which about one-half pay the full rate for unlimited service. The National Telephone Company have by active canvassing and by their reduced charges succeeded in getting 1,015 subscribers. Of the above 180 are subscribers to both the telephone systems, so that the total number of telephone users in the town is equal to 1,688. The Corporation undertaking, formally inaugurated at the end of July, 1901, has actually been at work some 16 months, and up to the present no authoritative statement of its financial position has been issued by the borough accountant. Certain favourable figures were published when the town had to seek more capital from the Local Government Board. In spite of strenuous opposition they were successful in getting this.

A new phase in the competition between the two undertakings was entered into on Wednesday, Nov. 5, when at a special meeting of the Tunbridge Wells Town Council a draft of a proposed agreement was submitted for the approval of the members present. This draft was prepared by the town clerk, Mr. W. C. Cripps, on his own initiative, and after considerable negotiations between him and Mr. Gaine, the general manager of the National Telephone Company. From what we gather, Mr. Stone, ex-mayor of Tunbridge Wells, was the only member of the Corporation who was aware of what was being done previous to the meeting on Wednesday, Nov. 5. The agreement, which is too long to give in detail in our columns, provides for the complete transfer of the Corporation telephone undertaking to the National Telephone Company for the actual cost expended on the same. The terms of the agreement may be briefly summarised as follows: The company may either repay in a lump sum the whole of the capital spent by the Corporation, or may pay the half-yearly instalments of the interest and sinking fund as they come due. The company would take over the telephone undertaking from the Corporation, and would indemnify them against all claims and liabilities. The rates would be raised to £6 per subscriber for unlimited service, this rate to apply to all now connected to the exchange and to those who apply before March 25 next. The message-rate scales of the Corporation would be abolished, and one adopted providing for the annual payment of £3. 10s. per annum, plus 1d. per outgoing call, with a minimum charge of £5 per annum The company would have a free hand in fixing its charges for any subscribers applying after March 31 next. The company would have the use of the Corporation exchange for the next two years at the present rental, and would take over the staff of the Corporation at their present rates of remuneration. The company would pay the Corporation 2s. 6d. per annum for every subscriber on the unlimited service. This payment is spoken of as a wayleave rental. The Corporation would agree not to transact telephone busines within the licensed area nor to consent to anyone else doing so while the agreement remains in force—*i.e*, until, we presume, the expiration of the license in 1925. The only other feature of importance in the agreement appears to be that the Corporation shall do its best to obtain the consent of the Postmaster-General to the agreement, and that the company is bound to afford a proper, efficient, and continuous telephonic service within the licensed area.

The full agreement, as outlined above, was brought before the special meeting of the Corporation on the 5th inst. and was very nearly passed, although it had not even been read by the members. The opposition, however, succeeded in adjourning the matter until Wednesday this week.

The outcome of the above has been a series of indignation meetings in the town The first of these took place on Friday, Nov. 7, when the following two resolutions were passed with very little opposition: (1) "That this meeting expresses its strong opinion that the disposal of our municipal telephone undertaking, which was commenced on behalf of the ratepayers, should not be considered until a reasonable time for its development has elapsed." (2) "That this meeting protests against the manner in which the proposed transfer of the telephone undertaking to the National Telephone Company was brought before the Town Council; and it further expresses its opinion that no such transfer should take place until full information on the subject has been laid before the Council, and ample time has been given to consider it in detail."

An even more unanimous meeting on Monday passed, without any opposition, the resolutions below: (3) "That this meeting of the burgesses of Tunbridge Wells and subscribers to the Corporation telephone service records its emphatic protest against the attempt recently made to transfer the Corporation undertaking to the National Telephone Company, without either the Telephone Committee, the Town Council, or the ratepayers being put into possession of the true facts of the case, and it demands that these facts shall be brought to light, and that full reports from the borough accountant, the telephone engineer, and the committee be obtained before any further action be taken by the Town Council." (4) "That this meeting strongly disapproves of the disposal of any undertaking entered upon by the Town Council without such undertaking being given a full and fair trial." (5) "That the previous resolutions passed by that meeting should be sent to the Prime Minister, the Postmaster-General, the two members of Parliament for the district, and the Town Council."

The speakers at these meetings condemned the action of the town clerk in proceeding with negotiations with the company without any authority from either the Telephone Committee or the Town Council. In fact, a proposal from a strong supporter of the National Company in the town that Mr. Cripps should be empowered to meet Mr. Gaine in conference, was considered before the Telephone Committee in July last and negatived. They suggested instead that the chairman and one member of the Telephone Committee should meet representatives of the National Telephone Company; this was refused by the company. Remarks made by various speakers clearly showed that there is a distinct reason for the company pressing forward the agreement at the present time. On Nov. 11 last year a new license was issued by the Postmaster-General to the National Telephone Company extending the periods of the company's operations in the Tunbridge Wells area until 1925. According to the telephonic inter-communication regulations provided for in the Telephone Act of 1899, and issued by the Duke of Norfolk on Sept. 26 that year, the position of the company in organising competition to the Corporation exchange was considerably altered. These regulations, which were, of course, included in the new license, provide that the company shall give intercommunication between its system and that of any competing licensee when that licensee of the Post Office has a quarter of the number of subscribers belonging to the National Company, or has 500 subscribers in all. The company has a right to charge 1d. to 1½d. per call under these conditions, but if the subscribers of the new licensee equal or exceed in number one-half of the company's subscribers, the intercommunication must be free. This condition applies in Tunbridge Wells, so that the Corporation has now the right of free connection with all the subscribers of the National system.

It was also stated by those who have had an opportunity

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of perusing the new license that the company is precluded from under-cutting the Corporation as regards price, and that a notice has already been served by the Postmaster-General on the company calling on them to abolish the £4 rate at once, and to adopt for the unlimited user the minimum charge of £5. 17s. 6d.—*i.e.*, the same rate as charged by the Corporation. It would seem, therefore, that the new license effectually prevents competition as far as price is concerned, in which case the efficiency of the service would be the sole determinant as to which of the two undertakings new consumers will pay their subscriptions to.

Wednesday's Meeting of Council.

Despite many protests from the ratepayers, the Tunbridge Wells Town Council on Wednesday resolved by 19 votes to 8 to dispose of their telephone undertaking to the National Telephone Company for £25,000, the amount, by the way, which had been expended by the Corporation on the undertaking. The discussion was principally based on a report signed by Mr. W. C. Cripps (town clerk), Mr. J. W. Forster (borough accountant), and Mr. G. S. Wallace (telephone manager), which stated that in the month of February last, on the occasion of the Corporation's application to the Local Government Board for sanction to a loan of £15,000, making, with the amount previously sanctioned, a capital sum of £25,000, it was estimated by Mr. Bennett, the consulting engineer, that for this total expenditure of £25,000 there could be constructed 1,148 actual revenue-earning lines. On the experience gained in the working of the undertaking up to that time, it was estimated by the borough accountant, with the concurrence of Mr. Bennett (the consulting engineer), that the annual expenditure when the 1,148 lines had been completed would be £4,162, giving a surplus of income over expenditure of £1,086, which it was considered would be ample to meet any contingencies which might arise beyond £135 per annum, which had already been allowed for in the estimate of expenditure.

It was shown in the course of the report that the long lines to the country districts have proved much more costly than had been anticipated. The report further stated that Mr. Bennett in his estimate inadvertently omitted the whole cost of the aerial lines required to render the Molyneux Park and Beltring-road cables revenue earning, the amount thus omitted being at least £2,500.

A report on the situation was presented to the committee in July from Mr. Wallace, but the committee decided not to publish it, as to do so would simply injure the Corporation undertaking and tend to reduce its value, but they directed Mr. Wallace not to proceed with the Paddock Wood, Goudhurst, or Lamberhurst extensions, or the cable to Molyneux Park, to reduce the gangs of men employed on "capital" work, and to stay any steps with regard to a then contemplated extension to Cousley Wood.

"Since Mr. Wallace's report was presented in July last every economy has been practised, and the connection of fresh subscribers has as far as possible been limited to those whose lines would clearly be remunerative. But the time has now arrived when the £25,000 loan has been exhausted, as appears by the following balance-sheet:

Liabilities.

Proceeds of £28,200 stock	£25,000
Sundry creditors	1,859
	£26,859

Assets.

Cost of undertaking, including stores	£25,148
Debtors	11
Cash in hand	1,700
	£26,869

At the end of October, 1902, the number of actual revenue-earning lines constructed was 853, and by using the stores in hand and reducing them to the value of £600, Mr. Wallace is of opinion that the number of lines can be raised to 883. If, further than this, Mr. Bennett waives the whole of his commission, Mr. Wallace would be able, by carefully selecting the orders, to increase the number of lines to 1,010. The average rate of earning per line has, however, fallen since February, 1902, from £4. 11s. 5d. to £4. 2s. 10d. The average cost of construction per line, as estimated by Mr. Bennett in February last, was £21. 15s. 6d.—*i.e.*, 1,148 lines were estimated to cost £25,000. Actual experience has shown that the average cost of construction per line has been £28. 6s.—*i.e.*, only 883 lines will have been constructed for £25,000. The diminution in the number of lines from 1,148 to a possible maximum of 1,010, coupled with the reduction in the average annual earning of each line brings about the result that the excess of income over expenditure which was estimated for at the time of the enquiry has disappeared, and the undertaking shows an estimated annual loss of £19, without taking into account any allowance for contingencies. It appears to the three gentlemen signing the report that there are two courses open to the Corporation: (1) to accept the offer of the National Company; or (2) to endeavour to obtain the sanction of the Local Government Board to a further loan of at least £10,000, explaining the position in which the Council is placed, and increasing the rates charged to subscribers—running the risk of a decrease in their number. It is manifestly impossible for the Council to continue its undertaking unless it can obtain a fresh loan, as after the 1,010 lines have been completed all new subscribers would have to be refused, and no work involving capital expenditure on construction could be undertaken."

After Mr. CRIPPS had read the report abstracted above, deputations waited on the Council from Tunbridge Wells and Tonbridge protesting against the sale of the undertaking.

The TOWN CLERK read a telegram from Mr. Bennett, the consulting engineer, as follows: "If my name is brought into the discussion, I consider the Town Council will do me a great injustice if they come to a resolution without hearing me. Please convey this to them."

Councillor MARSH, who opened the discussion, remarked they had had to work their undertaking upon estimates supplied, which had proved not free from inaccuracies. Such a thing was not peculiar to the estimates of the telephone undertaking by any means. It was a thing which occurred very often and generally; they had had other estimates which were none the less inaccurate. In the report presented to the Council they were told that by providing 1,010 lines they would have a deficit of £19 on the year's working. He presumed that 1,010 lines were calculated to bring in £4 per annum. They were told they would have a deficit of £19 at the end of the year. This was based on the £4 charge, but if the charge were raised to £5, an amount which they had just heard their subscribers were willing to pay, the deficit of £19 would be changed into a surplus of £890. What guarantee of an efficient service would the town have if it accepted the agreement from the National Telephone Company?

Councillor STRANGE regarded the agreement as an injustice, not only to the municipal subscribers, but to all the party-line subscribers on the National. The town clerk's argument that they could get all their names in the National Telephone Company's directory was a most trivial argument, especially as other towns were starting municipal telephones. He moved an amendment that the further consideration of the proposal should be deferred until the end of the present financial year.

The MAYOR ruled that it was a direct negative.

Councillor HICKS contended as there had been no allowance for depreciation or contingencies there would be a net loss, based on the present position of the undertaking, of £1,471. 12s. 6d.

Councillor WESLEY SMITH said the report on the undertaking was a great surprise to him They had heard a great deal about secret negotiations, but he thought the Telephone Committee had been responsible for a good deal of secrecy. In July last the committee were told something that ought to have been communicated to the whole of the Council, and not to have allowed them to go on thinking that it was a paying concern.

Alderman DELVES said he had always held that the estimate for capital was wrong, and that the figures were wrongly estimated. Why need the town take further responsibility when they had a company to take the

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scheme over? The object of the telephone undertaking was to secure cheap telephones, and now they had got them.

Councillor ABBOTT defended the undertaking, and urged that they should give it a fair trial. He regretted that such an ignominious surrender should be contemplated, and he declared with some emphasis that they would be selling their birthright if they put their hand to the proposal.

After several amendments had been proposed and defeated, the resolution that the municipal scheme should be transferred to the National Telephone Company, provided the sanction of the Postmaster-General was obtained, was carried by 19 votes to 8.

SOME NOTES ON AIR-PUMP DESIGN.

BY C. L. BROWNE.

The thermodynamic saving effected by the use of a condenser in conjunction with a steam plant may vary from 10 per cent. to as much as 60 per cent. at light loads, and it is no small factor in favour of its use in a power station that it obviates the noise and vibration caused by atmospheric exhaust and the soaking of everything in the immediate neighbourhood of the exhaust outlet by the particles of water held in suspension by the exhaust steam, and by this steam itself when condensed, the former results becoming especially objectionable when the power station is situated in a thickly-populated district. Judging, however, from the poor vacuum which obtains in many central electric lighting and traction stations in this country, there would seem to be an inclination to underestimate the important part borne by the condensing apparatus in the economical generation of electrical energy where steam-engines are employed for this purpose. Instance a combined generator giving an output of 1,500 kw. at a mean speed of 150 revolutions. Supposing the diameter of the low-pressure cylinder to be 62in., and the stroke 2ft. 6in., the loss of 1in. of vacuum in the condenser may mean the throwing away of 34 i.h.p. And yet is no uncommon thing to see a condensing plant placed in some out-of-the-way pit or corner, under the care of an unsympathetic attendant, hammering away to painfully create a vacuum of from 23in. to 25in., or even less.

The most economical vacuum at which to work a condenser depends upon the conditions under which the main plant is run. In a marine engine, for instance, where, as is usually the case, all heat given to the boiler feed means so much extra coal burnt in the boiler furnaces, it is of vital importance to keep the hot-well temperature as high as possible, and, moreover, provided that the air-pump is of ample capacity and good design—since an improvement in the condenser vacuum means a corresponding lowering of the hot-well temperature—the degree of vacuum to be decided upon is of necessity a matter of compromise. In a power station, however, the working conditions are somewhat different from those which obtain at sea, since by passing the boiler feed through a flue-fired economiser a quantity of heat equal to from 10 to 25 per cent. of the total heat of evaporation may be given to the water without directly affecting the coal bill. And if the economiser be of ample capacity, a lowering of the hot-well temperature by 10deg. or 15deg. will produce but little difference on the final temperature of the water on reaching the boiler check-valve. So that, although an improvement in the condenser vacuum involves a reduction in the hot-well temperature, the better vacuum may be the more economical.

And yet there is but little doubt but that the average vacuum obtained at sea is higher than that apparently considered satisfactory in many steam power stations ashore. Where cold water is used for the boiler feed, there is but little excuse for a poor vacuum in the condenser. In many land surface condensers as at present installed it would be necessary, in order to obtain anything above 25in. of vacuum, either to entirely renew the air-pump or to unduly crowd the circulating pumps; and it is very questionable whether, in the latter case, the increased economy effected in the main engines would outweigh the extra work expended in the circulating pumps. It must also be borne in mind that apart from the decreased efficiency of an overloaded pump, an increase of the velocity of the water through the condenser tubes means a decrease in the quantity of heat removed per cubic foot of water handled by the circulating pumps.

By far the most fruitful cause of poor vacuum is bad design in the air-pump, and this is the more inexcusable since the vacuum may be frequently improved by increasing the efficiency of the air-pump without any corresponding reduction in the temperature of the hot-well discharge. In order to obtain satisfactory results, the design of the condenser, and more particularly of the air-pump, demand as much careful thought as any other part of a steam plant, and yet, to judge from the reports of the principal British insurance companies, air-pumps are directly responsible for nearly 20 per cent. of the total number of engine breakdowns. It would seem, therefore, from purely financial considerations that a little more care and attention bestowed upon the theory and practice of air-pump construction would be amply repaid, for, after all, commercial fitness is the real and final standard by which all mechanical contrivances must be judged.

It is a well-known law that when two or more gases are confined in an enclosed vessel, each gas will exert its own pressure upon the walls of the vessel, independent of the pressure exerted by any other enclosed gas—that is to say, that the total pressure in the vessel will be the sum of individual pressures of the respective gases enclosed. The pressure in a condenser under working conditions will be the sum of the pressure of the water vapour and that of the air entrained with it. Although the permanent gases liberated in the condenser consist chiefly of oxygen, nitrogen, and carbonic acid gas, that is, the chief constituents of air, the proportion in which these gases exist is slightly different from that which obtains in the atmosphere. The feed water introduced into the boiler contains a certain varying proportion of air mechanically mixed with it, and a certain proportion, also varying, of the above-named gases in solution. But since carbonic acid gas is more soluble than oxygen, and the latter than nitrogen, the dissolved gases liberated in the condenser cannot, strictly speaking, be referred to as "air." It will be near enough for the purposes of this article, however, to assemble under the general term of "air" the whole of the permanent gases that exist in the condenser. The function, then, of the air-pump is to remove from the condenser the air and the condensed steam, and in so doing to keep the vacuum as nearly perfect as possible. In a jet condenser the air-pump has also to remove the water used to condense the steam, and, in addition, the air drawn into the condenser along with this water. The latter type of condenser, though not favoured in central electricity works in this country, and for other reasons almost totally abandoned at sea, is by no means defunct. There are hundreds of large high-class Corliss engines used for mill-driving, running in connection with jet condensers, which efficiently and cheaply maintain a vacuum of from 26in. to 27½in. throughout the working year. The decision as to whether an independent condensing plant should be installed or whether the air-pump should be driven direct from the main engines, will also influence to a certain extent the design of the air-pump.

It is, of course, out of the question to consider driving the air-pump direct from one of the quick-revolution engines which have been so popular in this country during the last few years, and which are still highly esteemed in some quarters at the present day, and the fact that an independent condensing plant is in all cases necessary when it is desired to work this type of engine in conjunction with a mechanically-operated condenser, may be one of the disadvantages which attend its use. But where slow-revolution engines of large power are employed, it is undoubtedly cheaper in first cost, maintenance, and repairs to drive the air-pump direct from the main engines, beside the fact that less power will be absorbed in maintaining a given vacuum. In many of the Lancashire cotton mills the power absorbed in driving a direct-driven jet condenser is less than 1 per cent. of that developed by the main engines. The loss of the convenience of a good vacuum for starting up the engine, which is

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involved where the above course is adopted, is readily sacrificed for the advantages obtained thereby. Another objection which has been urged against the use of the direct-driven air-pump is that it is compelled to work at a constant speed relative to the main engine, whether the load on the engine, and consequently the quantity of steam to be condensed, be great or small. This objection, however, carries but little weight with it, since, neglecting friction, the work expended in driving the air-pump is directly proportional to the amount of air and condensed steam delivered against the pressure of the atmosphere. The friction to be overcome in working a single-acting vertical air-pump is almost negligibly small. A more important objection to the above course is that a serious breakdown in the air-pump may possibly necessitate the temporary shutting down of the main engine.

Independent condensing plants when steam driven are expensive in first cost and comparatively exceedingly wasteful in steam consumption, and many of them give evidence of a perverted ingenuity exercised in cramping them into the smallest possible compass at the expense of accessibility and efficient design, and it can only be under very unusual circumstances that the saving in floor space effected can warrant the sacrifice of efficiency involved. On the other hand, an independent steam-driven condensing plant may be started up before the main engines, and so allow the engine to be more rapidly run up to speed. The pumps also may be driven at any desired speed, and no failure therein need necessitate the shutting down of the main plant provided arrangement has been made for atmospheric exhaust. Motor-driven air-pumps are more economical than those driven by steam and have much to recommend them, but the intervention of gearing between the motor and the pumpcrank shaft is apt to lead to annoyance unless the design and workmanship are of the highest class; the bucket weight, etc., also requires to be carefully balanced if back lash is avoided.

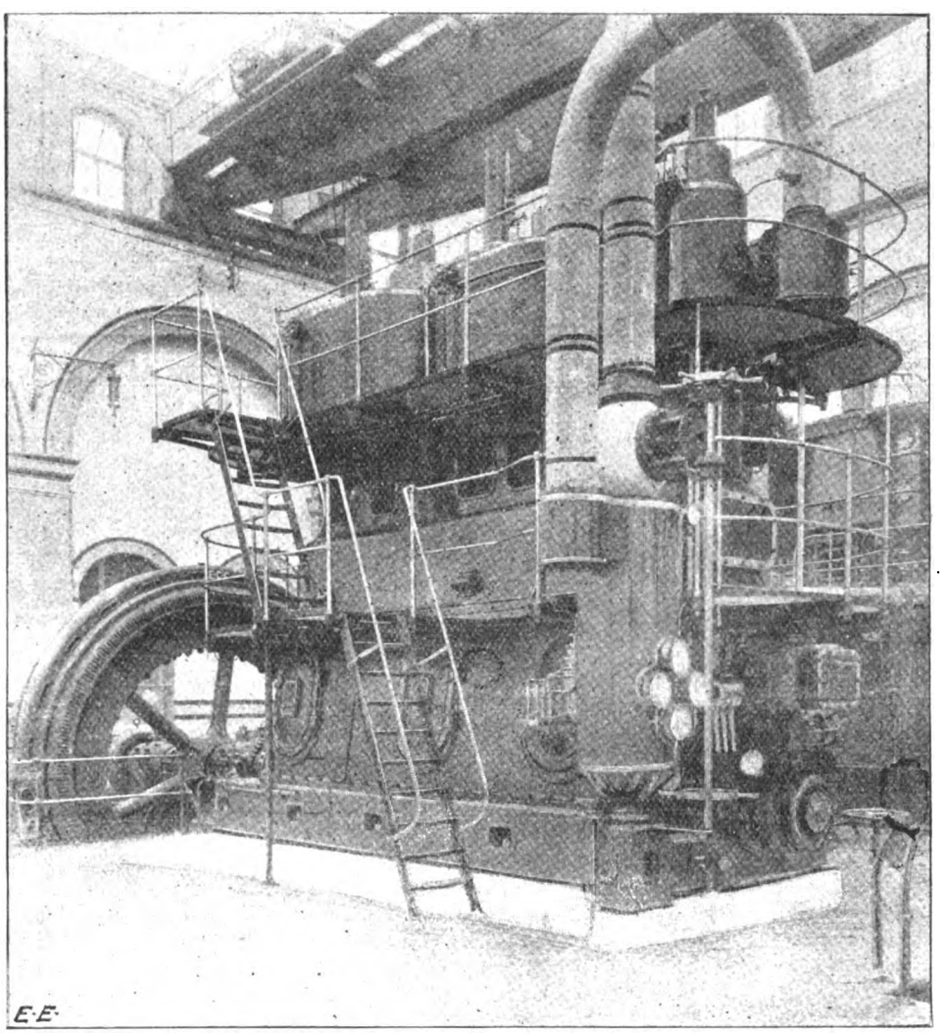
It may be remarked in passing that the American plan of coupling a motor direct to a centrifugal pump is an excellent way of dealing with the circulating water for a surface condenser, since the necessity of gearing is avoided, and the centrifugal pump is at its best when dealing with a comparatively large volume of water against a small head, and the water is handled without shock. It must be counted against this arrangement, however, that the centrifugal pump is more expensive, and requires slightly larger pipes and valves, and also takes up more room.

Generally speaking, and taking into consideration first cost, interest on idle capital, etc., where several engines are running in one power station the balance of opinion is in favour of an independent condensing plant.

(To be continued.)

LEEDS ENGINES.

We are able to reproduce herewith a photograph of the large Belliss engine which has been placed in the extension of the Leeds electricity works, described in our last week's issue. Its output of 2,500 h.p. at 200 revolutions per minute is an indication of the progress of high-speed engine design. The principal dimensions of this triple-expansion engine are as follows: high-pressure cylinder, 22½in. diameter; intermediate pressure, 35in. diameter; low-pressure cylinder 55in. diameter. The stroke of all the pistons is the same—*i.e.*, 30in. Piston valves are used throughout, and the governing is done by a throttle valve on the steam inlet. It will be noticed that the engine can be driven either from the floor level or from the first platform. The dynamo coupled to this Belliss engine is a 1,750-kw. two-phase alternator, made by the Electric Construction Company, of Wolverhampton.



The Belliss 2,400-h.p. Engine used to drive a Two-Phase Alternator at Leeds.

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A CONTRIBUTION TO THE THEORY OF COMMUTATION.*

BY ALEXANDER ROTHERT.

I have already dealt with this subject in a previous paper in the *Elektrotechnische Zeitschrift* of April 10, 1902. As a preliminary to a rational treatment of the subject of sparkless commutation I there laid down the condition that the brush position must remain fixed for all loads. I also briefly pointed out that sparking at the commutator must depend principally on the 'sparking voltage"—*i.e.*, on the voltage existing between segment and brush tip at the instant when contact is broken, and also on the strength of current per brush. The "sparking voltage" is distinguished from the well-known reactance voltage and similar criterions by the fact that it makes allowance for the variable contact resistance between brush and segment, whilst this is assumed constant in the reactance voltage calculations. The difference between the two methods is necessarily considerable, since the resistance is not even approximately constant, being at first infinitely great, then falling to a minimum whose value depends on the conductivity of the brush, and finally becoming infinite again.

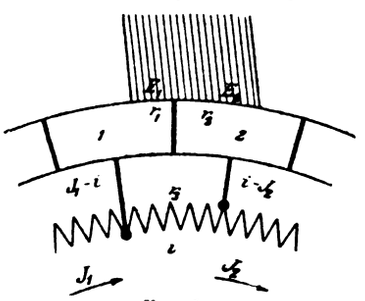

FIG. 1.

Before turning to the mathematical treatment of the subject, it will be as well to consider the general conditions somewhat more closely. Fig. 1 shows a commutator with brushes whose width is equal to that of a segment. The thickness of the insulation is assumed to be very small. The arrows indicate the direction of rotation of the commutator. Let the current, J, flowing through each armature conductor be considered as being first positive, and then becoming negative after the passage under the brush, so that $J_1 = +J$, and $J_2 = -J$. Currents $J_1 - i$ and $i - J_2$ (where i is the current in the short-circuited coil) will flow in the connections to the commutator. At the first instant of the commutation period—*i.e.*, when the brush begins to touch segment 1—the current i is equal to $J_1 = J$ and $J_1 - i = 0$. No current will as yet flow from segment 1 to the brush, for the contact resistance, r_1, between brush and segment will be infinitely great, and the contact area will be zero. At the same instant, the brush just covers the whole of segment 2, and its resistance, r_2, attains its minimum value. The whole current to the brush flows through the second segment, and

$$i - J_2 = -2\,J_2 = 2\,J, \text{ for } i = J_1 = J.$$

The current flowing to the brush and given out by it into the circuit is constant, and equals 2 J. At this instant, when the brush just covers the whole of segment 2, the whole current, 2 J, passes through this segment and through its connection into the winding. At the next instant the brush touches segment 1; the resistance r_1 is no longer infinite, and part of the current now passes through segment 1. The current, i, in the short-circuited coil will have diminished by this amount. This change in the current i brings the self-induction of the short-circuited coil into play, and the tendency of this is to retard all change. If there were no self-induction present, the subdivision of the current 2 J between the two segments would be such as to make the current in each segment proportional to its contact area with the brush. When, for instance, the brush is exactly central between the two segments, each segment would give half the total current = half of 2 J. At this instant i must be zero. The more of segment 1 which the brush covers, the greater the proportion of the total current which it will give, until finally, when the brush covers it entirely, it will give the whole current, 2 J, whilst segment 2 will give no current. At the same time i will have become equal to J_2—*i.e.*, the commutation period will be at an end—since the current, i, in the short-circuited coil will have changed its sign from $J_1 = +J$ to $J_2 = -J$. Since, with non-inductive commutation, the current, $J_1 - i$, given by segment 1 is proportional, as shown above, to the contact area between the brush and segment 1, $J_1 - i$ must be a linear function of the contact area—*i.e.*, of the time—and as J_1

* Translated from the *Elektrotechnische Zeitschrift* of Sept. 25, 1902, and Oct. 2, 1902. After practically completing this article in Alloa, where reference to the literature on the subject was impossible, I learnt that Arnold had already written on it exhaustively some years ago. As, however, in the meantime several aspects of the subject have altered considerably, and as my method is different from Arnold's, I may be forgiven for returning to the subject, especially as I have obtained certain results which have not been previously published, so far as I know. Whilst Arnold, with the aid of a mathematician, has used the difficult analytical method, I have chosen the simpler, if less exact, graphical method, and both, as shown by an example, give the same results.

TABLE I.—

i.	$r_1 = \frac{s}{l}$	$r_2 = \frac{s}{T - l}$			J = 10.								
						L = 1.				L = 0·5.			
	r_1	r_2	$r_1 + r_2$	$r_1\ r_2$	J $(r_1 - r_2)$.	i.	$i\,(r_1 + r_2)$.	$\frac{di}{dt}$.	E_2.	i.	$i\,(r_1 + r_2)$.	$\frac{di}{dt}$.	E_2.	$L\frac{di}{dt}$.
0·5	2	0·1055	2·1055	1·8945	18·945	9·5	20	−1·055	2·06	9·35	19·70	−1·51	2·05	−0·755
1	1	0·1111	1·111	0·888	8·88	8·97	9·95	−1·07	2·11	8·7	9·65	−1·54	2·075	−0·77
1·5	0·666	0·118	0·785	0·549	5·49	8·4	6·59	−1·1	2·17	7·95	6·25	−1·52	2·115	−0·76
2	0·5	0·125	0·625	0·375	3·75	7·85	4·91	−1·16	2·23	7·10	4·44	−1·38	2·135	−0·69
2·5	0·4	0·133	0·533	0·2666	2·666	7·26	3·87	−1·204	2·295	6·4	3·42	−1·52	2·185	−0·76
3	0·333	0·143	0·476	0·19	1·9	6·65	3·165	−1 265	2·38	5·6	2·67	−1·54	2·23	−0·77
3·5	0·286	0·154	0·44	0·132	1·32	6·02	2·65	−1·33	2·47	4·85	2·14	−1·64	2·285	−0·82
4	0·25	0·166	0·416	0·084	0·84	5·35	2·225	−1·385	2·55	4·05	1·68	−1·68	2·33	−0·84
4·5	0·222	0·182	0·404	0·04	0·4	4·63	1·87	−1·47	2·67	3·25	1·313	−1·82	2 41	−0·91
5	0·2	0·2	0·4	0	0	3·9	1·56	1·56	2·78	2·3	0·92	−1·84	2·46	−0·92
5·5	0·182	0·222	0·404	0·04	− 0 4	3·15	1·27	1·67	2·92	1·4	0·566	−1·93	2·52	−0·965
6	0·1666	0·25	0·416	0·084	− 0·84	2·3	0·957	−1·797	3·08	0·45	0·187	−2·05	2·61	−1·025
6·5	0·154	0·286	0·44	0·132	− 1·32	1·4	0·616	−1·936	3·25	−0·6	− 0·264	−2·11	2·69	−1·055
7	0·143	0·333	0·476	0·19	− 1·9	0·43	0·2045	−2·1045	3·47	−1·67	− 0·796	−2·2	2·77	−1·1
7·5	0·1333	0·4	0·533	0·2666	− 2·666	−0·62	− 0·3305	−2·335	3·75	−2·75	− 1·47	−2·38	2·9	−1·19
8	0·125	0·5	0 625	0·375	− 3·75	−1·8	− 1·125	−2·625	4·10	−4·0	− 2·5	−2·5	3·0	−1·25
8·5	0·118	0·666	0·785	0·549	− 5·49	−3·1	− 2·435	−3·055	4·58	−5·25	− 4·13	−2·72	3·16	−1·36
9	0·111	1	1·111	0 888	− 8·88	−4·63	− 5·14	−3 74	5·37	−6·65	− 7·4	−2·96	3·35	−1·48
9·25	0·1083	1·335	1·4483	1·2267	12 267	−5·57	− 8 04	−4·227	5·90	−7·38	− 10·68	−3·17	3·5	−1·585
9·5	0·1055	2	2·1055	1·894	− 18·94	−6·65	− 14	−4·94	6·70	−8·2	− 17·28	−3·32	3·6	−1·66
9·65	0·1037	2·865	2·969	2·761	− 27 61	−7·4	− 21·95	−5·66	7·45	−8·68	− 25·8	−3·62	3·78	−1·81
9·8	0·1022	5	5·1022	4·898	− 48·98	−8·3	− 42·33	−6·67	8·5	−9·22	− 47	−3·96	3·9	−1·98
9·90	0·1011	10	10·1011	9·9	− 99	−8·97	− 90·03	−9·03	10·3	−9·60	− 97	−4	4·0	−2
9·95	0·1005	20	20·1	19·9	− 199	−9·43	189·3	−9·7	11·4	−9·82	− 197	−4	3·6	−2

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is constant (=J), the current i must itself be a linear function of the time. This is shown graphically in Fig. 2. The scale is chosen so that the time of commutation, T, is equal to the brush width, so that every time t represents the corresponding brush position. The conditions indicated in Fig. 2 hold both for the case when the self-induction is zero and also when the contact resistance between brush and segment is very great—*i.e.*, when the conductivity of the carbon is very small. We will next consider what happens when the self-induction is neither zero nor negligible. The effect of self-induction is shown by the retardation, or putting back in time, of all current changes, and this retardation is greater the smaller the resistance of the circuit under consideration—*i.e.*, of the short-circuited coil—is.

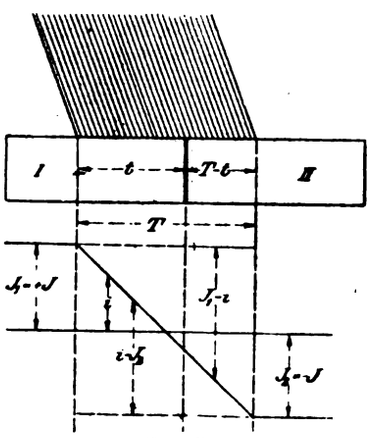

FIG. 2.

In our case, the retarding effect of self-induction is confined within limits by the fact that the time of commutation, T, cannot alter, since the commutation must be at an end when the brush leaves segment 2. With large self-induction, the last portion of the commutation is completed more or less suddenly, and the commutation time is then extended by a spark passing between brush and segment. Fig. 3 shows the approximate effect of self-induction graphically. The straight line, 1, represents self-inductionless commutation. When self-induction is present, its retarding effect is shown by the current i falling off less rapidly. As, however, the two extremities of the curve for i must coincide with those of the straight line, it follows that the current i must fall off all the more quickly towards the end the slower it changed at the beginning of the commutation period. Curves 2 and 3 show the approximate effect of a small and a large amount of self-induction.

Fig. 3 gives us an opportunity to investigate the current density under the brush. As indicated in Figs. 2 and 3, the ordinates of the curve for i, measured downwards from J_1, give the values of $J_1 - i$—*i.e.*, the current in segment 1—and measured upwards from J_2 the values of $i - J_2$, the current in segment 2. This last value divided by the corresponding abscissa of T, measured from the end—*i.e.*, divided by $T - t$—gives us the current density between the brush and segment 2. If the current density at the brush tip becomes too great towards the end of the commutation period, it may lead directly to sparking under the brush, and at the same time it may indirectly encourage it by causing the brush tip to become red hot. We see from Fig. 3 that the greater the self-induction is, the greater also will the current density be. The object to be attained, therefore, is to keep the curve of i—the

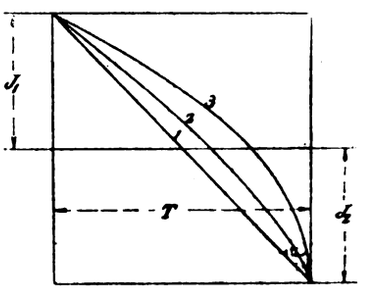

FIG. 3.

current commutation curve, as we may call it—as closely as possible to the straight line, as otherwise sparking is encouraged in two ways. This object can be attained in two ways: either by reducing the self-induction or by increasing the brush resistance. Later on we shall mention a third method. Returning once more to Fig. 1, we will further consider the "sparking voltage." As already stated, this is the voltage existing between brush and segment at the end of the period of commutation. If a spark occurs when the brush tip leaves the segment it is due to this voltage, and it will be greater the greater this voltage is and the greater the current in the brush. If r_2 is the resistance between segment 2 and the brush, as shown in Fig. 1, we obtain the sparking voltage by multiplying r_2 by the current flowing from segment 2 into the brush—*i.e.*, by $i - J_2$. The sparking voltage is, therefore, $E_2 = (i - J_2) \cdot r_2$. In the same way that E_1 is the voltage between segment 2 and the brush, the voltage $E_2 = (J_1 - i) r_1$ is the corresponding voltage between segment 1 and the

For $x = 1$, T = 10.

J = 10. L = 2.					J = 20. L = 1.					$r_3 = 0{\cdot}4$. J = 10. L = 1.				
i.	$i(r_1+r_2)$.	$\frac{di}{dt}$.	E_2.	$L\frac{di}{dt}$.	$J(r_1-r_2)$.	i	$i(r_1+r_2)$.	$\frac{di}{dt}$.	E_2.	$r_1+r_2+r_3$.	i.	$i(r_1+r_2+r_3)$.	$\frac{di}{dt}$.	E_2.
9·65	20·3	— 0·675	2·07	— 1·35	37·89	19	40	— 2·11	4·11	2·5055	8·5	21·3	—2·35	1·95
9·32	10·35	— 0·73	2·15	— 1·47	17·77	17·95	30	— 2·22	4·22	1·511	7·33	11·15	—2·27	1·925
8·95	7·02	— 0·765	2·24	— 1·53	10·98	16·8	13·2	— 2·22	4·34	1·185	6·2	7·33	—1·84	1·91
8·57	5·35	— 0·8	2·32	— 1·6	7·5	15·7	9·82	— 2·32	4·46	1·025	5·27	5·4	—1·65	1·91
8·16	4·35	— 0·84	2·41	— 1·68	5·33	14·6	7·78	— 2·45	4·6	0 933	4·42	4·12	—1·45	1·915
7·73	3·68	— 0·89	2·54	— 1·78	3·8	13·35	6·35	— 2·55	4·77	0·876	3·7	3·24	—1·34	1·96
7·28	3·2	— 0·94	2·66	— 1·88	2·64	12·05	5·3	— 2·66	4·83	0·84	3·02	2·54	—1·22	2·0
6·82	2·835	— 1·0	2·79	— 2·0	1·68	10·77	4·47	— 2·79	5·1	0·816	2·4	1·96	-1·12	2·06
6·32	2·55	— 1·075	2·97	— 2·15	0·8	9·38	3·79	— 2·99	5·35	0·804	1·85	1·488	—1·088	2·16
5·8	2·32	— 1·16	3·16	— 2·32	0	7·9	3·16	— 3·16	5·68	0·8	1·32	1·057	—1·057	2·26
5·2	2·1	— 1·25	3·38	— 2·5	— 0·8	6·33	2·56	— 3·36	5·83	0·808	0·8	0·646	—1·046	2·4
4·57	1·9	— 1·37	3 64	— 2·74	— 1·68	4·65	1·93	— 3·61	6·16	0·816	0·28	0·2285	—1·0685	2·57
3·88	1·71	— 1·515	3·97	— 3·03	— 2·64	2·85	1·25	— 3·89	6·53	0·84	—0·27	— 0·227	—1·093	2·78
3·12	1·48	— 1·69	4·37	— 3·38	— 3·8	0·9	0·43	— 4·23	6·95	0·876	—0·8	— 0·701	—1·2	3·06
2·28	1·215	— 1·94	4·91	— 3·88	— 5·33	— 1·18	— 0·63	— 4·7	7·53	0·933	—1·4	— 1·32	—1·346	3·44
1·3	0·813	— 2·28	5·65	— 4·56	— 7·5	— 3·54	— 2·21	— 5·29	8·23	1·025	—2·07	— 2·125	—1·625	3·96
0·13	0·102	— 2·795	6·75	— 5·59	— 10·98	— 6·18	— 4·85	— 6·13	9·2	1·185	- 2·85	— 3·375	—2·115	4·77
—1·28	— 1·42	— 3·73	8·72	— 7·46	— 17·77	— 9·23	— 10·25	— 7·52	10·77	1·511	—3·93	— 5·935	—2·945	6·07
—2·22	— 3·21	— 4·53	10·38	— 9·06	— 24·53	—11·12	— 16·1	— 8·43	11·85	1·848	—4 67	— 8·625	—3·642	7·12
—3·38	— 7·12	— 5·91	13·25	—11·82	— 37·89	—13·22	— 27·84	—10·05	13·55	2·5055	—5·6	— 14·02	—4·92	8·8
—4·28	— 12·7	— 7·45	16·4	—14·91	— 55·22	—14·75	— 43·72	—11·5	15·05	3·369	—6·33	— 21·3	—6·31	10·5
—5·39	— 27·5	—10·74	23·1	—21·48	— 97·96	—16·47	— 84	—14	17·65	5·5022	—7·28	— 40·05	—8·93	13·6
—6·48	— 65·5	—16·75	35·2	—33 5	—198	—17·88	—180·5	—17·5	21·2	10·5011	—8·19	— 86	—13	18·1
—7·3	—146·8	—26·1	54	—52·2	—398	—18·75	—376·5	—21·5	25	20·5	—8·88	—182	—17	22·4

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brush. Both these voltages must fulfil the condition that the sum of all the voltages in the circuit formed by the short-circuited armature coil is zero. Besides the voltages, E_1 and E_2, existing in this circuit there are the self-induction voltage, $L\frac{di}{dt}$, and the voltage lost in the resistance of the armature coil, including its connections to the commutator $= i \cdot r_3$. Taking the current as positive in Fig. 16 when flowing from left to right we get

$$-E_1 + E_2 + i \cdot r_3 + L\frac{di}{dt} = 0.$$

This equation may be interpreted as indicating that the flow of current from segment 2 to the brush is produced by the voltage E_2, and that from segment 1 by the differential voltage $-E_1 + i \cdot r_3 + L\frac{di}{dt}$. This means that in consequence of the self-induction more current flows through segment 2 than is indicated by the ratio of the resistances, r_1 and r_2. Inserting the values $(J_1 - i)\,r_1$ and $(i - J_2)\,r_2$ for E_1 and E_2 respectively we get

$$-(J_1 - i)\,r_1 + (i - J_2)\,r_2 + i\,r_3 + L\frac{di}{dt} = 0;$$

and replacing J_1 and J_2 by J and $-J$ respectively, we get

$$L\frac{di}{dt} + i\,(r_1 + r_2 + r_3) - J\,(r_1 - r_2) = 0. \quad . \quad (1)$$

This is the fundamental equation for commutation when the brush width is equal to that of a segment. It contains the constant L, the coefficient of self-induction of the armature coil; its resistance, r_3; and the current in each conductor, J. The variables are i, whose relation to the time, t, we wish to know, and the contact resistances, r_1 and r_2, between the brush and the two segments. The resistances, r_1 and r_2, are inversely proportional to the corresponding contact areas, and these last are proportional to the times t and $T - t$ respectively; so that we may write

$$r_1 = \frac{x}{t} \text{ and } r_2 = \frac{x}{T - t}.$$

When $t = 0$, $r_1 = \infty$, and r_2 reaches its minimum value, $r_2 = \frac{x}{T} = R$, where R represents the contact resistance of the whole brush.

In the same way, when $t = T$—*i.e.*, at the end of the commutation period—$r_2 = \infty$, and

$$r_1 = \frac{x}{T} = R.$$

We can therefore replace x by R T, and

$$r_1 = \frac{R\,T}{t} \qquad r_2 = \frac{R\,T}{T - t}.$$

In the great majority of cases r_3 may be considered negligible as compared with the carbon brush resistances, r_1 and r_2, an exception occurring when artificial resistances are inserted, and this special case will be considered later. Generally we can write

$$L\frac{di}{dt} + i\,(r_1 + r_2) - J\,(r_1 - r_2) = 0 \quad . \quad . \quad (2)$$

It is next necessary to solve this differential equation.*

I have attempted this solution, and have found that, even if obtainable, it would be a most involved one. Possibly some better mathematician may be more fortunate†, but until then we must be content with a separate graphical solution for each case. Considering equations (1) or (2) from this point of view, we see that di/dt represents the tangent of the angle of inclination of the commutation curve (Fig. 3) to the abscissæ (t). Since L and J are known to us as constants, and r_1 and r_2 can be determined for every time t we can calculate the shape of the curve with fair accuracy by dividing the time T up into a sufficient number of parts, starting from either end.

I have constructed the curves for a great number of cases in this way, and obtained results which give a very good idea of the change of current. These curves also enable the sparking voltage to be determined in a relatively simple manner. I shall give the curves for certain special cases below. In order to determine the shape of the curve, I have selected round figures for the values of T, J, L, x, and drawn the curves as accurately as possible on a large scale, starting from $t = 0$, and determining the first point by trial and error. The equation, in fact, gives a self-correcting curve—*i.e.*, the tangent of the angle of inclination will, for instance, work out larger if the preceding point has been chosen too high. This greatly simplifies the determination of the first point of the curve. My method was to select a likely value for $t = 5$ (T = 10), then to determine one or two further points, and then to

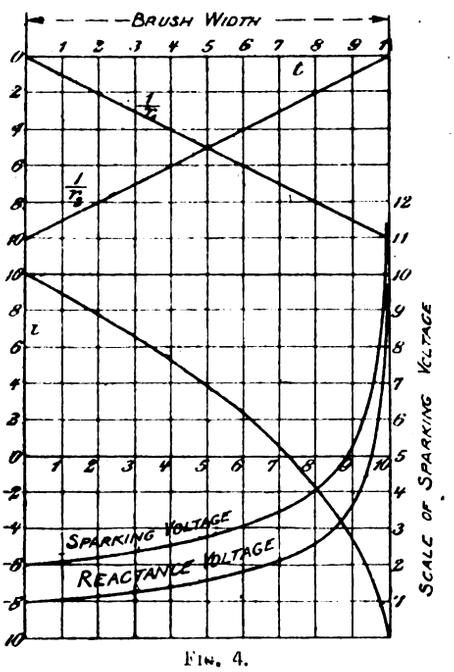

FIG. 4.

correct the first point so that it lay more nearly on the curve, and, finally, to correct the other points.

Example I.

J = 10. T = 10. L = 1. x = 1. r_3 = 0.

Then
$$r_1 = \frac{x}{t} = \frac{1}{t}$$
$$r_2 = \frac{x}{T - t} = \frac{1}{10 - t}.$$

The calculated (or rather, graphically determined) points for this example are given in the first part of Table I. The time T is divided into 20 equal parts. Towards the end of the commutation period I have, however, taken more points for greater exactness. I first determined the values of r_1 and r_2 corresponding to $t = 5$, $t = 1$, $t = 1{\cdot}5$, and so on. Then J $(r_1 - r_2)$ was obtained, and by taking the values of i from the curve the product $i\,(r_1 + r_2)$ was determined. Finally, by means of equation (1) or (2), the value of $\frac{di}{dt}$, the angle of inclination, which determined the next point, was obtained. The first part of this table corresponds to Fig. 4, in which the reciprocal values of r_1 and r_2 are shown at the top. These are naturally straight lines. The figure further shows the commutation curve and the "sparking voltage," which last is seen to rise steeply at the end. Unfortunately, the method employed does not permit the limiting value of the sparking voltage to be obtained, but it shows that it reaches a very high

* For the special case of inductionless commutation the solution offers no difficulties. When L = 0 we get $i\,(r_1 + r_2) = J\,(r_1 - r_2)$, or

$$i = J\frac{r_1 - r_2}{r_1 + r_2} = J\frac{x\,T - 2\,x\,t}{t\,(T - t)\left(\frac{x}{t} + \frac{x}{T - t}\right)} = J\frac{T - 2\,t}{T}.$$

This, as would be expected, gives a straight line solution having the value + J when $t = 0$ and − J when $t = T$.

† Aruold has obtained the solution (see the first note above), but it is too involved for use by non-mathematical readers.

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figure in this case. From the nature of the curve, the average value of the reactance voltage is obviously insufficient for determining sparking, seeing how steeply the sparking voltage rises just at the end. The reactance voltage itself is represented by $L\frac{di}{dt}$, and is also shown in Fig. 4. The shape of the curve is similar to that for sparking voltage.

The commutation curve forms a measure of the current density in the brush tip, as indicated above. Before proceeding to determine the curve for other conditions, it may be pointed out that the shape of the curve depends on the ratio $\frac{x}{L}$, where $\frac{x}{L}=\frac{RT}{L}$. Thus equation (2) may be altered as follows :

$$L\frac{di}{dt}=J(r_1-r_2)-i(r_1+r_2),$$

or

$$\frac{di}{dt}=\frac{J(r_1-r_2)-i(r_1+r_2)}{L}.$$

Substituting for r_1 and r_2 their equivalents, $\frac{x}{t}$ and $\frac{x}{T-t}$, we get

$$\frac{di}{dt}=\frac{x}{L}\left[J\left(\frac{1}{t}-\frac{1}{T-t}\right)-i\left(\frac{1}{t}+\frac{1}{T-t}\right)\right] \quad . \quad (3)$$

Equation (3) shows that the commutation curve remains unchanged if, when x is altered, L changes correspondingly. In other words, the harmful effect of large self-induction can be counteracted to a certain extent by choosing a brush of lower conductivity. Though the shape of the curve remains the same for a given value of the ratio $\frac{x}{L}$, yet the amounts of the reactance and sparking voltages do not. Both these voltages become greater the greater L and x are, for with a given $\frac{di}{dt}$ the reactance voltage is $L\frac{di}{dt}$, and with a given J and i the sparking voltage is $E_2=(J+i)r_2=(J+i)\frac{x}{T-t}$.

The fact that large self-induction can be counteracted by increased brush resistance is well known.* Equation (3), however, also shows that $L\frac{di}{dt}$ (*i.e.*, the reactance voltage, both maximum and average value) is by no means independent of the resistance. This equation (3) has great practical value according to the above; it only holds, however, for $r_3=0$—*i.e.*, for the case when no resistances are inserted between the commutator and the winding.

(To be continued.)

FROM SMELLS TO WATTS.

The opening paper† of the session read before the Manchester Section of the Institution of Electrical Engineers on Tuesday dealt with refuse destructors, and consisted principally of a consideration of their merits (with very marked reference to a certain well-known type) The demerits of destructors (and particularly those of the accentuated system) were apparently such a negligible quantity as to be beneath consideration; certainly the author, Mr. W. F. Goodrich, of London, did not unnecessarily fill up valuable time with this side of the question.

The paper, after some preliminary sparring of the time-honoured looking-backward description, hits out strongly for home and country in the shape of (the never-to-be forgotten system referred to) four cells in one, whereby one cell of the four can be recharged and clinkered without materially disturbing the efficiency of the set. Sketches are also given of this in the printed copies of the paper, and to finally impress the system on the dull provincial mind, at the end of the paper the identical sketches were shown by limelight and again fulsomely described. Photographs also of a number of destructors (of the unobtrusive type previously mentioned) in course of construction and working were cast upon the screen, together with results tabulated and in curve form, all of which were credited by the author as being "very satisfactory" and "most promising." Tabulations were also given in the course of the paper regarding the use of destructors, and comparisons were made of the numbers in use and the performances (especially of a certain type which shall here be nameless).

Mr. Highfield, of St. Helens, opened the discussion with a tribute to the smells, and described the ideal destructor-cum-electricity works as having a high wall and a field (not a highfield and a wall) separating the two component parts. He complained of the dust fouling the surface condensers, and in his experience men were more unhappy where a dust destructor added physical discomfort to the mental anxiety of a supply station. Men, in fact, needed so much more additional supervision to work properly under such conditions that he had been compelled to institute a system of piecework at ½d. per ton consumed above a fixed wage of about £1. This worked satisfactorily, as the men made good money and it paid the Corporation well, except on Saturday nights, when the money had to be got rid of somehow, and the steam pressure suffered. He attributed the large amount of drink consumed in St. Helens to the destructor piecework system. He decried the firing of cells with small quantities at a time, on account of the greater cooling effect; described the tipping platform at his station, and criticised the Wrexham arrangement of not collecting on holidays as making more plant necessary. He also thought that two sets of flues should be made to enable one battery to be cleaned out while the other kept steam up.

Mr. Cooper, of Colne, described some of the uses he put his destructor steam to, and referred to the convenient changing of responsibility over the plant at Colne, which was originally controlled by the Housing Committee, and was later taken over by the Electricity Committee, who, however, on the appearance of litigation in connection with it, promptly handed the plant back to its former masters. His idea of the functions of a destructor were: (1) to destroy refuse, and (2) to make steam. He lamented the fact that the increasing use of gas stoves in Colne was responsible for the inferior class of refuse now dealt with, and feared for the future, as cabbage leaves had not a high thermal value. His plant averaged about 1lb. of refuse to 1lb. of steam.

Mr. Brookman, of Rochdale, advocated shovel firing, from a 15 years' experience of it, and was against top feed anyway. He rebuked Mr. Highfield for his levity regarding drunken employés, and opined that it was only partly the fault of the men themselves.

Mr. Meldrum (whose name the assembly appeared to have heard before during the evening), after correcting some very obvious misprints in the paper, recommended the employment of agricultural labourers as better fitted for being taught how to stoke refuse than regular stokers, whose preconceived ideas are based upon coal stoking, which really needed different methods. For offal firing only hoppers were necessary, conveyors could not deal with the varied kinds of materials so well as shovels, and he preferred hand-firing. Steam-jets for forced draughts kept the bars cool, but did not cool the fires.

Mr. Birkett, of Burnley, made bitter complaint on the score of the stench experienced at his station, which "had driven him to drink." When fairtime came around, no one would work the dust-carts, which made foul times for him. Sixty tons of the unspeakable stuff would accumulate, and when it was eventually disturbed, the effluvia could be cut with a knife. He pleaded with the destructor makers that, since committees would force the wretched things on their suffering engineers, to let them down as lightly as possible by devoting special attention to non-stink devices.

A few other gentlemen spoke, either briefly or somewhat irrelevantly, and the chairman (Mr. E. W. Cowan) and Mr. J. S. Highfield consecutively had to drop violent hints as to the enemy.

* It follows from previous theories of commutation (Arnold), according to which $\frac{RT}{L}>1$ should hold.

† See supplement with this week's issue.

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MOTOR TESTS.—(D. Selby Bigge.)

Works department or machine.	Work done by motor: Total of machines on motor.	Work done by motor: Usual and average machines on load.	E.H.P. absorbed: Shafting and all machines light.	E.H.P. absorbed: Average machine light.	E.H.P. absorbed: Average machine loaded.	E.H.P. absorbed: Maximum load on motor.	Size and type of motor.
Fitting-shop motor.	2 9in. centre lathes. 1 12in. centre lathe. 1 3ft. centre chuck lathe. 1 planing machine, 9ft. stroke. 1 slotting machine. 1 milling machine. 1 shaping machine. 1 punch and shears machine. 2 2½in. vertical drills. 1 emery wheel. 1 cold saw (hack). 1 fan supplying 9 smiths' hearths. Shafting: 20ft. by 3in. C shaft; 5 others to 10ft. long.	2 9in. centre lathes. 1 12in. centre lathe. 1 3ft. chuck lathe. 1 slotting machine. 1 drilling machine. 1 emery wheel. Fan.	Shafting alone. 1·75 e.h.p. All machines light. 62 e.h.p.	3·7 e.h.p.	9·5 e.h.p.	14·9 e.h.p., with fluctuations, to 19 e.h.p.	20 b.h.p.
No. 1 galvanising-house motor.	4 large galvanising pots, each for 20 tons metal. 2 drying machines, attached. 1 large sheet-stretching machine. 1 large corrugating machine (press). 2 circular shearing machines, counter-shafting, and belts.	All machines, pots, and drying machines continuous, and others intermittent.	Shafting alone, 1·5 e.h.p.	—	Average full load, 11·2 e.h.p.	Fluctuation to about 18 e.h.p.	20 b h.p.
No. 2 galvanising-house motor.	1 large galvanising pot. 2 small galvanising pots (large, 20 tons; small, 10 tons each). 1 drying machine, attached. 1 rolling machine. 1 stretching machine.	All machines, pots, and drying machines continuous, and others intermittent.	Shafting alone, 1·0 e.h.p.	—	Average full load, 6·9 e.h.p.	Fluctuation to about 12·0 e.h.p.	10 b.h.p.
"Dolomite" crusher.	1 9ft. diameter pan mill, short counter-shaft.	—	2·6 e.h.p.	—	8·2 e.h.p.	11·5 e.h.p., occasionally.	10 b.h.p.
Stamping-house motor.	20 stamping machines, of various sizes and types, for armature and field core plates.	—	6·5 e.h.p.	—	9·8 to 10·3 e.h.p.	11·0 to 12·5 e.h.p.	10 b.h.p.
Steel-charging machine in steel mill.*	1 electrically-driven charging machine, charging and discharging—*i.e.*, heating furnaces and supplying live rolls, with ingots up to 10cwt. each.	—	Motor and 1st, 2nd, and 3rd motion shafts and gearing, 1·55 e.h.p.	Lifting 3·2 to 4 e.h.p.; travelling, 7·8 e.h.p; slewing, 4·9 e.h.p.; racking, 5·0 e.h.p.	11·0 e.h.p. 11·0 to 12·8 e.h.p. 6·3 to 8·0 e.h.p. 6·5 to 8·5 e.h.p.	Maximum when working three motions simultaneously about 22 e.h.p. under worst conditions	20 b.h.p.

* Weight of standard billet lifted, 10cwt. (maximum, 12cwt.). Travelling rails, 6ft. gauge; wheels, 2ft. diameter. Collector gear = D.P. overhead bare trolley cable, with tramway collecting gear. Travel of peal = 12ft. 6in. When peal is racked in towards machine, the distance between centre of bogie and steel billet is approximately 20ft., taken radially. When peal racked out is approximately 32ft. 6in. from centre of support. Total lift of peal = 3ft.

MOTOR TESTS.—Tests on Cranes, Quick-Motion Overhead Travelling. Taken Aug. 18, 1902.

Works department.	Size and type of travelling crane.	Work done by crane: Average.	Work done by crane: Maximum.	Motion.	Actual tests on crane—figures taken Aug. 18, 1902. E.H.P. absorbed. Crane light. Starting effort.	E.H.P. absorbed. Crane light. Running power.	E.P.H. absorbed. Crane loaded. Starting effort.	E.P.H. absorbed. Crane loaded. Running power.	Speeds and loads during test. Actual load.	Speeds and loads during test. Approximate speeds.	Size of motor. H.P., brake or electrical.
No. 1 crane—plate mills loading.	5-ton 3-motor crane. Works in exposed position, both in and out of shop.	1 to 3 tons.	4½ tons.	Lifting.	13·4	·5	29·1	18·3	3 tons 6 cwt.	43ft. per min.	22 e.h.p.
				Traversing.	14·8	7·7	16·8	9·6		125ft. per min.	15 e.h.p.
				Travelling.	23·6	11·8	29·4	12·6		150ft. per min.	22 e.h p.
No. 2 crane—plate mills floor.	5-ton 3-motor crane. Works under cover.	1 to 2 tons.	4 tons.	Lifting.	18·0	9·6	27·8	12·8	3 tons	Speeds approx. as above.	22 e.h.p.
				Traversing.	20·6	9·35	24·5	10·3			15 e.h.p.
				Travelling.	28·5	11·3	34·0	12·4			22 e.h.p.
No. 3 crane (new)—plate mills loading.	6-ton 3-motor crane. Built and erected by Dowlar's Cardiff Works. Works in exposed position, both in and out of shop.	1 to 3 tons.	4½ to 5 tons.	Lifting.	22·3	9·5	29·4	19·2	3 tons 6 cwt.	60ft. per min.	20 b.h.p.
				Traversing.	11·3	6·2	14·9	7·3		150ft. per min.	20 b.h.p.
				Travelling.	29·5	12·0	32 8	13·8		165ft. per min.	20 b.h.p.

Remarks.—Cranes Nos. 1 and 2 have the motors fixed on the main girders above end carriage. Drive by square shaft and gear. Water starting and regulating switch, and metallic lever controlling switch. No. 3 crane has travel motor on main girders, and lift and traverse motors on the bogie. Gear driven. Water starting and regulating switch, and metallic lever controlling switch.

Note.—The starting efforts given above can be regarded only as approximate, being merely momentary and volts drop being disregarded. The cranes above are on 220-volt circuit. One longitudinal trolley wire only employed, the return being to "earth." The above working load tests present a fair and good heavy average load, and are seldom exceeded under actual working conditions in these works.

Mr. Goodrich, in his reply, mentioned that the labour (on a certain remarkable plant) at Tooting averaged 7½d. per ton burnt, and at Rochdale 8d. per ton.

The usual informal discussion in the tea-room afterwards dealt principally with the uses (and abuses) of advertisement and the substitution of granitic substances for bread

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MOTOR TESTS.

Designation of machine.	Work done—Maximum.	Work done—Average.	E.H.P. absorbed by motor with machine running light.	E.H.P. absorbed with load on.	Size of motor recommended. B.H.P.	Remarks.
Large plate edge planer ...	35ft. by 1in.	$\frac{7}{8}$in. or 1in. plate.	14·75	24·5	30	Cut ·05in. thick on 1in. plate 4ft. long at time of test. [reverse.
Small plate edge planer ...	15ft. by $\frac{3}{4}$in.	$\frac{5}{8}$in. to $\frac{3}{4}$in. plate.	6·33	20·1	25	This machine took 29·5 h.p. to Cutting $\frac{3}{4}$in. plate 22in. long. 21 h.p. to reverse.
Plate-straightening rolls ...	4ft. 6in. by 4ft. 6in. by 1$\frac{1}{2}$in.	10in. by $\frac{1}{2}$in. to 15in. by $\frac{3}{4}$in.	4·5	6·1 16·1 14	— — 15	10in. by $\frac{1}{2}$in. plate. Plate 4ft. square by 1$\frac{5}{16}$in. thick. Same plate on slow speed. [reverse.
Cold saw	16in. by 6in. girder.	About 12in. by 6in.	1·45	2·6	7	This machine took 19·1 e.h.p. to Cutting 12in. by 3$\frac{1}{2}$in. by $\frac{1}{2}$in. channel. Saw fitted with friction gear for feed, which prevents a heavy load.
Punch shears and angle cutter	12in. shear, $\frac{7}{8}$in. [plate. 1$\frac{1}{8}$in. hole, $\frac{7}{8}$in. plate.	— $\frac{3}{4}$in. hole, $\frac{1}{2}$in. plate.	3·85	6·0 8·85 5·15 4·9	10 — — —	$\frac{3}{4}$in. hole, $\frac{3}{8}$in. plate. 25 to min. 1$\frac{1}{8}$in. hole, $\frac{3}{4}$in. plate. 20 to min. Shearing 10in. by $\frac{1}{2}$in. plate. Cutting 3in. by 3in. by $\frac{3}{8}$in. angles.
Large ending machine	Knives 22$\frac{1}{2}$in. long	—	1·88	15·42	15	Ending 20in. by 7$\frac{1}{2}$in. girder, $\frac{1}{2}$in. web, 1in. flange.
Straightener and angle cutter	Angles and small bars.		1·53	11·55 6·15	10 —	Cutting 3$\frac{1}{2}$in. by 3$\frac{1}{2}$in. by $\frac{1}{2}$in. angle (momentary load). [piece. Straightening 6in. by 6in. angle
Shafting driving six radial drills	1in. holes.	$\frac{3}{4}$in.	3·7	7·5	8	All 6 drills at work. $\frac{3}{4}$in. holes in girder steel.
Large straightener	20in. by 7$\frac{1}{2}$in. girders.	12in. by 6in. girders.	3·96	6·9	8	Straightening 20in. by 7$\frac{1}{2}$in. girder.
Milling-tool notching machine	—	—	2·42	8·05 maximum load 5·8 av. load	8 —	4in. by $\frac{1}{2}$in. notches in flanges of 8in. by 4in. girders. Two notches cut at once.
Joggling machine	1$\frac{1}{4}$in. plate.	$\frac{3}{4}$in. plate.	9·85	16	—	Joggling 1$\frac{1}{8}$in. plate.
Scarphing winch	2 tons at 40ft. per min.	—	5·65	12·1 10·75	— —	
Shafting	Driving lathes, nibblers, planes, machines, etc.	Slotting machines, drills, milling, about 70 in all.	21	40-48	50	No. 1 shaft drives about 70 machines.
			1st motor 23, 2nd motor 22	40-50	50	No. 2 shaft drives about 40 machines on first motor.
			2nd motor 24	42-50	50	No. 3 shaft drives about 25 machines, slots and planers.
Grindstones	—	—	20·5	53-55	60	Seven grindstones varying from 5ft. to 10ft. dia.; each has fast and loose belt, also one Tusca grinding machine on same shaft.
Cranes	—	—	Driving ropes doing no work, 23	48	50	All rope-driven cranes.
						2 30-ton cranes; 1 15-ton crane; 2 10-ton cranes; all cranes are nearly full load at once.
Cold rolls (locomotive work)	Plates 40ft. by 4ft. 6in. by 1$\frac{1}{2}$in.	1in. plates.	Driving countershafts and belts only, 5	30	30	Straightening a plate 36ft. by 4ft. 6in. by 1$\frac{1}{4}$in. [by 1in.
				7	—	Straightening a plate 9ft. by 17in. Machine is driven by cross and open belts, and has four top rolls and three under rolls.
Joiners' shop machines.....	—	—	Driving shafting, 5·5	10	20	During a week this motor was not seen to rise above 10 h.p. When busy it absorbs about 17 to 18 e.h.p. It drives 12 tools, including two circular saws.
Vertical shipyard drills and countersinks	1$\frac{1}{4}$in. holes and 1$\frac{3}{4}$in. countersinks	—	Driving countershaft off which 2 per cent. drills are worked, 3·5	7·5	7	1in. hole and 1$\frac{1}{4}$in. countersunk; two machines doing 280 holes in 8 min. [min.
Punch and shears	1$\frac{1}{4}$in. holes in 1in.	Plate	2·7	6	12	$\frac{5}{8}$in. holes, $\frac{5}{8}$in. plate, 36 strokes per
	Shearing 1in.	Plate.	—	15	—	Shearing $\frac{5}{8}$in. plate 16ft. per min.
Punch and shears	Shearing 1in.	Plate.	2·75	3·5	12	$\frac{5}{8}$in. holes, $\frac{1}{2}$in. plate, 34 strokes per min.
				11	—	Shearing $\frac{1}{2}$in. plate 11ft. per min.
Mangle rolls	1$\frac{1}{8}$in. plates.	$\frac{3}{4}$in. by $\frac{5}{8}$in.	4·5	13·5	15	Motor is a series motor, with a tramway controller; belt drives direct to machine, and motor is reversed when mangling. This arrangement has given most excellent results. [broad in 2 min.
Wood-working tools.						
Hatch-boring machine	1in. holes.	$\frac{5}{8}$in. holes.	2·05	3	3·5	Boring $\frac{5}{8}$in. hole in hatch 22in.
Wood-planing machine ...	—	—	4·4	8·8	8	Cutting $\frac{1}{4}$in. off plank 10in. broad by 17ft. long in 1·5 min.
Wood-planing machine (heavy)	—	—	4·5	16	16	$\frac{1}{4}$in. off plank 7in. broad by 13ft. 6in. in 30 sec. [long in 20 sec.
32in. circular saw	—	—	0·9	14·8	15	Cutting 3in. teak, handfed, 14ft.
Heaviest class of shearing machinery	Steel tyres of loco. wheels.	General scrap.	2	29	30	Machine cut about 35 pieces 11in. by 1$\frac{1}{8}$in. section in 1 min.
Punching machine	2in. dia. holes in 1$\frac{1}{4}$in. plates.	1$\frac{1}{4}$in. holes in 1in.	3	10·5	12	Punching 19 holes per minute 1$\frac{1}{8}$in. dia. through 1in. plate. Machine driven by belt.
Large shipyard rolls	26ft. rolls to bend 1$\frac{1}{4}$in. plates.	$\frac{5}{8}$in. and $\frac{3}{4}$in. plates.	8	26	30	Bending plates 20ft. by 4ft. by $\frac{3}{4}$in. (load at reverse 26 e.h.p.). Rolls driven by cross and open belts.
18in. dock pump	—	—	—	74	70	Pump discharges about 500,000
5in. dock pump.....	—	—	—	11	10	Leakage pump. [gallons per hour.
Plate edge planer	$\frac{5}{8}$in., $\frac{1}{2}$in., and $\frac{3}{8}$in. plates.	Planing about 24ft. per min.	5$\frac{1}{2}$	$\frac{3}{8}$in. plates. 10	20	This machine took 23 e.h.p. to reverse; motor has cross and open belts on; special wide pulley, thus dispensing with the use of a countershaft. [min.
Punch and shears	1$\frac{1}{4}$in. by 1$\frac{1}{4}$in.	[plates. 1in. holes in $\frac{5}{8}$in.	3·5	7·5	10	1in. hole, $\frac{5}{8}$in. plate. 31 strokes per

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THE APPLICATION OF ELECTRIC POWER IN THE IRON AND STEEL INDUSTRIES.*

BY D. SELBY BIGGE.

(Continued from page 670.)

Machinery Tests.

In his papers before the Iron and Steel Institute, Cleveland Engineers, and Manchester Society of Engineers, the author gave a short table of powers absorbed by various classes of machinery. This was necessarily at the time of writing the papers somewhat scanty and incomplete. He now, therefore, places at the disposal of the institute an entirely new and complete schedule of tests, which have been carefully and accurately obtained by members of his staff during the past few months, and he trusts that engineers and managers of works may find these figures of some practical service and guide to them in deciding upon the horse-power of motors to be adopted for the driving of various classes of machinery. The list will be found to embrace the greater part of those tools usually found in all engineering establishments.

Motor Tests, taken Aug. 18, 1902.

Description of machine.	Work done by machine	E.H.P. absorbed.	Type and size of motor.	Remarks.
Three-ton skull-breaking winch.	Lifts ball weighing 3 tons 8cwt. to height of 50ft. at speed of 60ft. per min., timed	Light, 8·5 Loaded, 17·8	Two-pole open-type armature at bottom, 18 e.h.p., series wound.	This winch is of ordinary band pattern, driven through works and spur gear, with brakes and clutch. Water starting and regulating switch.

A table of machine tests in a somewhat different form is appended:

Condensing Plant.—One 10-h.p. motor 220 volts, driving direct-coupled 3in. centrifugal pump, driving also with belt air-pump 9½in. diameter by 9in. stroke, and feed pump 2in. diameter by 9in. stroke. Boiler pressure 200lb.

Operation.	Revs.	Amps.	Volts.	Vacuum.	Electrical H.P.	Electrical H.P.
					Total.	Actual per operation.
Centrifugal pump	1,100	6	240	—	1·9	1·9
Ditto with air and feed pump	160	12	240	27in.	3·8	1·9

Brass-Shop Motor. 5 H.P. 240 Volts.

Operation.	Revs.	Volts.	Amps.	Electrical H.P.	Electrical H.P.
				Total.	Actual per operation.
Motor and shaft	220	250	7·0	2·3	2·3
Disc grinder, 18in. emery discs running light	1,800	246	8·5	2·8	0·5
Facing 6½in. brass valves	1,800	246	24·0	7·9	5·6
6in. capstan lathe (light)	—	248	9·75	3·2	0·9
Turning and screwing 1½in. brass bars for ¾in. tap bolts	—	248	12·0	4·0	1·7
Parting ditto	—	248	10·0	3·3	1·0

No. 1 Foundry—Roots Blower, Acme No. M.

Operation.	Revs.	Volts.	Amps.	Electrical H.P.	Electrical H.P.	Time.
				Total.	Average.	
Motor and shafting light running	—	245	14	4·6	—	—
Blowing cupola—						
Maximum	360	246	104	32·7	28·2	4½ hours
Minimum	350	233	66	21·7		

Total weight of iron melted ..... 22 tons 10 cwt.
,, ,, ,, per hour 5 ,, 0 ,,

No. 2 Foundry.—Roots Blower, Acme No. K.

Motor and shafting light running	—	232	9·5	Total. 2·96	Average. —	—
Blowing cupola—						
Maximum	430	237	57	17·1	15·94	3 hours
Minimum	394	225	50	15·2		

Total weight of iron melted ..... 12 tons.
,, ,, ,, per hour ..... 4 ,,

Remarks.—No. 1 cupola is capable of melting on an average seven tons per hour.

* Paper read before the Iron and Steel Institute.

Boiler-Shop.—Vertical Plate-Bending Rolls.

Length of rolls		11ft. 7in.
Diameter of rolls	2	1ft. 11in.
Mean size of plates rolled		20ft. by 10ft. 6in. by 1in.
Maximum size of plates rolled		16ft. by 11ft. 5in. by 1½in.

Operation.	Amps.	Volts.	Electrical H.P.	Electrical H.P.	Time.
			Total.	Actual per operation.	
Motor and shaft light running	20	242	6·4	6·4	—
Rolls light running	24	242	7·7	1·3	—
			Average.		
Rolling plate, 23ft. by 11ft. 2in. by 1¼in.	90-68	233	19·2	12·8	3 min.
Putting squeeze on plates	30-60	233	9-18	6-12	—
Reversing the rolls	50	233	15·6	9·2	—

Air-Compressor, Belt-driving from Motor.

Operation.	Revs.	Volts.	Amps.	Electrical H.P.	Remarks.
Motor, shafting, and pumps	175	230	22	6·7	Air-compressor, 9in. diameter, 10in. stroke.
Pumping up to maximum pressure	170	230	70	21·5	Maximum pressure, 80lb.

Pattern-Shop Motor. 15-h.p. Motor. 220 Volts.

Operation.	Revs.	Amps.	Volts.	Electrical H.P.	Electrical H.P.
				Total.	Actual per operation.
Motor and shafting	170	9·5	233	2·9	2·9
Circular saw, 2ft. 8in. in diameter, running light	800	10·5	233	3·2	·3
Cutting yellow pine 11in deep, 7ft. per minute	Max.	40	233	12·4	9·2
	Min.	18	233	5·6	2·4
	Average	29	233	9	5·8
Thickness machine, 2ft. 6in. bed, running light	3,800	12	230	3·7	0·8
Surfacing yellow pine 11in. wide, 13ft. per minute	—	17·9	232	5·5	1·8

37-h.p. Motor.

Motor and shafting	—	12	230	3·7	3·7
Circular saw, 3ft. diameter, running light	1,200	21	230	6·4	2·7
Sawing yellow pine 11in. deep, 20ft. per minute	—	71	230	21·5	15·1
Circular saw, 33in. diameter, running light	—	26	230	8·0	4·3
Cross-cut lignum vitæ, 9½in. deep × 18in. long	—	41	230	12·6	4·6

30-ton Cranes. Boiler-Shop, 25-h.p. Motor. 220 Volts.

Operation	Amps.	Volts.	Electrical H.P.	Electrical H.P.	Time.	Feet
			Total.	Actual per operation.		
Motor and shafting and belts (light)	12	230	4·3	4·3	—	—
Heaving (light)	16	230	4·9	0·6	—	—
Cross travel (light)	15	230	4·8	0·5	—	—
Longitudinal travel (light)	16	230	4·9	0·6	—	—
Longitudinal and cross travel (light)	18	230	5·5	1·2	—	—
Travelling long	15 2	230	4·9	0·68	1 min.	90ft.
Weight 16 tons, heaving	36	230	11·1	6·2	1 min.	5ft.
Cross travel	30	230	9·2	4·4	—	—
Longitudinal travel	18	230	5·5	0·6	1 min.	90ft.

(To be continued.)

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INSTITUTION OF ELECTRICAL ENGINEERS.

The opening meeting of the new session of the Institution of Electrical Engineers in London was marred by the absence of the President, Mr. James Swinburne. This, we regret to say, was in consequence of illness, but his wide circle of friends will be relieved to hear that this not of a serious nature. In his absence the formal business of the meeting was transacted, and the premiums awarded for papers read during the last session were presented.

In spite of the wish of Mr. Swinburne that the address should be read for him in his absence, the Council decided to adjourn the same to a special meeting to be held on the 21st inst., when it is hoped that the President will be able to deliver it himself.

ST. HELENS ELECTRICITY ACCOUNTS.

From the accounts of the St. Helens electricity works, just issued, it appears that the total expenditure on capital account to March 31, 1902, amounted to £123,546. Abstracts of the revenue account, balance-sheet, etc., are given herewith.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£1,324	19	9			
Oil, waste, water, and engine-room stores	183	14	4			
Wages at generating stations	856	7	11			
Repairs, etc., of buildings and plant	693	12	5			
				3,058	14	5
Distribution of Electricity.						
Repairs and renewals of mains	283	8	9			
Free wiring	4	13	5			
Repairs and renewals of meters, etc.	5	7	1			
Repairs, etc., of overhead equipment	924	18	10			
Changing from alternating to direct current	15	8	2			
Sub-stations	13	14	9			
				1,247	11	0
Rents, Rates, and Taxes.						
Rents payable	216	19	0			
Rates and taxes	196	13	9			
				413	12	9
Management Expenses.						
Salaries of engineer and staff	1,170	19	0			
General establishment charges	350	14	0			
				1,521	13	0
Interest on loans				2,224	1	11
Dividend on 3 per cent. stock				272	10	2
Interest per bank				780	11	10
Interest on deposits				13	10	1
Sinking funds				1,521	18	8
Repayment of loans				1,478	6	9
Redemption fund				264	11	3
Superannuation fund				6	5	0
Subway charges account				51	3	11
Insurances, etc.				44	8	3
Total expenditure				12,898	19	0
Balance profit for the year				260	11	1
				£13,159	10	1

Cr.	£	s.	d.
Sale of current per meter, less discounts	10,437	12	8
Public lighting	229	6	1
Rental of meters and other apparatus	121	6	5
Fitting account	28	3	5
Motors	16	6	3
Repairing, etc., public lamps	40	16	0
Rents receivable (traction)	2,165	7	3
Other items—interest	120	12	0
	£13,159	10	1

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	92,000	14	1
Sundry creditors	2,288	7	6
Sinking fund account	2,495	13	11
Reserve fund account	226	13	9
Deposits (consumers)	392	7	0
Parr's Bank, Limited (overdraft)	34,488	0	1
Due to treasurer	108	5	0
Stock redemption fund	586	16	7
Premium on stock	354	4	6
Loans repaid from revenue account	3,625	1	5
Stock redeemed	520	0	0
Revenue account—surplus for year	260	11	1
	£137,346	14	11

Cr. Assets.	£	s.	d.
Capital account—amount expended on works	123,546	12	7
Stores on hand at March 31, 1902	3,668	19	0
Sundry debtors for current supplied	2,256	12	2
Other debtors	4,420	9	1
Suspense account	101	11	7
Parr's Bank, Limited, stock redemption fund	856	16	7
Parr's Bank, Limited, sinking funds	2,495	13	11
	£137,346	14	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			1,480,786
Quantity sold: Public lamps	55,033		
Quantity sold: By contract—tramways	827,837		
Quantity sold: Private consumers by meter	355,095		1,237,965
Quantity used on works			140,803
Total quantity accounted for			1,378,768
Quantity not accounted for			102,018
Number of public lamps			35
Total maximum supply demanded (kilowatts)			792

LEYTON ELECTRICITY ACCOUNTS.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£2,296	7	11			
Oil, waste, water, and engine-room stores	184	16	10			
Proportion of engineers' salaries	396	6	8			
Wages at generating station	602	17	8			
Repairs, etc., of buildings and plant	931	13	5			
				4,412	2	6
Distribution of Electricity.						
Repairs and maintenance of mains	122	15	0			
Repairs and renewals of meters, etc.	19	6	1			
Repairs, etc., of other apparatus	28	7	10			
				170	8	11
Public Lamps.						
Attending and repairs	599	17	0			
Renewal of lamps	186	16	6			
				786	13	6
Rents, rates, and taxes				503	11	3
Management Expenses.						
Salaries—engineer's department and staff.	893	11	5			
Stationery and printing	80	12	8			
General establishment charges	86	1	3			
				1,060	5	4.
Law and parliamentary charges				1,630	10	4
Special Charges.						
Insurances, etc.	73	16	11			
Self-insurance against breakdown	80	0	0			
Interest on deposits	8	15	9			
Cost of temporary plant, less amount realised by sale	944	13	4			
				1,107	6	0
				9.670	17	10
Amount carried to net revenue account				2,065	9	2
				£11,736	7	0

Cr.	£	s.	d.
Sale of current by meter	8,753	5	8
Ditto for public lighting	2,672	14	5
	11,426	0	1
Less bad debts written off	33	16	8
	11,392	3	5
Rental of meters and other apparatus	248	15	0
Rents receivable	10	0	0
Profit on installation work and repairs	85	8	7
	£11,736	7	0

Dr. GENERAL BALANCE-SHEET.	£	s.	d
Capital account—amount received	99,571	0	0
Sundry creditors	2,530	6	1
Amount due to treasurer (less cash in hand)	21,649	14	4
Self-insurance fund	211	0	0
Consumers' deposits	357	7	8
	£124,319	8	1

Cr.	£	s.	d.
Capital account—amount expended for works	109,448	19	7
Stores on hand	293	9	8
Sundry creditors for current supplied	3,685	16	9
Ditto for work done	145	18	11
Net revenue account	10,745	3	2
	£124,319	8	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			934,352
Quantity sold: Public lamps	261,315		
Quantity sold: Private consumers by meter	549,826		811,141
Quantity used on works			50,582
Total quantity accounted for			861,723
Quantity not accounted for			72,629
Total maximum supply demanded (kilowatts)			617·5

Number of public lamps: 439 incandescents, 63 arcs.

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CONTENTS.

Notes	685	The Faraday Club	704
Tunbridge Wells Corporation Telephones	690	Institution of Civil Engineers	704
Some Notes on Air-Pump Design	692	Forthcoming Events	705
Leeds Engines	693	Appointments Vacant	705
A Contribution to the Theory of Commutation	694	Questions and Answers	706
From Smells to Watts	697	New Committees	708
The Application of Electric Power in the Iron and Steel Industries	700	Legal Intelligence	709
Institution of Electrical Engineers	701	Companies' Meetings and Reports	709
Leyton Accounts	701	New Companies Registered	710
St. Helens Accounts	701	Contracts for Electrical Supplies	710
Municipal Telephone Competition	702	Traction Notes	712
Correspondence	703	Lighting Notes	715
		Provisional Patents, 1902	718
		Complete Specifications	719
		Companies' Stock and Share List	719
		Traffic Returns	720

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed*

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MUNICIPAL TELEPHONE COMPETITION.

At the time the Telegraph Act of 1899 became law we stated our objections to the policy, or rather want of policy, of the Government. This Act did nothing to remove the complaint which could justly be brought against the actions of previous Governments when dealing with the telephone question—*i.e*, that there was no continuity or fixed policy displayed in telephone control. The great uncertainty respecting the telephone undertaking of the country is still what is to happen in 1911, when the original licenses held by the National Telephone Company expire. It is true that if the licenses are not renewed the company cannot legally continue to give a telephone service; it is equally true that the business of the country will not allow of the telephone service suddenly ceasing in that year. The granting of licenses without a definite provision as to what is to happen at the expiration of the same was a serious blunder, or want of statesmanship, which Parliament seems incapable of rectifying. In 1899 it was decided that new licenses should be issued to municipal authorities allowing them to compete with the National Telephone Company. Presumably it was thought the competition would give greatly improved service, and that decreasing the value of the National Telephone Company's undertaking would make the ultimate solution of the transfer of either undertaking to the Government more simple. As we have frequently pointed out, the reverse is the case, as with two competing exchanges the wasted capital outlay is enormous, and this the Government would have to allow for under a compulsory purchase. It is curious to note, now that the provisions of the Act have been experimented with, that the rate-aided competition of a municipality is not bound to be successful against private enterprise even when burdened with watered capital. The first fight—*i.e.*, that at Tunbridge Wells—has apparently ended in favour of the National Telephone Company. Before the competition commenced the district was admittedly a badly-served one, the telephone rates were high, and the connections were limited both in number and in area. As soon, however, as competition was assured, the company completely reorganised their exchange, installing the most modern switchboards and instruments, while at the same time they reduced their rates to what must have been to them greatly below paying prices. Newspaper agitation followed, in which anonymous writers contributed weekly long collections of statistics more or less incorrect to prove that the Corporation's system was doomed to failure. The result of the fight is not complimentary to the Corporation of Tunbridge Wells. The full details of the agreement by which they are handing over their undertaking to their rivals will be found elsewhere in this issue, and it only awaits the Postmaster-General's consent to become legal. It is curious that the agreement in question should have been drafted entirely on the responsibility of the town clerk with the knowledge of an ex-mayor, and that until it came up for approval by the Corporation the financial condition of the department was not generally known. The fact that a slight raising of the rates for telephone connection such as is to be made under this agreement would have made the municipal undertaking a success, makes it more difficult to understand the hurried transfer. The position when this has been made will be that the National Telephone Company will have secured an extended license for the Tunbridge Wells area on most favourable terms, and it will be empowered to charge what rates it likes to all subscribers joining after March 25, 1903. It will be interesting to see what the Postmaster-General will have to say when the agreement

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is submitted to him for approval. It would seem to be a case in which he has the right under the Act to carry on the work as a department of the Post Office. From the company's point of view the situation is all that can be desired, as they have routed a rival within eighteen months of the competition starting, and will be able to use this as an argument against other corporations taking up similar work. From what we know, however, of the character of the Glasgow councillors, and of the public men in other towns where telephones are being considered, a temporary loss will not prevent them from rendering what they consider to be a public service. Neither are they likely to throw up a fight just at the time when the best weapons of their adversary are rendered useless by clauses in the new telephone license of the company. Eventually, however, the whole telephone communication of the country must be in the hands of the Post Office, and this fiasco at Tunbridge Wells may convince the Government that the sooner this is definitely arranged the better.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE INCORPORATION OF UNIVERSITY COLLEGE, LONDON, IN THE UNIVERSITY OF LONDON.

SIR,—The policy of the incorporation of University College in the University of London has met with general approval as an important step in the direction of establishing in London a real teaching university which shall have its own professors, laboratories, buildings, and equipment.

For the purposes of incorporation a sum of £92,000 has already been subscribed. A further sum of £108,000 still remains to be raised in order to place the medical school of University College on a proper footing, and to transfer University College School to a more suitable quarter of London, and thus to satisfy the demand that exists in the suburbs of London for secondary education of the first grade. This sum of £108,000 includes the estimated cost of a new site for the school of advanced medical studies, which it is found desirable to provide in order to avoid encroaching on the ground it is proposed to place at the disposal of the university for the further extension of university buildings

The university and the college are both equally interested in speedily obtaining the money that is still required, and in view of the important issues involved it cannot be considered that the total sum asked for is a large one.

We appeal with confidence to those who are aware of the needs of London in respect of university education to assist in carrying out the proposed incorporation.

Subscriptions should be sent addressed to Sir Richard Farrant, University College, London, Gower-street, W.C., who will be glad to supply any information desired.—Yours, etc.,

(Signed) REAY, President of the College.
BRASSEY, Chairman of the Appeal Committee.
RICHARD FARRANT, Treasurer of the College.

ON THE BRAKING OF TRAMWAY CARS.

SIR,—The importance of efficient car brakes, and the proper handling of the same, is a subject which has recently and frequently been brought to the front. Whether the subject would have been left so long (one might almost say in abeyance) had tramway engineers and managers first had to have served as drivers, is, perhaps, a very open question; but there is little doubt that the man who is driving a car every day and doing his work properly is a really practical driver. He may never be a genius in designing brakes—or anything else, for that matter—but he *can* tell when the brakes are sufficient to hold his car. He can even tell which of the many brakes requires the hardest work to obtain the best results, and those which keep him longest out of lumber. He perhaps has had sufficient training to enable him to regulate and adjust them should he find the shoes not all come on to the wheels together, or if all his strength is exhausted in the pull-off springs. So that one cannot help but think that suggestions from him on this point may give the cue to managers and engineers as to which is the best direction to apply the talents of invention.

There are many kinds of brakes in use to-day, but I do not propose to advertise or condemn the work of any particular firm by the mention of names of anyone responsible for what, at the time, was, and perhaps is, a good and efficient brake—*under certain conditions*—but when others come along with one more efficient — well, we must in all fairness admit that it is not only "never too late to mend," but that we—experts and knowitalls—none of us are too old to learn. Brakes are one of the principal essentials, if tramway accidents are to be avoided; yet only too often good brakes get the blame, and persons who should really know better are only too prone to believe "the brakes failed to act," which is the usual excuse for runaway cars and big accidents. "Failed to act. Why?" "On account of the greasy state of the rails." *Now* you see it's the *rails* which get the blame. "Yes," says the delinquent, "the brake failed to act, because the rails were greasy, and the wheels picked up or skidded." Failed! How has it failed? Why, the very fact of it having skidded the wheels proves at once that it was in *good* and perfect order, for what can a hand-brake do more than stop the wheels from revolving?—providing, of course, that when we are told the wheels skidded it is meant that *all of the* wheels were locked. If only a part of them skidded, then the brake *was not* in perfect order, but if *all* were stopped from revolving, the shoes all going on the wheels together, *then* it was not the brake at fault, but the driver was too strong in the arm, and too ——. For if too much of anything causes that which is undesirable, the remedy is simplicity itself. Take away the cause—or at least a part of it—and the result will be different. In speaking thus of the driver we must not close our eyes to the fact that if the cant of the rails is so that the wheels touch and run on a mere part of the outer or inner edge of the rail tread (about as much as the front edge of a table knife) that the driver then, under such conditions, must not only *not* use his arm; he can—figuratively speaking—scarcely *look* at the brake before the wheels will pick up and skid, in which case the poor wretch is between the "devil and the deep sea," and should *not* be blamed, but the blame should rest on those who are answerable for the track. I say wretch because under such conditions the driver's life would be a wretched one, and of no more value to him than that of an ordinary street dog.

It will be seen that up to this point I am dealing with the ordinary hand-brake acting on the rim of the wheel; but I have also experienced the use of a good track or slipper brake, but refrain from mentioning names of firms, as it is possible to be charged with seeking bribes or cheap advertisements for any firm mentioned.

The slipper or track brake gears in use in this country are of several types, yet all aim at the same object, but several miss it except under certain conditions, and whether they be applied by hand or any other means, they are almost all *pressed* on to the rail, and this takes part of the car weight off the wheels, little or much, according to the amount of strength put into the leverage; nor does it matter whether the shoes be of wood or any other material, they practically all tend to lift the car off its wheels, so that there is a great deal more danger of their being picked up or skidded as soon as the ordinary hand brake is applied. This being so there is also a great deal more danger of the car jumping or mounting over the rails; more especially is this so in curves. It does not matter whether the brake has been applied by manual labour, steam, vacuum, or compressed air, they all give the same tendency to jump the car over the rail (unless the driver could be prevailed upon to release the slipper before entering upon the curve), and this it would not be fair to expect, because he has been instructed that the slipper brake will stop his car which is running away. These brakes *may* be effective enough for the straight, but when curves, turnouts, crossovers, etc., are in front, over goes

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the wheels, and the car is stopped by the kerbstone or the housside, and not by the jacks which have lifted her off.

There is one track brake which I have not yet dealt with—*i.e.*, the magnetic—and this appears to attain the desired end, or to approach so very near to it that one fails to detect any failure in it; it may be more expensive at first cost, but there is undoubtedly much to be said in its favour as a good and effective preventer of accidents. It may appear, at the first glance of a layman, to lift the car like the others, but being a magnet it cannot help but pull itself down and *cling* to the rails; not only this, but it is also pulling more weight on to the car wheels, so that there is more power still put upon the shoes which are applied to the wheel-rim, and upon arriving at the curves and dangerous places the car is not so likely to mount over the rail as the others were, whose wheels were relieved of part of their usual weight. There is one other and perhaps important point in its favour, which is that it can be applied in two movements of the left hand in about as many seconds. There need be no hurried struggle with ratchet pawls, levers, and wheels, with perhaps a miss and slip thrown in, but two simple movements, and the car is trying to fasten itself to the rails.

If tramway owners wish to keep their reputation free from the taint of accidents, and their purse strings from unscrupulous claimants, they should not hesitate to equip their rolling-stock with a good and efficient magnetic track brake, and instruct and train their hands in the proper use of it; the first cost may appear great, but it is like many another thing, "the best is cheapest in the long run."

But all the brakes in the world will not stop a runaway car unless there is a man with brains in his head on the front of it.

SAFETY.

PORTABLE LAMPS.

SIR,—We are interested in the purchase of large quantities of portable electric hand lamps of a small size suitable for storing in one's pocket. We understand they range about 4in. to 6in. long by, say, 1in. diameter, and are somewhat after the stye of the gas lighters. It is an inexpensive line we are looking for to put on the Far Eastern markets in order to throw a light in districts where traffic is carried on under difficult circumstances by reason of the thoroughfares being so badly lighted. We do not know whether the article is of English, German, or American origin, but perhaps you can assist us in tracing the makers. Please accept our thanks in anticipation of a favourable reply.—Yours, etc.,

R. B.

MOTOR.

SIR,—Will any of your readers kindly inform me if a dynamo 110 volt 50 amperes will charge accumulators to drive a motor (7 h.p.) of the same voltage, also the size and number of accumulators required?

INQUIRER.

THE FARADAY CLUB.

On Friday last this club held its annual dinner and reception, at which a considerable number of invited guests were present, and passed an exceedingly enjoyable evening. The clubrooms are at the St. Ermin's Hotel, Westminster. Although the name perpetuates that of one of Britain's greatest sons, one whose work in the realms of science, and especially in electricity and magnetism, will be historic as long as history lasts, the members are not wholly restricted to the electrical profession, but represent many branches of the engineering profession. The club is comparatively young, but numbers some 180 members, and is eager to increase this number by suitable names. The presiding genius at Friday's feast was Mr. J. Swinburne, who is also this year's president of the Institution of Electrical Engineers. Our experience during the evening was: the dinner was good and well served, the company bright and cheery, the toast list short, the musical entertainment admirable; and our conclusion about the whole matter is the members are companionable good fellows, and that such meetings make life worth living, allowing men to cast aside the restriction of professional work to show their natural good feelings, and generally to make man think more highly of his fellow-man. May the Faraday Club long survive and be increasingly prosperous!

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, Nov. 11, 1902, Mr. John Clarke Hawkshaw, M.A., president, in the chair, the paper read was "Electric Tramways," by Messrs. C. Hopkinson, M.I.C.E., B. Hopkinson, and E. Talbot, M.I.C.E. The authors stated that when, about the year 1897, electric tramways had begun to be constructed in Great Britain on a large scale, there had already been many thousand miles in operation in America, and a vast amount of American experience had been available in connection with this branch of engineering. Consequently, British tramways had been constructed largely according to American methods, and showed a good deal of the uniformity characteristic of American practice. The authors' experience had been gained principally in the construction of the tramway systems of Leeds and Newcastle-on-Tyne, and the paper discussed a number of important points in tramway practice, which were illustrated by reference to these two systems of tramways. The paper was divided into four sections—viz.: (1) generation of power; (2) transmission of power to the cars; (3) rolling-stock; (4) earth returns.

The nature of the load on a tramway generating station was discussed, and it was shown from actual records to what extent increasing the number of cars resulted in making the load more uniform. With 70 cars or more, the load was so nearly constant that the steam consumption per unit was substantially the same as though it were constant and equal to the mean. Hence in a station of this size, equalisation of the load by means of a storage battery was of no use as regarded economy, though in a small station it might be of great value. A storage battery equal to replacing one-third of the generating plant for half-hour, should, however, be installed in a continuous-current power station for the purpose of replacing a generating unit in case of breakdown, and for running cars at night. The effect of short-circuits on the generator was considered; in the worst case there might be a force equal to three or more times the normal force applied at the periphery of the armature for a period of one-tenth of a second, that being the time which a circuit breaker took to open. This necessitated a very strong connection between armature and flywheel. Another effect of the opening of the circuit breaker was the sudden diminution of the load on the engine to nothing, which necessitated special arrangements for preventing the engine from running away. This required either very quick governing or a heavy flywheel. Except for short-circuits, an ordinary governor and an ordinary flywheel were sufficient. Tachograph records showing the rise of speed on one of the Newcastle engines when the load was thrown off were discussed. The question of over-compounding dynamos was considered, and dynamos wound for constant potential were recommended.

The simplest method of transmitting the power to the cars was to make the trolley wire into an electrically continuous network and to feed the current into it at various points. In practice, however, it was found necessary to divide the trolley line into sections insulated from each other, each section being fed at one point. The points of division in the centre of a city were determined by considerations of safety; in the outer districts, questions of economy and the necessity of keeping the variations of line potential within limits might come in. The principles were illustrated by reference to Newcastle-on-Tyne. There was no objection to the line potential occasionally dropping 100 volts below normal, and this led to the result that a $2\frac{1}{2}$-minute service of cars could be worked up to a distance of two miles from a feeding point. The most economical size of cable was next considered; the mean current density should rarely exceed

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300 amperes to the square inch. This entailed a mean drop of potential of about 13 volts per mile of feeder, and feeders could be carried to a distance of 1 mile or 1½ miles without boosting. The loss in the trolley wire in supplying 10 cars on one mile of double track from one end was between 2 and 4 per cent. of the power given to the cars. The conclusion was that on the outer sections the line might be divided into sections two miles long In many cases excessive traffic on a particular route had to be dealt with on a few days of the year, the traffic being small on other days. This was illustrated by reference to a case in Leeds, where 50 cars had to be supplied with current on 20 days in the year at an average distance of 3½ miles from the generating station. The method by which this was done with continuous current and boosters was discussed, and was compared with and found preferable to three-phase high-tension transmission and conversion. The Leeds tramway system was as extensive a system as could be economically served by a single continuous-current generating station placed in the centre of the system.

The most important requirements in a motorcar for use in city tramway systems were that it should be capable of rapid and well-sustained acceleration, and that it should be able to go quickly uphill. These requirements could be fulfilled only by motors capable of travelling on the level of speed far above what was allowable in practice. Curves were given showing the acceleration of the car from rest with various motors and under various conditions. A mean acceleration of 3ft. per second per second up to a speed of 10ft per second could be obtained with motors of a type found to be satisfactory in Leeds and Newcastle. The effect of bad driving on starting was considered.

There was much difference of opinion on the subject of earth returns. In Great Britain the Board of Trade restriction of the rail drop to seven volts had made cases of electrolysis by return currents very rare, but it could not yet be said that absolute safety was secured for metallic pipes in the neighbourhood of tramway tracks. The resistance of the rails and bonds used in tramway practice as determined in experiments by the authors was given. In a new fished and bonded joint a good deal of current went through the fishplates and soleplates. The Falk cast-welded joint was described, and also the thermit-welded joint. It was unadvisable to use such joints on sharp curves or on crossing a bridge with steep approaches on account of the effect of expansion and contraction. On straight track, however, the lateral support to the rails prevented variations of temperature from doing damage. Experiments were described from which it appeared that from one-sixth to one-fourth of the current in the rails was diverted into the earth. A service of about 10 cars per double mile could be worked over a distance of two miles, the feeding point being at one end, without the seven-volt limit being exceeded. The system of return feeders in Newcastle and Leeds was described. Where the Board of Trade limit was exceeded, if all the current were taken out of the rails close to the power station, the extension of the return feeder to points about half a mile distant from the power station would produce a very marked reduction in the rail drop, owing to the fact that the great concentration of current which took place in the centre of the city with converging routes was thereby avoided. This was the system now adopted in Newcastle-on-Tyne, but provision had been made on the switchboard whereby the cars could be divided into two groups, each group being run by its own generator. The first comprised all the cars outside a radius of three miles, and a second all within that radius. In Leeds the greater part of the current would be taken out of the rails close to the power station, but a portion sufficient to bring the drop of potential in the rails within the legal limit would be sucked back through a number of return feeders about one mile long. Exceptional traffics at particular points were dealt with by special boosters and return feeders. The authors' experiments showed that a current of 300 amperes in the rails between two points, two miles apart, implied a potential of about five volts between those two points. The potential was proportional to the current within 1 per cent., which showed that the conduction of the leakage current through the earth was metallic in its nature and not electrolytic to any considerable extent. Examination of the current in the rails and of the potential at various points of the tramway system with a constant current of 300 amperes passing had shown that only a very small portion of the current got into the gas-pipes. This result was discussed and was shown to be not surprising. The possibility of electrolysis with such currents as did get into the pipes was considered. Unless there were strata of such small extent and high conductivity compared with the average, and so placed as to cause a concentration of the current into the pipe to a density of 1,000 times the mean current density or more, no corrosion of the pipe would take place, and the seven-volt limit might be exceeded many times without damage to the pipe. On the other hand, if such strata were present, electrolysis (with damage to the pipe) was quite possible even though the seven-volt limit was not exceeded.

FORTHCOMING EVENTS.

FRIDAY, NOV. 14.

Electrical Engineers' Volunteers.—At 7.45 p.m., smoking concert at headquarters, Regency-street, Westminster, S.W.

SATURDAY, NOV. 15.

Institution of Junior Engineers.—Visit to the new shipbuilding and marine engineering works of Messrs. Yarrow and Co.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Diesel Engine."

MONDAY, NOV. 17.

Institution of Electrical Engineers (Newcastle Section).—Opening meeting.

TUESDAY, NOV. 18.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper for further discussion: "Electric Tramways," by Messrs. Chas. Hopkinson, B. Hopkinson, and E. Talbot. The succeeding paper will be "High-Speed Electrical Generating Plant," by Mr. T. H. Minshall.

Royal Statistical Society.—At 5.30 p.m., at the Society of Arts, John-street, Adelphi, opening meeting. Presidential address by Major P. G. Craigie, C.B.

WEDNESDAY, NOV. 19.

Institution of Electrical Engineers (Birmingham Section).—At 8 p.m., opening meeting. Inaugural address of Mr. Henry Lea on "Recent Progress in Electrical Engineering in Great Britain." Students' Section: At 7.30 p.m., ordinary meeting. Discussion on "Steam v. Electric Traction."

Society of Arts.—At 8 p.m., opening meeting. Inaugural address of Sir Wm. H. Preece, K.C.B., F.R.S.

Royal Meteorological Society.—At 7.30 p.m., at the Institution of Civil Engineers, ordinary meeting.

FRIDAY, NOV. 21.

North-East Coast Institution—Second general meeting at Newcastle, postponed from the 14th inst.

Institution of Junior Engineers.—At 8 p.m., opening meeting. Presidential address on "The Preparation of Engineering Projects," by Colonel Ed. Raban, C.B.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. The adjourned discussion will be resumed and concluded upon Captain C. C. Longridge's paper on "Oil Motorcars of 1902." If time permits, the following paper will be read: "Recent Practice in the Design, Construction, and Operation of Raw Cane Sugar Factories in the Hawaiian Islands," by Mr. J. N. S. Williams.

APPOINTMENTS VACANT.

Chief Clerk, Swindon Corporation Electricity Department, £100 per annum, Nov. 18. See advertisement.

Assistant Electrical Engineer, Swindon Corporation, £100 per annum, Nov. 18. See advertisement.

Cable Jointer, Swindon Corporation, 35s. per week, Nov. 18. See advertisement.

Superintending Engineer, to take charge of the works in connection with the equipment of an electric light station for a firm of contractors. See advertisement.

Mechanical Draughtsmen (2), for the design of central-station switchgear See advertisement.

Electrical Engineers, Kirkcaldy Corporation, £250 per annum. Particulars may be obtained from Mr. W. L. Macindoe, town clerk, Nov. 22. Greenock Electricity Department, £200 per annum. Particulars may be obtained from Mr. C. MacCulloch, town clerk, Municipal Buildings, Greenock, Nov. 19, at 10 a.m.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

533. Is there an installation working at the present time in the British Isles where wind power is utilised for generating electric energy? If so, describe working details.—H. H. R.

534. Define the meaning of the terms "inductance" and "reactance," and explain clearly the application of these terms in determining the sparking limit of a continuous-current dynamo. Give a fully-worked-out example.—H. O. C.

ANSWERS.

Question No. 527.—From the results of Tesla's experiments it is popularly supposed that there is no danger from electric shock when the voltage applied reaches a very high limit. A lot of misunderstanding exists on this point Explain the matter clearly, and show what is the real significance of Tesla's experiments.

Best Answer to No. 527 (*awarded* 10*s.*).—"M. W. K." may take it that there *is danger* from an electric shock at a high voltage, but that if it is an alternating-current circuit with a sufficient number of alternations per second to prevent (by reactance) the passage of more than one or two milliamperes, then the conditions are *practically safe*. That the periodicity is a great governing factor is seen from the well-known equation:

$$\text{Current} = \frac{\text{impressed volts}}{\sqrt{(\text{resistance in ohms})^2 + (2\,\pi\,n\,\text{L})^2}},$$

where n = number of alternations per second,
L = self-induction in henrys.

It will at once be noticed that if n reaches a high figure the current is reduced accordingly. Tesla, in his classic experiments, used a machine that gave about 13,000 alternations per second. It has been estimated that the current used by him did not exceed one or two milliamperes. We may, from accounts which have been published of various experiments, assume that a current of two milliamperes is perfectly safe. Medical authorities say that while currents at a high voltage cause death by asphyxia—*i.e.*, suffocation—low voltage currents give rise to contraction of the capillaries, and thus by preventing the flow of the blood stop the heart. It has been noticed by experimenters that in the case of animals acted upon by an electric current, the stoppage of the heart, instead of being gradual, as in the case of ordinary death, is sudden. As to the actual amount of current the human body can carry with safety there is much dispute. Mr. Trotter in his experiments at the Institution of Electrical Engineers last February is said to have taken a direct current of 8 to 10 milliamperes without discomfort. Against this, however, several deaths have occurred under conditions which certainly point to a smaller current than this proving fatal. So much depends upon the kind of contact made, state and condition of individual, temperament, etc., that it is impossible to fix an exact figure; every care, however, should be taken to prevent any person taking more than, say, two milliamperes. Speaking from personal experience, I have had many shocks from dynamos running at 500-600 volts with a current of 10 amperes. The pain was very sharp, and felt as far as the elbows, but no after-effects were experienced.—M. M.

Answer to No. 527 (*awarded* 5*s.*).—The misconception mentioned in the query as to the lack of danger with extra high voltages arises from the nature of the experiments carried out by Tesla. The apparatus used gave high voltages at high periodicities, and what appeared to be an effect of the former was really caused by the latter. It is well known that the higher the periodicity, the higher is the current density upon the surface of the conductor, the core of the cable being practically unused by the current. Therefore, with the high periodicities used to produce the high voltages there is less risk of the current touching a vital part. Also it should be remembered that with a given amount of electrical energy put through transformers to give a maximum voltage the amperes decrease in proportion to the increase in volts, so that with these exceedingly high voltages the current was a hardly measurable one, and therefore unlikely to produce harmful effects. It is to be hoped, however, that no one will, on the strength of the Teslaic experiments, personally short-circuit any extra high-tension apparatus of a working-day frequency and with a boiler-house behind it.—B C. H. J.

Answer to No. 527 (*awarded* 5*s.*).—Tesla's experiments were originally made "with a view to telegraphing through the earth without wires, to securing an effective electric light by means of vacuum tubes, and to the controlling of a torpedo-boat from the shore by electricity." These seem to have led him to a study of very high E.M.F.'s obtained by induction machines, or, perhaps, it would be more correct to say influence machines, such as Wimhurst's and Holtz's. With these he used condensers, and obtained very rapid succession of sparks and also very rapid alternations or frequencies. The discharges being at very great E.M.F.'s readily pierced glass and other dielectrics, as we might reasonably expect them to, and, further than this, they had a great influence on neighbouring objects; in fact, so much so that they illuminated vacuum tubes which were not in connection with the electric apparatus At this stage a somewhat curious discovery was made—viz., that a man might take hold of the terminal wire and make himself part of the circuit by holding his other hand near a vacuum tube, when the tube would show luminosity without the man being injured in any way. This, of course, needed a little explanation, as it was well known that nobody could with impunity receive a shock from a high E.M.F.—at all events, if any current passed through his skin. The explanation given and received at the time and also now was that the alternations being very rapid had not the necessary time to act upon the nervous system before the succeeding alternation neutralised it, and we know that nerves require time to act. It is said that the nervous impulse travels in man at the rate of about 34 yards per second, and this is much slower than an electric impulse travels, for an electric impulse goes across the Atlantic Ocean from Ireland to Newfoundland in one second or less. It is therefore obvious that the impulses from a rapidly alternating E.M.F. might not last long enough to affect human nerves. Further than this, experiments have shown that a certain amount of actual current must pass through the body before it can do any harm, and I believe I am right in supposing that Tesla's apparatus could not give more than a very small amount of static charge, while a current of 200 or 300 milliamperes may be passed through the human body without ill effects, provided fairly large electrodes are used. If, however, small electrodes are used, then burning of the skin occurs. We know, further, from Volta's and also from more recent experiments, that an electric current applied to a muscle will contract it many times provided that a small interval of time is allowed between each application, but if the applications or passages of the electricity into the muscle are at all rapid, then permanent contraction occurs. This shows plainly that both current and time are required to act upon muscle. Again, post-mortem examinations of persons killed by lightning show plainly that a considerable amount of electricity must have passed through the body and clothing. The general effect of the lightning may be stated in general terms somewhat as follows: Death is always instantaneous, and probably caused by shock to the nervous system and brain, but often no mark of violence can be found on the body, although more frequently lacerations, burns, bruises, and sometimes even broken bones are found. The clothing is often burnt or burst (see good specimen in the museum of the College of Surgeons, London), and metallic substances, such as watches, money, etc., are often melted, thus showing the passage of

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a considerable amount of electricity (C^2 R effect). It is also interesting to observe that when the stroke is not fatal then insensibility, paralysis, burns, skin eruptions, loss of speech, or loss of some special sense may ensue—*e.g.*, blindness. In studying this subject we must carefully bear in mind that the person killed or hurt may have really suffered from the effect of the "return shock" or "return stroke," which is an induction effect (see text-books), and would be much less violent than the actual lightning. We must also bear in mind that the condition of the skin makes a lot of difference to the resistance of the circuit. If wet, a severe shock may be received, but if the skin is dry it may act as a perfect insulator to the same source of electricity. A cut or wound is very sensitive to electricity.

I think with "M. W. K." that a lot of misunderstanding exists, but I hope the above will put the whole subject clearly before readers. The inference I draw from Tesla's experiments is simply that the high frequency is the cause of the electricity having no effect upon the human nervous system. It is not correct to imagine that the higher the E.M F. the safer the current, for we know the reverse of this to be true I have myself received shocks from 60, 120, and 200 volt dynamos direct current while working under ordinary conditions, and I should describe them thus: 60 volts can be touched with impunity, but not pleasure; 120 volts is too much, and would be avoided by preference; and 200 volts is very painful and quite intolerable—in fact, it draws muscles and sinews up so tight that there is no possibility of opening the hands or stretching out the arms. I have had shocks from influence machines and also from induction coils made for medical purposes until I could not possibly leave go and could bear the effect no longer, but even then I do not consider an induction coil anything like so painful as a 200-volt dynamo. A good many years ago my chief told me to be careful about a 200-volt alternating-current dynamo because it had killed a man in France.—F. G. A.

Answer to No. 527 (*awarded* 5*s.*).—If, as this query states, the popular belief is that there is no danger from electrical shock when applied voltage reaches a very high limit, then the popular belief requires considerable modification. Briefly put, Tesla's experiments simply show that with a coil giving a potential difference of 200,000 volts and a frequency of a million per second, no pain is felt when the body is made to form part of the circuit, but the *high frequency* is essential to this result. Tesla himself has explained the absence of shock by saying that "the body of the experimenter offers an enormous section to the current, and the density is very small, but if only a small fraction of that energy should be applied in such a way that a current would traverse the body in the same manner as a *low-frequency* current, a shock would be received which might prove fatal"

Some years ago this subject occupied the attention of several well-known experimentalists and medical men, and various experiments were performed with the view of establishing the truth of the hypotheses which had been framed to explain this phenomenon. In one case a 100-volt lamp, which required a current of two amperes, was rendered incandescent by an alternating voltage of 100,000 volts, a body forming part of the circuit, but in order that the consumption of energy might be the same in both cases, the current in the second instance had only to reach the value of two milliamperes. This single experiment is regarded as containing the key to the whole matter, and the conclusion drawn from it is—and amongst authoritative medical men there is general agreement—that high-frequency currents of high potential are harmless *if the magnitude of the current is small*, and that in experiments such as those referred to the high potential is obtained at the expense of the current, which diminishes as the potential is raised. If the area of the electrodes by which the currents are led into and out of the body be lessened, the passage of the currents becomes distinctly painful; but if the contacts be made by holding copper rods or cylinders in the hands, then on touching the terminals of a coil—as in Tesla's experiments—having a frequency of 1,000,000 per second and a voltage of 200,000 volts, the currents can be received with impunity.—A. F.

Question No. 528.—On systems of electrical distribution at high voltages (not an overhead system) it appears to be fairly common practice to arrange spark-gap devices to the feeders, apparently to discharge any accumulative static charge on the feeders. Are these spark-gap devices really necessary, and what is the explanation of the accumulative static charge on the feeders? What limit is there to the rise of voltage of this static charge if spark gaps are not used?

Best Answer to No. 528 (*awarded* 10*s.*).—On systems of electrical distribution at high pressure, especially when the mains are laid underground, it is frequent for the phenomenon known as "resonance" to occur, and it is to prevent high charges of voltage from accumulating, due to this phenomenon, that spark-gaps are provided on some systems of distribution. Every electrical system or circuit has a definite natural periodic time, depending on its inductance and capacity—that is to say, if an E.M.F. be applied momentarily at any point in the system an electric wave will be started which will surge to and fro in the circuit until the energy is all dissipated by ohmic losses or by hysteretic losses in any iron which may be affected by the circuit and in the dielectric of the cable. The periodic time of the system is the time taken by this surging wave to travel once to and fro, and for any system is given by the equation

$$T = 2\pi\sqrt{L\,C},$$

where C = capacity in farads;
L = inductance in henrys.

Now, it is clear that as the energy of an oscillating pendulum is augmented by the application of repeated pushes administered synchronously, so will an oscillating voltage wave be augmented if there is in the circuit an alternator running synchronously with the natural periodicity of the system, and at each alternation adding its voltage to that already accumulated. If it were not for ohmic, hysteretic, and dielectric losses, this voltage would rise indefinitely, or, at least, until the insulation broke down. Neglecting hysteretic and dielectric losses, the limiting voltage which would accumulate is given by the formula

$$V = \frac{f\,L}{R}\,.\,E,$$

where V = maximum voltage obtained;
f = frequency;
L = inductance of circuit in henrys;
R = resistance of circuit in ohms;
E = voltage of alternator.

For example, take an alternator giving 2,000 volts at 110 periods per second, and suppose it to be delivering into a circuit containing inductance and capacity of 1 henry and ·000002 farad and a resistance of 15 ohms. Then from the formula $T = 2\pi\sqrt{L\,.\,C}$, we get T = ·0088 second—that is, about 110 periods per second—and as this coincides with the frequency of the generator, we shall get complete resonance. Applying the formula $V = \frac{f\,L}{R}\,E$, we get V maximum accumulated voltage = 15,000 volts, which is a dangerous voltage. Obviously, the method of preventing resonance is to alter either the inductance or the capacity or the frequency. The latter is usually fixed by other considerations; but inductance or capacity may easily be inserted in a system to make the natural periodicity of the system differ by a sufficient amount from the frequency o the generator, to prevent resonance.

In most transmission lines the capacity is not sufficient to give synchronism with the main or fundamental frequency of the generator, but these main or fundamental waves are frequently accompanied by higher harmonics of considerable amplitude, and these are more likely to synchronise with the natural periodicity of the circuit. In any case where the voltage is high and the mains are underground, it is best to provide spark-gaps, as even if resonance is completely absent, it may be liable to appear at any time when the inductive nature of the load is altered.—A. M. D.

Answer to No. 528 (*awarded* 5*s.*).—These spark-gap devices are undoubtedly a safeguard on extra high-tension underground feeder cables, though if the cables are of sound make—*i.e.*, having a dielectric material of high

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disruptive strength, such as impregnated paper, and a dielectric thickness sufficient to allow for short temporary rises of E.M.F. between the conductors—they should not be necessary. The most experienced cablemakers would probably say these devices are *unnecessary*, as up to a short time ago the Board of Trade required the dielectric thickness (in mils) between any two conductors of a cable to be not less than the working pressure divided by 20. Thus, for a cable working at 10,000 volts between conductors, the dielectric thickness would be $\frac{10,000}{20} = 500$ mils, or ·5in., which is probably 25 to 30 per cent. thicker than the normal electrical or mechanical conditions require, besides allowing a large factor of safety. To-day the cablemakers would supply a 10,000-volt cable having a dielectric thickness equal to about 75 per cent. of that previously required by the Board of Trade (75 per cent. of ·5in.), and would test this cable for an hour before leaving the factory with 30,000 or 40,000 volts. Providing such a cable were properly laid and jointed, this test would be a sufficient guarantee of its ability to stand any temporary risings of E.M.F. or static charges, the factor of safety being very high. It would seem, therefore, that spark-gap dischargers would not be necessary on such a cable.

It is well known that any change in an electrical current carrying circuit of high potential produces surgings of the E.M.F. which may rise to two, or even three, times the normal working E.M.F. This would be the case in suddenly switching on or off, say, a 10,000-volt feeder, or if a partial fault or short-circuit came on the cable or any of the apparatus to which it was connected, when the E.M.F. might rise to, say, 20,000 volts (for short periods, of course. It is to safely limit this rise of voltage that these spark-gap dischargers are fitted, and they consist elementarily of an air-gap between two metallic poles (one connected to the conductor and one to earth), and so adjusted that when the volts exceed, say, 50 per cent. above the normal, the current sparks across the gap to earth, and so discharges the cable. The apparatus is made so that the arc is at once blown out or smothered. This is the principle of the Partridge patent discharger, which is fitted on some of the London 10,000-volt concentric feeders, which I believe carry as much as 3,000 h.p. If one of these feeders is switched off there is also a static charge of high potential left in the cable, the conductors of which act as an ordinary condenser, and a common way to discharge the cable is to have a bank of 100 8-c.p. 100-volt incandescent lamps connected in series between the inner conductor and the outer conductor, which is earthed, so that the cable is discharged immediately through the lamps. The cable, or any switchgear in connection with it, is then safe to work upon. These remarks also apply to two and three phase extra high-tension trunk mains.—J. A. MORTON.

Answer to No. 528 (*awarded* 5*s.*).—Under ordinary operative conditions it is somewhat questionable whether spark-gaps are necessary for the protection of the station apparatus, since the feeder cables are much more apt to puncture than the transformers or generators; but since a station engineer always has to consider the protection of his cables, then the spark-gaps should be unhesitatingly installed. The amount of static that can accumulate on a cable is in proportion to its capacity, and it is caused by the fluctuations in the voltage. That such a state exists can be easily perceived by watching the discharge that is always going on at a static discharger when current is on the line. However, it is not only to take care of the ordinary accumulated static that dischargers are used, but the enormous increase of voltage due to an arc holding, such as when an air break switch is opened or a fuse holds its arc. In either of these cases, the inductive effect due to the arc being in series with the capacity of the line, the potential may rise to an almost infinite quantity.—W.

Answer to No. 528 (*awarded* 5*s.*).—On high-voltage systems of distribution it is generally considered advisable to arrange spark-gap devices on the feeders to avoid the danger of sparks piercing the insulation in the event of the circuit being suddenly broken or interrupted from any cause. If spark-gaps be not provided, then the limit of the rise of voltage of the oscillatory currents set up when the circuit is interrupted is difficult to calculate, unless one knows the periodicity of these surgings, the inductance of the conductor and its capacity, which are both dependent upon that periodicity. Practically, therefore, the limit is determined by the breaking-down stress of the insulation. Both on series arc lighting circuits and on moderately high-tension single-phase circuits trouble has frequently been caused by the breakdown of the insulation when the pressure has been switched on or off.

From the investigations of Lodge and Hertz, it seems to be reasonably proved that at the moment a circuit having both inductance and capacity is broken oscillatory currents are set up, which may be easily calculated from the ordinary formulæ, and but for a kind of resonance effect the voltage generated would not be dangerous. These oscillatory waves apparently travel with a very high velocity, approximately equal to that of light, and the successive inductive actions produce an accumulative effect, as though each wave were superimposed upon the next, so that the ultimate maximum voltage is not measured by the amplitude of one wave, but by the sum of the total accumulation of waves; thus, an effect is produced similar to that when a body of soldiers march in step along a suspension bridge vibration is started and the bridge begins and continues to swing with an ever-increasing amplitude, until finally the stability of the structure is overcome and the bridge probably destroyed.—ALPHA.

NEW COMMITTEES.

The following new committees have been appointed:

LEICESTER.—*Gas and Electric Lighting*—Messrs. Bruce and Canner, Alderman Coleman, Messrs. Edwards, Flint, Hancock, William E. Hincks, Hurley, Jackson, Jennings, and North, Alderman Payne, Messrs. Richards and Joseph W. Smith, Alderman Thomas Smith, Messrs. Spurway, Thos. W. Walker, and Watts, Alderman Wood, and Mr. Woolley. *Tramways*—Messrs. Banton, Bruce, Collier, Edwards, Faire, Flint, Hancock, Henderson, Hudson, Jackson, and Mann, Alderman Marshall, Messrs. Matts, McCall, and Shires, Alderman Thos. Smith, Mr. Tollington, Alderman Vorley, Messrs. John E. Walker, Walters, and Woolley. The Mayor is *ex officio* a member of every committee.

MANCHESTER.—*Electricity*—G. Howarth, chairman; Aldermen Griffin and Richards; Councillors Allison, Arrandale, Beastow, Bowes, Burgon, Cowan, Craven, Dreyfus, Halliday, Hart, Heenan, Hesketh, Howarth, Jennison, Kay, Maxwell, G. Simpson, and J. Simpson. *Tramways*—Aldermen Bax, M'Cabe, Mainwaring, Tunstall; Councillors Bowes, Boyle, Brocklehurst, Dearden, Dixon, Fildes, Scott, Sutton, Taylor, Thompson, Trevor, Wainwright, Whyman, and Wilson. *Telephones*—Aldermen Briggs, Copeland, Gibson, Sir B. T. Leech, M'Cabe, Milling, Southern, Tunstall; Councillors Boyle, Brocklehurst, Grimshaw, Maxwell, O'Doherty, Pennington, Plummer, Smethurst, Smith, Vaudrey, Wainwright, and Wilson.

HULL.—*Electric Lighting*—Messrs. F. Askew, T. B. Atkinson, G. J. Bentham, G J. Briggs, J. Brown, W. T. Cartledge, E. Hanger, A. E. Kessen, D. McLaren, W. G. Millington, J. Pybus, G Sipling, J. T. Skinner, H. Toozes, and H. J. Work. *Telephones*—Messrs. J. Beautement, G. J. Bentham, J. Brown, W. H. Cockerline, F. Costello, H. Feldman, W. Hakes, George Hall, E. Hanger, W. Holder, F. Larard, G. Latus, J. Pybus, G. Sipling, J. Watt, and H. J. Work.

BIRKENHEAD.—*Tramways*—Aldermen Cook, Gamlin, Jones, and Singleton; Messrs. Curphey, Edwards, Evans, Hazlehurst, Laird, Lilwall, Oates, H. Laird Pearson, Snape, Venables, and Wall. *Electricity*—Alderman Lees; Messrs. Bennett, Brewer, Cox, Dalzell, Griffiths, Hazlehurst, M'Gaul, Paterson, Rees, J. G. Robinson, Russell, Tooth, and Wall.

BRIGHTON.—*Tramways*—The Mayor; Aldermen Reeves, Sendall, and Stafford; Councillors Blaker, Butt-Thompson, Carden, Galliers, Halliwell, Holloway, Sone, Swift, and Wilson. *Telephones*—The Mayor; Councillors Allen, Beryl, Black, Carden, Colbourne, Holder, Jarvis, Lintott, Mayston, Robinson, and Stringer; (one additional member to be nominated at the next Council meeting). *Lighting*—The Mayor; Aldermen Botting and Lowther; Councillors Blaker, Briant, Broadbridge, Bedford, Butt-Thompson, Carden, Galliers, Halliwell, Holloway, and Swift.

ABERDEEN.—*Gas and Electric Lighting*—Councillor Kemp, chairman. *Tramways*—Councillor W. Coutts, chairman.

BRISTOL.—*Telephones*—Messrs. Curle, Levy Langfield, and Moore. *Electrical*—The Lord Mayor, Alderman Pearson, Dr. Cook, Messrs. Hughes, Lloyd, Elkins, Billing, Harris, Chandler, Moore, Carter, and Witty.

HUDDERSFIELD.—*Electricity*—Number of members, exclusive of the Mayor, 19: the Mayor; Aldermen F. Calvert (chairman), Hellawell, Whitehead, E. Woodhead; Councillors Longbottom (vice-chairman), William Joseph Barras, Berry, Chatterton, Cook, Dobson, Gledhill, J. Holroyd, Jepson, Pogson, Ernest Shaw, Smith, Alfred Sykes (North), Charles Frederick Sykes, Thomson, Whittle, Woolven,

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Tramways—Number of members, exclusive of the Mayor, 21: the Mayor; Aldermen Firth, Jessop, Whitehead, Willans; Councillors Ainley, Frederick Arthur Barras, Broadbent, Cartwright (vice-chairman), Cockin, Cook, Coward, Dobson, Gee, Lawley, Moore (chairman), Oxley, Pogson, Ernest Shaw, Swallow, A. Sykes (North), Thomson

GLASGOW.—*Electricity*—Mr. Willock, convener; Mr. Burrell, sub-convener. *Tramways*—Mr. Paton, convener; Bailie Alexander, sub-convener. *Telephone*—Mr. J. Alexander, convener; Bailie Stevenson, sub-convener.

FALKIRK.—*Electric Light*—Bailie Fairlie (convener); Provost Weir; Bailies Bogle and Russell, Judges Flannigan and Christie; Councillors Lochhead, Stevenson, and Russell.

HEYWOOD.—*Electric Lighting*—The Mayor; Aldermen Hodgkinson, Maden, and Marlor; Councillors Ashworth, Cockerill, Coupe, D. Healey, Wm. Healey, Ingham, Jackson, Popple, and Smith.

DERBY.—*Tramways*—Aldermen Duesbury, Fletcher, and Spriggs; Councillors Butterworth, J. Dean, Eaton, Gandy, Haslam, A. Ottewell, Walker, and Wilkins. *Electric Lighting*—Aldermen Ann, Duesbury, Fletcher, and Spriggs; Councillors Brigden, Butterworth, Eaton, Foster, Haslam, Shackleton, and Wilkins.

AYR.—*Lighting*—Whole members of Council (five a quorum; Mr. Young, convener) *Tramways*—Whole members of Council (five a quorum; Mr. Craig, convener).

WARRINGTON.—*Electricity*—Mr. Wilkinson, chairman. *Tramways*—Messrs. Elliston and Pemberton (chairman).

HARROGATE.—*Lighting*—The Mayor; Aldermen Chippindale, Fortune, Hudson, Simpson, Ward; Councillors Amos Chippindale, Davidson, Dobson, Holgate, Houfe, Marshall, Matthews, Sheffield, Shepherd, and Turner.

PENZANCE.—*Electric Lighting*—Messrs. Carne, Banfield, Caldwell, W. J. Bazeley, Colenso, Poole, and Bennetts.

BIRMINGHAM.—*Electric Supply*—Mr. G. H. Johnstone, chairman.

ROTHERHAM.—*Electric Lighting and Tramways*—Alderman D. L. Winter, chairman.

BRADFORD.—*Electricity*—Mr. Dowson, chairman; Alderman Hustler, deputy chairman.

LEGAL INTELLIGENCE.

SOUTHEND TRAMWAYS CONTRACT.

In the Court of Appeal on Wednesday the Master of the Rolls and Lords Justices Romer and Mathew gave judgment in the case of Bow, McLachlan, and Co. *v.* Dutilh Smith, McMillan, and Co. The appeal was by plaintiffs from a decision of Mr. Justice Jelf in chambers staying the action and allowing the case to go to arbitration. The short facts are these: The plaintiffs are electrical engineers carrying on business in Glasgow, and the defendants are a firm of electrical engineers who had a contract with the Southend Corporation for the installation of the electric tramway system in the town. They sub-let the engineering part of the contract to the plaintiffs, the total amount of which sub-contract was about £8,000. The claim in the action was for about £3,000, the balance alleged to be due under the sub-contract from the defendants and £900 for extras. The defendants by a counter-claim sought to recover from the plaintiffs £3,500. It appeared that under the contract between the defendants and the Southend Corporation any dispute arising between the parties was to be referred to the arbitration of the Southend Corporation engineer, Mr. A. Fidler, and the sub-contract contained a similar clause. Mr. Justice Jelf, in view of this, on the application of the defendants, stayed the action started by the plaintiff, and referred the matter to the arbitration of Mr. Fidler. The plaintiffs appealed from this decision on the ground that Mr. Fidler's interests were so fully mixed up in the dispute that he could not approach the matter with a sufficiently open mind to give an unbiassed opinion upon it. The dispute had reference to the supply by the plaintiffs of two engines, each capable of producing 200 kw. of electricity, and a third engine of 125 kw. capacity. These engines did not pass the tests of Mr. Fidler, and he made the defendants substitute a new engine for the smaller engine and repair the two other engines, the amount of this contract being the sum claimed by way of counter-claim. The plaintiffs alleged that if anything was wrong with the machinery it was the boilers which Mr. Fidler himself supplied, and in those circumstances they submitted he was not the proper person to arbitrate on the matter.

The Master of the Rolls, in giving judgment, said it seemed to him there was no reason to anticipate that Mr. Fidler would not honestly act between the parties in his position as arbitrator. Therefore, Mr. Justice Jelf was right in staying the action, and submitting the dispute to the arbitration of that gentleman. The appeal would be dismissed with costs.

Lords Justices Romer and **Mathew** concurred.

On the application of **Mr. Hamilton, K.C.**, who appeared for the plaintiffs, their Lordships stayed the proceedings under the arbitration for a week to enable the plaintiffs to consider whether they would appeal to the House of Lords.

WINDING-UP PETITIONS.

In the Chancery Division on Tuesday, Mr. Justice Byrne dealt with the winding-up petition of the Electric Lighting Boards (British Manufacturing Company, Limited). This was the petition of M. De Grolle Handret and Co., on which Mr. T. Terrell, K.C., appeared, and said they had arranged, with his Lordship's approval, to take a supervision order, and it was proposed to appoint Mr. Keyser to act as joint liquidator with the present liquidator. He added that there was going to be a reconstruction of the company. His Lordship made the usual supervision order

His Lordship also dealt with the case of the Electric Railways Company, Limited. This was the petition of H. A. Nepean, Fyers, and Co. Mr. H. T. Eve, K.C., said it stood over last week in the hope of getting the support of the Great Western Railway Company to the Bill to be promoted in furtherance of the company's project of a line from Kennington to Paddington. They had now received an intimation from the Great Western Railway Company which shattered this hope, and they had no alternative but to submit to an order. Counsel having supported the petition, his Lordship made the usual compulsory order.

CLAIM FOR TELEPHONE RENT.

In the Wandsworth County Court on Monday, before Judge Russell, the National Telephone Company sued a Balham tradesman for £17 alleged to be due under an agreement. It was stated that in July, 1901, the defendant entered into an agreement with the plaintiff company for the use of the telephone for a term of five years at £17 per annum, payable in advance. In July last, when the second year's rent became due, the defendant wrote to the company regretting that the bad state of trade prevented him sending a cheque, and stating that he would be obliged to discontinue the use of the telephone. The company replied, pointing out that there was a five years' contract, and that they could not release him from it, at the same time offering to charge him £5 per annum for the use of the machine and a fee of 1d. for every time it was used. This the defendant was unable to accept, hence these proceedings. The defendant complained that the company disconnected the service, and he contended that they could not sue him.

His Honour said it was an unfortunate position of affairs, but the defendant had entered into the contract. He thought, however, a big company like this ought to have considered the defendant's appeal. There must be judgment for the plaintiff company with costs.

VAGARIES OF THE METER.

An Interesting Point.

In the City of London Court on Tuesday Judge Rentoul, K.C., heard a claim by the City of London Electric Lighting Company against Mr. R. B. Oakley, of 11, Queen Victoria-street, to recover the sum of £3. 1s. 10d. for a quarter's supply of electric light. The case raised the important point as to whether the record of the meter is to be held to be conclusive evidence of the consumption of electric current.

The **Defendant** stated that for five years his account had come to less than £1 in the corresponding quarter, and a little while since the plaintiffs put in a new meter. In two days it registered double the consumption of a whole quarter in previous years He had paid £1. 3s. 6d. into court, which he contended was ample to meet the claim. The plaintiffs' second meter must have been faulty. There were over 500 offices in the building, and there had been a complete rebellion on the part of the tenants, who were up in arms at the company's charges.

Plaintiffs' case was that under their own Act of Parliament the consumer was bound by the record of the meter.

Judge Rentoul, in giving judgment, said it was a very extraordinary jump from £1 to £3. In spite of the plaintiffs' Act of Parliament, he did not see how they could insist on their claim. It would be an outrage of commonsense if he were to allow it. Mistakes would occur, and in view of the evidence judgment must be given for the defendant, with costs.

QUESTION OF LIABILITY.

At the Bristol County Court on Friday Judge Austin tried the action of the National Telephone Company, Limited, *v.* Colonel McClellan, which was a claim to recover the sum of £10. 14s. 2d. for rent of telephone to the headquarters of the 3rd V.B. Gloucestershire Regiment and to Colonel McClellan's private residence. So far as the amount was concerned, the claim had been admitted, and judgment had been entered for the plaintiff company, and the question his Honour was asked to decide was as to liability. Colonel McClellan contended that the telephone communication was necessary for the business of the corps, and Major Hobhouse, M.P., Major Podmore Clark, and Captain Moss-Flower had been joined as third parties.

His Honour said he was satisfied that Colonel McClellan ordered the telephone in good faith, and used it for the purposes of the corps, but he could not find that the gentlemen who had been made third parties were liable to indemnify the colonel against the expense which he had incurred as commanding officer of the corps. It was not for him to suggest what remedy there was against the funds of the corps. That was a matter for the legal advisers and Colonel McClellan. There must be judgment for the third parties as against the colonel. His Honour stayed execution for 13 days with a view to appeal.

COMPANIES' MEETINGS AND REPORTS.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The report of the directors for the half-year ended June 30 last, to be submitted to the meeting on the 19th inst., states that the gross receipts have amounted during that period to £283,856, against

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£346,336 for the corresponding half-year of 1901. The latter figures, however, included about £23,000 for revenue derived from exceptional sources; consequently the actual decrease in traffic receipts amounted to about £40,000, and is chiefly due to reductions of traffic which have not yet resulted in any substantial increase of traffic. The working expenses, including £27,490 for maintenance of cables, absorb £121,268, against £115,781 for the corresponding period of 1901, leaving a balance of £162,618. From this is deducted £7,692 for income tax and £6,400 for interest on debenture stock, leaving £148,526 as the net profit for the half-year. Two quarterly interim dividends of 1¼ per cent. each, amounting to £75,000, have been paid for the half-year, leaving a balance of £73,526 to be carried forward. The laying of the British Pacific cable between Canada and Australia has recently been completed, and the cable is expected to be opened for traffic before the end of the current year. Since the close of the half-year the Company has contracted to supply and lay, on account of the Netherlands Government, a submarine cable between Balikpapan, in the island of Borneo, and Kwandang and Menado, in the island of Celebes. The cable has been manufactured by the Telegraph Construction and Maintenance Company, and will be conveyed to its destination and laid by the two repairing steamers now being constructed for the Company on the Tyne. These steamers were successfully launched a few weeks ago, and are rapidly approaching completion.

BLACKPOOL ELECTRIC TRAMS (SOUTH).

On the 7th inst. an informal meeting was held at Manchester of the preference and ordinary shareholders of this Company, Mr. Guthrie presiding. The notice convening the meeting stated that an explanation would be given as to the present position and prospects of the Company. The present directors and other officers, it also stated, were appointed four weeks ago, as the result of an effort on the part of some gentlemen interested in the Company's debenture stock, whose desire was to save the position of the Company, and as far as possible ensure that its objects should be carried into effect and without further delay. The Electric Tramways Construction and Maintenance Company, Limited (from whom the present shareholders derived their shares by purchase), have now ceased to be associated with the management of this Company. A contract to carry out the actual work of converting the line into electric traction, and equipping the same, has been negotiated and approved of by the trustees for the debenture-holders, and executed and exchanged, and sufficient money has been appropriated to cover the cost of such conversion and equipment.

The **Chairman** said the old Board of directors had resigned, and the present Board consisted, *pro tem.*, of himself and Mr. Hall Neale, of Liverpool. He (Mr. Guthrie) and his colleague had assumed office for the purpose of doing the best they could for the shareholders under the present circumstances.

Mr Rutherford said that he and Mr. Harmood Banner, on the third of last month, got an agreement made between the Company and the Electric Tramways Construction Company, Limited, under which their (the Blackpool Electric Tramway, South) Company got possession of the undertaking, got clothed with the legal position, and in a position to appoint somebody to manage the Company who had nothing to do with the Electric Tramways Construction Company. They had negotiated and made a contract for the making of the line. The work was now actually in progress, and the money to pay for it was in the bank. The total amount of the contract for construction was £104,000, and an engineer had been appointed to see that the work was properly carried out in accordance with the Act of Parliament, and upon the most modern and improved system.

A number of shareholders expressed their satisfaction with the action of Mr. Rutherford and the directors, and a vote of thanks was passed to these gentlemen.

CAPE ELECTRIC TRAMWAYS.

The sixth ordinary general meeting of the shareholders in this Company was held on Wednesday at Winchester House, Old Broad-street, E.C., Colonel Sir Charles Euan-Smith presiding.

The **Chairman,** in moving the adoption of the report, said that the Board had again the pleasure of congratulating the shareholders on the very satisfactory results of the Company's operations during the past year. Both the traffic returns and the financial results showed a steady and continuous increase from the time that the Company was first incorporated. He was glad to state that since he last met them the measures which were then in progress for the completion of their plant, the placing of their power-house in a condition adequate to meet the requirements of the service, and the provision of their rolling-stock, had been almost arranged. The directors believed that every legitimate demand of the public could now be dealt with in such a manner as to afford no ground for complaint, and they trusted that the discontent which under the stress of very peculiar circumstances was felt in the beginning of last year with regard to the overcrowding of the cars would not recur. In Port Elizabeth the Homewood extension had been completed, and would soon be in working order, and although formal sanction for the docks line extension had been passed, the final permission to commence work had not yet been granted. From some circumstances—the reasons for which were not clear—the Cape Town Municipality and the Harbour Board had not been able to arrive at any decision in this important matter, and until harmony of action was attained by those bodies, their Company was powerless to act. He might, indeed, state on the part of the directors that, while willing to meet, with due regard for the interests of the shareholders, such legitimate demands as might be put forward in the public interest for the further extensions of their system, they were compelled to regard these proposals with great care and caution. The important litigation between the Eastern Telegraph Company and themselves, which had existed for some years, had been satisfactorily terminated by a unanimous decision in their favour in the matter of the appeal heard by the Privy Council on April 18 last. The decision thus given was, he said, of the greatest importance to all tramway companies, as being certain to afford a test case by which, in future, suits of a similar character would be decided. The Board had determined upon the further immediate distribution of a 3 per cent. interim dividend, which would take the form of a bonus. This, with former dividends, would make 55 per cent. paid on their capital. They would also note that the reserve fund now stood at £121,000.

Mr. Ludwig Breitmeyer seconded the motion, which was carried *nem. con.*

BRITISH ALUMINIUM.

The profit of the British Aluminium Company, Limited, for the year ended Dec. 31, 1901, calculated upon the same basis as in previous years, and without taking into account the special reductions in values hereinafter referred to, was £12,524. As this was insufficient to meet the necessary charges by £14,076, the debit balance has been increased from £4,888 to £18,965. As the result of an enquiry early in the current year it has been decided to reduce the item of patents and goodwill by £29,481, thus leaving it at £100,000. The stocks of metal and certain stores have also been valued at lower rates than before, following upon reduced prices in England. This has necessitated the writing down of values by £21,383. Further, the Company having in 1897 contracted to purchase large quantities of aluminium in America, which were afterwards found to be in excess of requirements, an agreement was concluded with the sellers to cancel the order for the undelivered balance in consideration of the sum of £5,600 being paid to them. These amounts have been carried to a suspense account, together with others resulting from the writing down of sundry investments, losses on consignments of metal, provision for bad and doubtful debts, and for special expenditure incurred in connection with mines development, issues of new capital, and the unsuccessful application for a prolongation of the Company's principal patent, etc. The total—£80,237—is shown in the balance-sheet, and the directors suggest that for the present this item should not be dealt with. During the last few months there has been a distinct improvement in the sales of aluminium, but, notwithstanding this, the Company was not in a position to pay the debenture-stock interest due on the 1st inst. The directors accordingly consulted the trustees of the debenture-stock holders, who, after consideration, and after conferring with Mr. Harmood Banner, have sanctioned for submission to the debenture-stock holders certain modifications in the provisions of the debenture trust deed.

BRITISH THOMSON-HOUSTON.

A meeting held yesterday afternoon of the above Company confirmed a resolution passed at an extraordinary meeting on the 23rd ult. for the alteration of article 18 of the articles of association by the addition of a proviso that any director duly appointed "shall hold office only until the next following ordinary general meeting of the Company, and shall then be eligible for re-election.

NEW COMPANIES REGISTERED.

Ryde Motors, Limited.—Capital, £6,000. Objects: to adopt agreements with F. W. E. Ryde and R. W. Vining, and to carry on the business of engineers, metal workers, builders, etc.

British Germain Motorcar Company, Limited. — Capital, £21,000. Objects: to import, export, manufacture, and deal in oil, gas, and electrical motors, machines, and engines, and to carry on the business of electricians, engineers, mechanicians, rubber manufacturers and merchants, cycle manufacturers, etc.

Colonial Motor Company, Limited.—Capital, £2,000. Objects: to carry on the business of transport and traction agents, tourist agents, carriers, packers, engineers, electricians, manufacturers of and owners of appliances for and means of transport, etc.

Inland Waterways, Limited.—Capital, £15,025. Objects: to construct, lease, or acquire canals, rivers, navigations, wharves, ships, works, buildings, land, and conveniences in England; to equip and work canals by electricity, steam, horse, or other power, etc.

West Central Trust, Limited.—Capital, £100. Objects: to carry on the business of financiers, trustees, merchants, manufacturers, miners, concessionaires, contractors, buyers and sellers of and dealers with tramways, light railways, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bucharest.—Tenders will shortly be called for 3mm. bronze wire for a telephone line from Bucharest to Constantza.

Brussels —The Telegraph Department require a large number of insulators, Specification No. 53 bis. Tenders by Nov. 19.

Swansea.—The Corporation invite tenders for the supply of electric motors and starting switches for a period of 12 months. Tenders by Dec. 1. See advertisement

Lowestoft. The Corporation invite tenders for overhead line equipment, poles, etc., and underground feeder cables, etc. Tenders by Nov. 26. See advertisement.

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Aberdeen.—The Tramway Committee invite tenders for one electrically-driven tower wagon for overhead equipment repairs. Tenders by Nov. 25. See advertisement.

Sunderland.—The Corporation invite tenders for one steam-driven three-phase generator, motor-generators, and static transformers, and high and low tension switchboards. Tenders by Nov. 28. See advertisement.

Eastbourne.—The Corporation invite tenders for motor-omnibuses to accommodate not less than 16 passengers. Particulars can be obtained from Mr. H. W. Fovargue, town clerk, Town Hall, Eastbourne. Tenders by Nov. 29.

Southampton.—The Corporation invite tenders for the supply of car bodies and electrical equipment, and trucks for 12 motor carriages. Specification, etc., can be obtained from Mr. H. F. Street, borough electrical engineer. Tenders by Nov. 18.

Warrington.—The Cheshire Lines Committee invite tenders for telegraph materials, etc., for the year 1903. Particulars can be obtained from Mr. S. Saxon Barton, storekeeper, Cheshire Lines, Warrington. Tenders by 10 a.m. on 28th inst.

Bridgend (Glamorgan).—The Urban District Council invite tenders for the construction of electric light main fittings, arc lamps and standards, incandescent lamps and fittings, sub-station fittings, and other works. Tenders by Nov. 25. See advertisement.

Caen (Calvados, France). The Prefect at this place requires tenders for the concession and working of a light railway between Trouville and Honfleur, a distance of about 10 miles, for goods and passenger traffic. Electric traction preferred. Tenders by Jan. 1, 1903.

Halifax.—The Tramways and Electricity Committee invite tenders for the supply and erection of a new 750-kw. steam dynamo complete, with condenser. Specifications, etc., can be obtained from Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders by Nov. 20.

Pontypridd.—The Urban District Council invite tenders for tramways permanent way, traveller, and storage battery. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on 22nd inst.

Manchester.—The Tramways Committee invite tenders for the supply of span-wire brackets for tramway poles. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by 1 p.m. on Nov. 15.

Broompark (near Durham).—The Broom Parish Council invite tenders for erection of poles and laying of cables and all necessary fittings for lighting with electricity Auton Style and Aldin Grange-terrace. Specifications, etc, may be seen at the office of Mr. John Bradley, clerk, Broompark, near Durham.

Pemberton (Lancs.).—The Urban District Council invite tenders for the reconstruction of the Ormskirk-road tramway, from Adams's Bridge, Newtown, to the terminus at Lamberhead Green. Specification, etc., may be seen at the offices of Messrs. Heaton, Ralph, and Heaton, Victoria-buildings, King-street, Wigan. Tenders by 19th inst.

La Valette.—The Municipality invite tenders for the establishment and working for 99 years of a tramway between La Valette and Senglea Cospiena, Vettoriosa and Casal Zebbug. Deposit £300. Tenders by Nov. 25 to Wm. Casolani, receiver-general and director of contracts, La Valette. Plans and particulars will be ready by March 1, 1903.

London, W.—The Hammersmith Borough Council invite propositions from manufacturers for the fitting up of a boiler at their electricity works to burn oil fuel. Full particulars, etc., can be obtained from Mr. G. G. Bell, engineer and manager, Electricity Works, 57, Fulham Palace-road, Hammersmith, W., and propositions to be sent in by 15th inst.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for motor-generators, combined change-over and equalising switches, starting motors, and transformers, combined boosting sets, combined balancing sets, and air-compressors, batteries of accumulators, and hand travelling cranes. Tenders by Nov. 24. See advertisement.

Glasgow.—The Caledonian Railway Company invite tenders for telegraph appliances, telephones, etc., electric lighting material and fittings, indiarubber and asbestos goods, etc., for 12 months from Jan. 21, 1903. Specifications, etc., may be obtained from Mr. Jas. Lorimer, stores superintendent, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Tenders by Nov. 24.

Dumfries (Scotland).—The Town Council invite tenders from companies as follows—viz.: (1) for the burgh's electric light provisional order, and alternately (2) for light and traction combined; (3) for a supply of electricity to drive the cars, if the Council resolve to conduct the traction; (4) if the Council construct the works, tenders for a lease of each. Tenders by Dec. 1. See advertisement.

Finchley, N.—The Urban District Council invite tenders for three water-tube boilers; two steam balancing sets, spare armature, and travelling crane; two storage batteries and accessories; and feeders, distributing mains, service cable, street-lighting leads, etc. Specifications, etc., may be obtained at the office of the electrical engineer to the Council, Mr. E. Calvert, Broadway, Finchley. Tenders by noon on 28th inst.

Blackburn.—The Town Council invite tenders for two Lancashire boilers, with mechanical stokers, etc., six superheaters, one battery of economisers, two feed pumps, etc., three ejector condensers, a complete system of pipework, tanks, valves, and accessories, and a coal and ash conveying elevating plant. Specifications, etc., may be obtained from the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Nov. 24.

London.—The County Council invite tenders for the supply and delivery of one 50-ton electric power overhead travelling crane, with auxiliary two-ton hoist, and for the erection of the same in the Council's electricity generating station at Greenwich. Delivery and erection of this plant at Greenwich is required as soon as the buildings are ready to receive it, which, it is anticipated, will be within about 15 months. Specification, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by Nov. 18.

Durban (Natal).—Tenders are invited for the following in connection with the new municipal telephone system: a complete exchange equipment for an ultimate capacity of 7,200 lines, the present contract to make immediate provision for 2,520 lines. The equipment comprises all distribution and switchroom boards, power plant, and wiring. The contract also includes the work of erection in Durban and maintenance for three months; and underground dry-core air-space cables, comprising approximately 15,000ft. 200 pair, 12,000ft. 150 pair, 25,000ft. 100 pair, 6,000ft. 75 pair, 7,000ft. 50 pair, 12,000ft. 25 pair. Tenders by Dec. 5. See advertisement.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

London.—The County Council invite tenders for the roadwork and platelaying required for the reconstruction on the conduit system for electrical traction of the tramways (a) from the Elephant and Castle, *viâ* New and Old Kent Roads, to East Greenwich, and (b) from the Elephant and Castle, *viâ* Walworth-road, Camberwell Green, Church-street, Peckham-road, and Queen's-road, to New Cross-gate. The contractor will be required to use the track rails and fastenings, the slot rails and conductor tees, which will be furnished by the Council under another contract; but all the remaining metal work and other materials, and all the special work at junctions, crossings, cross-overs, car-shed entrances, etc., beyond the track and slot rails and the conductor tees, will be included in this contract. Specifications, etc., can be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Nov. 18.

RESULTS OF TENDERS.

Canterbury.—The Corporation have accepted the tender of Venner and Co., Westminster, for supply of electricity meters for 12 months.

Bury. The Corporation have accepted the tender of the Forest City Electric Company for the protected type of rail bonds for the whole of their new system of tramways.

Newport (Mon.).—The Town Council have accepted the tender of W. T. Glover and Co., for carrying out the overhead equipment of the car-sheds and yard, at £619.

Sheffield.—The contract for a 500-kw. alternator, also for extensions to existing machines and switchgear extensions, has been obtained by Ferranti Limited, Hollinwood, Lancs.

Fulham.—The Borough Council a short time ago invited tenders for installing the electric light at the mortuary and coroner's court, Munster-road, and have decided that the work be carried out by the borough electrical engineer, in accordance with the plan and specification prepared by him, at an estimated cost of £23.

Battersea.—The Borough Council have accepted the following tenders in connection with the wiring, etc., of the Latchmere-road baths for lighting by electricity: Westminster Engineering Company, for supply of 16 arc lamps, £86. 3s. 8d.; Evered and Co., for supply of main switches, distributing boards, and fuse boxes, £48. 15s. 6d.

Cheltenham.—The Guardians have received the following tenders for renewing the electric bell installation at the workhouse: J. Such and Sons, King-street, Cheltenham, £120; R. E. and C. Marshall, Clarence-street, Cheltenham, £115; National Telephone Company, Cheltenham, £114. 16s. 10d.; Steel Bros., Montpellier-street, Cheltenham £105. 12s. (accepted).

Malvern.—The Urban District Council have accepted the following tenders: H. and T. Danks, Netherton, Dudley, two Lancashire boilers, with feed-water heater and pipework; W. T. Glover and Co., Trafford Park, Manchester, high and low tension concentric cables; Dick, Kerr, and Co., 110, Cannon-street, E.C., engines, alternators, exciters, switchboard, and transformers.

Walsall.—The Town Council have decided to accept the following tenders: Lambert Bros., Walsall, exhaust pipes for the new engine-room, £160; E. Green and Son, Manchester, economiser, £514; Bumsted and Chandler, Hednesford, induced-draught apparatus, £379; J. Russell and Co., Walsall, steam pipes required to connect No. 5 boiler with the new engine, £268. 2s. 6d.

Leyton (Essex).—The School Board have received the following tenders for electric lighting at Farmer-road Schools:

Allam and Co.	£1,054	15	0
H. Barlow	751	0	0
J. C. Christie	754	3	0
E. Ryan and Co.	683	1	0
W. Simmons	820	0	0
Wenham and Waters	872	0	0
W. R. Woodward (accepted)	675	5	0

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Huddersfield.—The Town Council have accepted the tender of the Fuller Wenstrom Electrical Manufacturing Company for the supply of motors, and W. T. Glover and Co. for one mile of service cable. The tender of the British Westinghouse Company, Manchester, is to be accepted for 68 transformers subject to the enquiries to be made by the chairman and borough electrical engineer being satisfactory, and if not, the tender of the Brush Company, subject to the time of delivery being shortened.

BUSINESS NOTES.

TRACTION.

Renfrew.—The Board of Trade inspection of the tramways will probably be made this week.

Redruth-Camborne. — The Redruth-Camborne electric tram service has now been commenced.

Halifax.—The tramway extension from Stump Cross to Hipperholme was opened for traffic on Tuesday.

Buralem.—Lifeguards have been ordered for the whole of the cars, which will be fitted as speedily as possible.

Rugby.—The Town Council are considering a proposal from a syndicate to construct electric tramways to connect different parts of the town.

Pemberton.—The Electricity Committee have passed the plan of the Warrington-road tramway, and it will now be submitted to the Board of Trade.

Durban.—In Durban, Natal, the wages of tramway men have been raised from 8d. to 10d. per hour, and the hours of labour are only eight per diem.

Devonport.—The Tramways Committee have approved a proposal of the Devonport and District Tramways Company to lay another length of line in Fore-street.

Aberdeen.—The Town Council have agreed to accept the conditions proposed by the Harbour Commissioners with respect to the proposed construction of the tramway to Torry.

King's Norton.—A meeting of the Council was held on Wednesday night to consider an important report on the tramways question. The proceedings were conducted in private.

Clydebank.—At the first statutory meeting of the new Town Council plans showing the designs of the tramway poles, section pillars, indicator posts, etc., were generally approved.

Hampton Wick.—The Council have decided to ask the tramway company for the wood block paving to be extended the whole length of the road along which the electric trams will run.

Wednesbury.—The Town Council on Tuesday night decided to give the South Staffordshire Tramway Company notice of the Council's intention to purchase the tramways at the earliest possible time.

Hartlepool.—A joint committee of the Town Councils of Hartlepool and West Hartlepool has been appointed to consider and deal with all questions relating to the Hartlepool and West Hartlepool tramway.

Derby.—The Tramways Committee have paid a visit to Wolverhampton and inspected the tramways in that town. The Derby Corporation are about to electrify their lines, but have not yet adopted a system.

Southport.—The tramways company have started a service of trams on Sundays, and the Corporation contend that this act is contrary to the terms of the agreement. Negotiations between the parties are proceeding.

Bournemouth.—At a meeting of the Town Council in committee on Monday it was decided to adopt the terms of a proposed agreement for the purchase of the undertaking of the Poole and District Electric Traction Company.

South London.—A meeting of the shareholders in the South London Tramways Company on Wednesday adopted a resolution approving the agreement for the sale of the undertaking of the company to the London County Council.

Presentation.—Last Friday the men employed in the Leeds city tramways department presented Mr. George Boulton, lately an inspector, with a marble timepiece, a pair of bronzes, and a purse of gold. There was a big attendance.

Electric Post.—A Rome message says that Signor Piscicelli left there on Monday for London, where he will form a syndicate to establish his new electric post. It is stated that he has radically changed his system as originally devised.

Glasgow.—The extension of the Corporation tramways on Paisley-road from Halfway House to Crookston has been opened for traffic. This extension brings the city lines within a mile and a half of the eastern terminus of the Paisley tramways.

Dudley.—The Tramway Committee report negotiations with regard to the reconstruction of the tramway to Birmingham, which is to be electrically equipped, and which they require to be carried out under the supervision of the Corporation engineer.

Reading.—The Tramways Committee propose to use wood paving and basalt lava in several instances when reconstructing the tramways. When the first length of line is completed, a service of horse cars will be run until the line is able to be worked electrically.

London and North-Western Railway.—This railway is reported to be considering the advisability of electrifying certain portions of their system in the North of England. Experiments to this end have been in progress for some time at the company's works at Crewe.

The Queue System.—This system of controlling the rush of would-be passengers at busy tramway termini is to be introduced by the London County Council at the Blackfriars terminus.

West Bromwich.—The tramway scheme here is progressing satisfactorily, but as yet it is impossible to say definitely when the cars will be running. Some structural alterations to the bridges over the railway in Dudley-road and Spon-lane have yet to be carried out.

Cape Electric Tramways.—A dividend of 3 per cent., free of tax, has been declared by the Cape Electric Tramways Company, payable to all shareholders registered on Nov. 6 and to holders of coupons No. 13. The dividend will be payable after the receipt of transfer returns from South Africa.

Light Railways in Essex.—It is stated that the contract for the making of the Kelvedon, Tiptree, and Tollesbury light railway has been let by the Great Eastern Railway Company. The new railway will run straight from Kelvedon to the water's edge at Tollesbury, *via* Tiptree and Tolleshunt D'Arcy.

Cumberland.—The County Council have confirmed a resolution requesting the Local Government Board to secure in the interests of the travelling public, either by legislation or otherwise, that a registered number be affixed on every motorcar as to ensure its identification both by day and night.

Electricity on Railways.—The London, Brighton, and South Coast Company will ask Parliament next session to grant them general powers for the electrification of their whole system or any part of it, so that they may adopt electricity on any section of their lines where they think it will prove remunerative.

Coventry.—Official notice was given on Tuesday that the tramways company intend to promote in the next session of Parliament a Bill for the extension of their lines. It is understood that they seek to add about 2½ miles to the existing route, and to include the most central streets of the city in their lines.

Brussels-Antwerp Railway.—There are now three schemes suggested for the construction of this line, and pressure is being brought upon the Government to take steps to ensure that the financing as well as the contracts for construction and plant are restricted absolutely to *bona fide* Belgian firms.

Vale of Rheidol Light Railway.—A party of members of the Aberystwyth Town Council and Cardigan County Council have made a trip over the new light railway, which runs from Aberystwyth to the Devil's Bridge. The line has been constructed at a cost of £68,000, and it is expected will shortly be opened for traffic.

Batley.—The agreement as to leasing the tramways to the British Electric Traction Company has not yet been signed, but it probably will be before very long. Altogether there will be some seven miles of tramways in the borough, and with a 15-minute service they will doubtless prove a great boon to the people of Batley.

Speed of Motorcars.—The Surrey County Council have adopted a resolution that, "in view of the widespread dissatisfaction with the provisions of the law as regards motorcars, and of the difficulties attending its administration, this Council desires to urge upon the Government the importance of immediate attention thereto."

Newport.—The Stow-hill and Clifton-road route for new tramways has been adopted by the Town Council. It is estimated that the cost of carrying out the proposed improvements and laying down and equipping the tramway will be £31,000. Mr. S. Yeates has been appointed clerk of works during the construction of the tramways.

Ayr.—Before the tramways are quite completed it is estimated that the capital expenditure authorised (£70,000) will be exceeded by £6,000. Leave having been refused the Corporation to take this sum out of the surplus tramway revenue, it will have to be requisitioned from the reserve fund until further borrowing powers are obtained.

Broughty Ferry.—A special meeting of the Town Council has this week conferred with the representative of an English tramway company with reference to the construction of the tramway between Broughty Ferry and Dundee. The proposals laid before the Council were, however, of such a nature that the scheme was rejected for the present.

Exeter.—The City Council have had before them the report of Mr. J. E. Waller on the proposed routes for electric tramways in the city, which we referred to in our last issue. The line of route as suggested by Mr. Waller was agreed to with one exception, and the town clerk was instructed to take the necessary steps to promote a Bill in Parliament.

Aston.—Sir Frederick Bramwell resumed the arbitration to determine the price to be paid by the Aston Manor Urban District Council to the Birmingham and Aston Tramways Company for their undertaking, partly under Act of Parliament and partly by agreement, on Saturday. After hearing further evidence the enquiry was adjourned to the 21st inst.

Lytham.—The Urban District Council have informed the Blackpool Tramways (South) Company that they will not be in a position to supply electric current for the tramways in the district in May next. The Council up to now have refused to go in for an electrical scheme on the ground that the expenditure involved would not be warranted in a small place like Lytham.

Staffordshire.—A resolution was passed at the quarterly meeting of the County Council on Tuesday empowering the Finance Committee to take, when satisfied that all necessary preliminaries have been complied with, all needful steps for raising £10,000, to be advanced by the County Council by way of loan to the Leek and Manifold Valley Light Railway, as authorised by the order of 1898.

Liverpool Overhead Railway.—On Saturday a slight accident happened on the Overhead Railway. When a train from the north end was running between the Pierhead and James-street Stations a loud report was heard, and a flash followed. A short-circuit had

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occurred, and the train was rendered useless for the present, and was pushed the remainder of the journey by another train.

Dundee.—Colonel von Donop, on behalf of the Board of Trade, made an inspection of the Constitution-road tramway route on Tuesday. Everything worked smoothly, the ordinary hand-brake being quite sufficient to bring the heavy car to a standstill at any point. The slipper brakes and the electric brakes were also tested. Colonel Donop expressed himself satisfied with his inspection.

Chester.—With regard to the proposed electric tramway from Birkenhead to Chester, the general opinion in the district appears that the advantages gained by the increased travelling facilities would not compensate for the destruction of the beauty of the rural districts through which the line would run. Already several gentlemen in the districts have expressed their determination to oppose the scheme.

Buxton.—Considerable surprise has been created in the district between Buxton and Chinley by the decision of the promoters of the scheme for an electric railway from Macclesfield and Buxton to Chinley, to defer that part of their scheme comprising the length between Chapel-en-le-Frith and Chinley. The promoters will thus go before the Commissioners with a scheme showing the terminus at Chapel-en-le-Frith.

Farnborough (Kent).—The Parish Council are unanimously in favour of electric tramways in the district. The Council have been approached by the British Electric Traction Company with reference to a proposal to lay down a tramway from Farnborough to Bromley, and the Council have written the Bromley District Council asking if they are considering any scheme of tramways of their own in this direction.

Thames Valley.—The last completed portion of the London United Electric Tramways system in the Thames Valley was opened at the end of last week, when the cars from Hammersmith and Shepherd's Bush ran direct to the new sub-station at Fulwell, *via* Kew and Twickenham. The additional line extends for nearly 1½ miles beyond Twickenham. There are now 23 miles of tramways in operation on the company's system.

Clacton.—The Tramways Committee have had a conference with the promoters of the light railway company with regard to the question of the company taking over the Council's electric lighting order, and also as to the construction of tramways in the district as an extension of the proposed light railway. The conference was adjourned to enable the Council to consider the estimate of the electrical engineer and go into details with him.

Keighley.—A specially-summoned meeting of the Town Council was held on Wednesday to consider the question of an extension of the borough tramway system. After a long discussion the Council resolved to take steps forthwith to obtain a provisional order to construct electrical tramways from North-street, down Cavendish-road, and along Bradford-road to the borough boundary at Stockbridge—a distance of about a mile.

Huddersfield.—Application is to be made to the Board of Trade for a provisional order authorising the construction of new tramways in Barton-road, Crosland Moor, New Hey-road, Lindley, Whitestone-road, Fartown, and Upperhead-road. With regard to a proposal to use the tramways for coal haulage, it is decided that coal will be conveyed only at convenient intervals during the day when the passenger traffic is limited.

Leeds.—Instructions have been issued to the conductors on the electric cars to allow eight excess passengers inside the cars from noon on Saturdays, all day on Sundays, and on holidays, and at any time when the weather is inclement. Ths only change from the old instructions is the substitution of the word "inclement" for "wet," and this gives a little additional latitude, so that the special rule will operate in snowy or boisterous weather as well as on a strictly rainy day

Burnley.—In his report on the working of the Corporation tramways. Mr. Mozley, the general manager, states that the income during the first 13 months was £18,601, and the expenditure £13,901. The report proceeds: "The future working of the main line will be affected advantageously by the construction of the branch line next year. The Corporation possess running and working powers over a number of undertakings, all of which will eventually be connected with one system."

Guiseley.—Messrs. Dick, Kerr, and Co. have informed the Yeadon District Council that no official of their company has had instructions to act in any way with regard to tramways between Guiseley and Leeds. In this case the scheme of Messrs. Le Maitre and Parker remains without a rival, or at least they will have no opposition from Messrs. Dick, Kerr, and Co. They propose to issue the official notices in connection with their application to the Light Railway Commissioners this week.

Lowestoft.—At the last meeting of the Town Council a letter was read from the Drake and Gorham Syndicate, Limited, asking whether if in the event of terms being agreed to for the purchase of their powers in connection with the East Anglian Light Railway, the Council would be prepared to agree that Mr. Walter Beer be their consulting engineer in the event of the works being carried out so far as regards the permanent way. The town clerk was directed to state that the Council could not see their way to enter into any obligation in regard to the employment of consulting engineers.

Gomersal.—Mr. Sidney Morse, solicitor to the British Electric Traction Company, has written the District Council to the effect that it would be necessary for the company to promote a Bill in Parliament during the coming session to obtain powers for the electrical equipment and extensions of the tramways, and to authorise the local authorities to grant leases The company were prepared to undertake the expenses of the Bill, but the seals of the various authorities would be required for the petition. Action in this matter, so far as the Council are concerned, has been deferred for the present.

Hove.—An important report regarding the proposed tramways here has been issued by the Tramway Committee. The Town Council are recommended to proceed with the Tramway Bill in Parliament, so far as the area within its own boundaries is concerned, but favourable allusion is made to the proposed connection with the tramways of Brighton. The proposed outlay is £80,500, and, taking eight cars, covering 300,000 miles per annum, and earning not less than 1s. per car a mile, a net profit of £2,670 is estimated.

Additional Traffic Returns.—Anglo-Argentine, £227 decrease; Barcelona Ensanche y Gracia, £28 increase; Barcelona, £254 increase; Brisbane, £217 increase (month of October, £10,359, increase £979); Buenos Ayres and Belgrano Electric, £225 decrease (month of October, £13,053, increase £183); Calcutta, £659 increase; Cape Town (month of October). receipts £16,507, expenditure £8,727; Isle of Thanet Electric, £22 increase: Mexico Electric (month of October), receipts £21,600, expenditure £12,580; Perth Electric, £143 increase; Port Elizabeth (month of October), receipts £3,832, expenditure £2,095.

Dewsbury.—An important addition is now being made to the Dewsbury Corporation's electricity works in Bradford-road. They have already cost nearly £40,000, and the extensions now being carried out will entail an expenditure of about £10,000. The present extension is rendered necessary to meet the demands of the British Electric Traction Company, who have agreed to take energy from the Corporation for their electric cars. Last year there was a slight loss on the undertaking, but it is confidently anticipated that when the cars begin to run the works will yield a substantial sum in aid of the relief of the rates.

Bath.—Notice has been received by the Urban Authority from the promoters of the electric tramways notifying that the work of laying the lines will be commenced on Monday next on the line of the old horse tramway route from Cornwell-buildings to the Old Bridge. The £8,000 ordered to be paid in lieu of wayleave has to be deposited this week with the Board of Trade before the roads can be touched. In preparation for the instalment the Surveying Committee has resolved to recommend the Council to spend £22,400 in extending the wood pavement and relaying the paving in the streets through which the trams are to pass, and the work will proceed simultaneously.

Sheffield.—The general manager has made a report to his committee with reference to the non-delivery of cars by Messrs. Craven, Limited, and the committee recommend that the penalty clause be enforced.. Application is to be made to the Watch Committee for the following alterations to be made in the car licenses—viz., that four passengers be allowed to stand inside double-deck cars; that six passengers be allowed to stand outside double-deck cars; that six passengers be allowed to stand inside single-deck cars. The question of advertising on the cars has been deferred for a week. The question of dry seats has been referred to the new Tramways Committee.

Adelaide.—The plans and specifications for the 42 miles of electric tramways to be constructed in Adelaide have been sent to London for approval, and the work of converting the existing horse tramways to electric will be commenced at the earliest possible moment. Gangs of men will be started at every terminus, and they will work towards the city, so that when the boundaries of Adelaide are reached their full strength will be centred on the city streets, in order to complete the work rapidly. It is estimated that the rate of progress will be five miles per month, so that the full length of the lines provided for in the Bill will only occupy about nine months from the time operations are started.—*New South Wales Railway Budget, Oct. 1.*

Yarmouth.—The Town Council at a meeting on Tuesday were invited to apply for powers to spend £45,000 on tramway extension. Under the Tramways Act two-thirds of the Council must be present and vote. When the question was put to the vote there were 28 for, and the opposition, by agreement, did not vote. The town clerk ruled that 32 members, or two-thirds, must take part in the voting. This decision was challenged, and the Corporation decided to take counsel's opinion on the town clerk's ruling. It was urged in argument that when the Moderates on the London County Council opposed the tramways in a similar way they walked out of the Council-chamber into the public gallery, in order to be in a position to decline to record their votes.

Newcastle.—At a special meeting of the City Council on Monday a motion was carried approving the application to the Board of Trade for a provisional order to authorise the construction of two additional tramways in the city. The number of cars in daily service now is 140, which exceeds the original estimate by no less than 50. With the prospect of a further increase in the number of cars, it has been found necessary to make some immediate arrangements to have additional engine power. Specifications have been sent out by the committee for the building of a new 3,000-h.p. engine, which was sanctioned by the committee some little time ago, and that, it is expected, will be ready next September. In the meantime Mr. Le Rossignol has been empowered to make enquiries with a view to obtaining a 1,000-h.p. engine at an early date.

Kirkcaldy.—Big efforts are being made to have the electric lighting and tramway schemes here carried out as expeditiously as possible. At the generating station the building has been delayed owing to the difficulty in obtaining stones from Grange Quarry. The car-sheds at Oswald-road, Gallatown, are now almost complete, and the rails have all been laid. Five of the 10 cars have been delivered. They are of the double-deck description, and have a capacity for 22 passengers inside and 26 outside, 48 in all. The cables for electric light and tramways are laid. About 2½ miles of overhead equipment have been erected, and the arc lamp brackets and posts are in order. The arc lamps are in course of being fitted up. Every effort will be made to have the light on by the end of the year, and the testing of the rolling-stock, preparatory to the Board of Trade inspection, will take place about the same time.

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Edinburgh.—Two schemes for the development of electric traction in the neighbourhood of Edinburgh have been submitted to the Town Council as a preliminary to parliamentary sanction being sought. One proposal is for the construction of a tramway from the city to the burgh of Queensferry, and the other scheme has been previously before the Council. The Drake and Gorham Electric Power and Traction (Pioneer) Syndicate, Limited, London, have written to the Edinburgh Corporation offering to enter into a friendly arrangement with the Corporation by which the gap now existing between the Musselburgh proposed tramway and the Edinburgh Corporation system could be bridged over, and that they would be prepared, if they were to get the support of the Council, to apply for a new tramway order in respect of this intervening gap.

Shields.—A conference took place on Tuesday at South Shields between representatives of the British Electric Traction Company and the South Shields Council, for the purpose of discussing the proposal of the company with respect to their Sunderland, Whitburn, Cleadon, and South Shields light railway scheme so far as it relates to the running powers over the Fowler-street route which are being sought in their Bill. The company's offer was to the effect that they are prepared to grant the Corporation running powers over their lines from the borough boundary to Harton village, in return for powers in respect to the Corporation's projected lines from Fowler-street along Mile End-road to a point near the terminus of the proposed tube between North and South Shields. It was decided that the company should formulale a clause to this effect for insertion in their Bill. to be submitted to the Corporation for further consideration at some later date.

Nottingham.—For the safe and convenient working of the tramways on the Derby-road the route from the Great Market-place *via* Market-street and Upper Parliament-street to the Derby-road is to be constructed forthwith. The estimated cost is £6,575. It is also necessary for the purpose of facilitating traffic and giving further accommodation to the public that a short length of line from Alfreton-road *via* Hartley-road to join the newly-constructed tramway in Radford-boulevard should be forthwith constructed. The estimated cost of this line is £7,100. At the last meeting of the Town Council a letter was read from Messrs. Ashwell and Tutin, solicitors to the promoters of the Nottinghamshire and Derbyshire tramways, as to an application to be made to Parliament in the ensuing session for powers to authorise the construction of electric tramways in the district similar to their application to the Light Railway Commissioners last year.

New Issue.—The Electric and General Investment Company, Limited, on behalf of the British Electric Traction Company, Limited, are offering for subscription 75,000 6 per cent. cumulative preference shares of £10 each at £12 a share. The prospectus states that the British Electric Traction Company are interested, either as owners, lessees, or shareholders, in upwards of 80 tramway, light railway, and electrical undertakings in various parts of the United Kingdom and in the Colonies. Many of these are in operation, and are earning revenue, but others are in course of construction or extension, and the present issue is made to provide capital for the latter purposes. The total route mileage of tramways and light railways controlled by the company and the associated companies is 570 miles. The share capital of the company is £4,000,000, divided into 200,000 6 per cent. cumulative preference shares of £10 each, and 200,000 ordinary shares of £10 each.

Birmingham.—The poll of the citizens of Birmingham on the question of promoting the Corporation Bill for the municipalisation of the tramways was completed on Saturday. The result was: votes for the Bill, 15,139; against, 8,558—majority for, 6,581. The Tramways Committee have received communications from a firm of London solicitors submitting a scheme for the formation of a trust to lease the tramways in Birmingham and its immediate suburbs and work them by some system of electric traction to be approved by the local authorities. The solicitors stated in their letters that they were not in a position to give the names of their clients, but any arrangement would be subject to the Corporation being satisfied as to their ability to raise all the capital required to carry the scheme into effect. The Tramways Committee have replied that they would require to know with whom they were dealing before any progress could be made, but that as the existing leases are in the hands of the British Electric Traction Company it is premature to discuss details.

Hull.—The Bellamy top covering, which is now in use on some of the Liverpool cars, and which was recently described in these columns, is to be placed on the new cars for the Hedon-road route at Hull. The covering encloses the top of the car from a point at each end a little outside the end of the car body, but leaves uncovered the staircase opening and some seats on the canopy. The ends of the enclosed space consist of fixed wood framing and glass, with sliding doors. The parts of the roof not covered by the boarding are enclosed by waterproof spring blinds, which can be pulled down at will by the passengers or conductor, and the sides of the covering can also be enclosed by spring blinds of canvas pulled down in like manner. The engineer-in-chief of the General Post Office has called the attention of the Corporation to the fact that the guard wires erected over the tramway wires are not satisfactory, and the electrical engineer has reported that to bring the guard wires into conformity with the new regulations new supports will have to be fitted. The report is under the consideration of the Works Committee.

Barnsley.—The formal opening of the Barnsley electric tramways, which have been promoted and constructed by the British Electric Traction Company, took place last Friday. The new lines have a total length of four miles—the system being three miles from end to end with a branch of one mile. The line commences at Old Mill lane, near the gasworks, and runs through the main thoroughfare of Barnsley, leaving the town on the other side by the Sheffield-road. At the top of the hill in Sheffield-road the line bi[illegible]s, one branch going to Worsborough Bridge and the other to Worsborough Dale. The overhead trolley system is adopted, and the cars are similar to those in use in Leeds and Bradford. There are some very steep gradients on the line, and the cars have consequently been provided with three brakes—hand, slipper, and electric. It is proposed to maintain a 10 minutes' service throughout the day. The line is being worked by the Barnsley Electric Tramways, Limited, an offshoot of the British Electric Traction Company. An agreement has been arrived at between the Town Council of Barnsley and the company, under which the Council undertake to supply electric current in bulk to the company, the price to be paid being 1½d. per unit, with a minimum annual payment of £1,000.

London County Council.—It was reported at the meeting of the Council on Tuesday that the agreement with the South London Tramways Company for the purchase of the company's undertaking by the Council was signed and sealed on the 7th inst. In consequence of the decision of the Council to refer the question of tube railways to a joint committee, the Highways Committee recommended the Council to rescind the resolution of July 1, authorising the Highways Committee to seek an interview with the President of the Board of Trade on the question of the method to be adopted in dealing with locomotion schemes affecting London. The Council were also recommended to rescind their resolution of July 29 last to seek powers to run omnibus services along the routes of the tramways while under reconstruction. A section rail has been designed which enables a temporary track to be laid on the surface of the carriageway, and the ordinary traffic as well as the cars can pass over this with little inconvenience. Thus the tramcar services can be maintained while the work of reconstruction is going on. A special report of the Highways Committee recommended that notices should be served on the Woolwich and South-East London Tramways Company requiring them to sell the whole of their undertaking to the Council.

Wolverhampton.—The Tramways Committee are in a position to report substantial progress towards an effective and efficient tram service, the whole of the track between Stowheath-lane, on the Bilston-road, and the terminus at the Wergs-road, both *via* Tettenhall-road and Newhampton-road, having been completed. The committee point out that during the coming municipal year the experimental period comes to an end. After April 17 the Council will have to give notice under the terms of the contract either that they intend to adopt the system, in which case they immediately take it over, or else that they have not found it to be a successful working undertaking, in which case they notify the Lorain Company to that effect, and the company are then under an obligation to remove it at their own expense. The committee do not think it advisable under the circumstances to express any opinion at the present upon the point. The whole matter will come up in due course, and it will then be for the Council to take one of the two alternatives presented. It should be added that the contract between the Corporation and the company provides, in the case of a dispute between them as to the practical working of the system, that there shall be a reference to arbitration, the referee being appointed by the Board of Trade.

Automobile Club Run.—A tour to Oxford organised by the Automobile Club of Great Britain and Ireland in commemoration of the coming into operation of the Locomotives on Highways Act of 1896 was made on Saturday by some 200 motorcars. The weather was very far from what could have been desired. Comprehensive regulations had been issued by the committee of the club to all drivers, and it was particularly stated that the tour was in no sense a race, but that by its means it was intended to popularise motor vehicles, and that, therefore, an unlawful speed at any time was eminently undesirable. No passing was allowed until Twickenham-green was reached. The assembling of the cars in Grosvenor-place was watched with great interest by large numbers of people. The variety of automobiles to be seen included bicycles, tricycles, tandem bicycles, and cars of every shape, power, and size. Petroleum spirit was the favourite motive power, few steam and still fewer electric cars being entered. Among the more notable drivers were the Hon. John Scott Montague, M.P., the Hon. C. S. Rolls, and Mr. Frank H. Butler, while nearly all the important English and French manufacturing firms were represented. American motors were not numerous. Punctually at half-past nine the long procession set out on its journey of 70½ miles, and it was over half an hour before the last car had passed Hyde Park-corner. The route pursued was through Knightsbridge, Brompton-road, Cromwell-road, on to Hammersmith, over Barnes railway bridge, and through Richmond Park to Twickenham, where the cars were restarted for the competition for non-stop certificates. Staines, Ascot, Wokingham, Reading, Pangbourne, Wallingford, and Dorchester were among the places passed. Instead of being numbered each car bore a name, and this made identification a matter of ease. In the evening those taking part in the run attended a dinner at the Clarendon Hotel, Oxford.

Tube Railways in London.—In a short letter to the *Times* of yesterday's date Mr. Chas. T. Yerkes gives his views on the tube railway problem in London. He says: "I have always felt that the custom by which tube lines were promoted—that is, permitting promoters to choose their routes and then asking Parliament to pass their Bill—was wrong, but as it had been the practice for so many years, I did not feel that it was proper for me to suggest a change. Now, however, that the subject is coming before the public so forcibly, I have no hesitation in saying that former methods not only did not give the results required, but tended greatly towards producing confusion. That there should be some regulating head, which will intelligently take all the conditions into consideration, regulate where lines shall be built, and the method by which they shall be run, there is no doubt. All the schemes for such transportation, if they do not emanate from one source, should at least be controlled by one directing body. To permit promoters to choose locations where lines shall be laid does not produce any harmony or regularity in the laying of lines or meet the necessities of

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the public. To have a central power managing and dictating the whole business, regulating where the lines shall go, how they shall be connected, and what systems they shall form is, without doubt, necessary, whether it be by commission, a committee, or what not. In fact, it is the only way in which order can be brought out of the chaotic conditions which now threaten this city. I would, therefore, say that I am heartily in favour of such a method as has been suggested in Parliament, but hope that, whatever power is given control of the subject, it will be one that can act quickly and even in less time than the regular Parliamentary Committee, to the end that the promotion of rapid transit in a direct and comprehensive manner can be promulgated without loss of time. I have read the article published in your paper of yesterday entitled 'The Tube Situation," and think it is full of information and most instructive. I may say my opinions are entirely in accord with those expressed therein."

The Chatham Accident.—The inquest on the bodies of the victims of the tramway disaster at Chatham on Oct. 30, which was reported in last issue, was resumed on Tuesday. F. C. Pearce, the driver of the car, gave evidence to the effect that at the top of West-court-street, where the accident happened, he stopped for five minutes for the pilot, and rang the bell for him about 20 times. When he saw the pilot approaching he started the car, as he had done on previous occasions, with the idea of picking him up about half-way down. He started the car by releasing the hand brake, and then applied the electric brake. After going about eight yards the car seemed to lurch forward, and he switched off the electric brake. He let some sand out and again applied the brake, and the car went at a terrible speed again, and dashed round the curve and overturned. He was a regular driver, and had been at the work for four months. He was previously a labourer. He had driven the car before, and had not had any other accident. In reply to Major Pringle, witness said he was satisfied before he started from the station that morning that the brake equipment on the car was in good working order. It was a foggy morning, and the rails were in bad condition, but he had had them quite as bad on other mornings, and had gone down the hill all right. He felt quite competent to go down without the pilot, and he used the same brakes as before. He had the slipper brake applied all the time. He did not know at that time that he could reverse the current on the car; all he knew was that he could apply the three brakes. He did not believe that the additional number of passengers had anything to do with the accident, as he had gone down before with an excess number. He was still in the employ of the company, but he was not driving. Further examined, witness said that the car had a wheel worn flat on the right-hand side, and that would upset the running. He reported this to the yard foreman, and he was told that it had been taken out, but he proved that the flat was there by seeing it after the accident. The wheels skidded nearly all the way down, and this was caused by the electric brake locking them. Further examined, witness said he was training for three weeks before he was taken on as a driver, and he was taught nothing about reversing the current. He was certain that the flat on the wheel upset the running of the car, but he did not believe that it had caused the accident or had anything to do with it. The enquiry was again adjourned for a week. We are informed that the Chatham and District Light Railway Company have taken prompt steps to prevent the recurrence of accidents like the present, and have decided to replace the present brakes (which are of the ordinary hand pattern) throughout the system by the Westinghouse magnetic brake, the order for the equipment having already been placed with the British Westinghouse Electric and Manufacturing Company, of London and Manchester. This apparatus combines with the advantages of the ordinary hand brake, the track brake, and the electric brake, certain peculiar advantages of its own which make the derailment of a car almost an impossibility.

LIGHTING AND GENERAL.

Ross.—An endeavour is being made to establish the telephone system.

Leigh.—Leigh and Southend contemplate joining in an electric lighting scheme.

Elland.—The price for electric current for lighting purposes has been fixed at 4d. per unit.

Bedford.—The Corporation propose to supply current for motive power at 2d. per unit net

Stroud.—The Urban District Council have resolved to apply for a provisional order for electric lighting.

Hebburn.—The Council-chamber, offices, caretaker's house, and stables are to be lighted by electricity.

Whitehaven.—The question of installing electric cranes is before a committee of the Harbour Commissioners.

Frome.—Specifications are being prepared for the Urban District Council's proposed electric light and power scheme.

Land Sales.—Particulars of land sales to be held on Nov. 18 and 20 at Westcliff-on-Sea appear in another column.

Switzerland.—The canton of St. Gallen has decided to utilise water power from the Rhine canal for electricity purposes.

Italy.—Several important projects for applying electric power to Italian railways are now before the Minister of Public Works.

Bristol.—An enquiry has been held into the proposals of the City Council for sanction to raise £84,450 for electric light extensions.

Big Ben.—"Big Ben" is to be wound by an electric motor. The winding up at present occupies two men three hours thrice a week.

Strathpeffer.—Strathpeffer is to be lighted by electricity, by water power flowing from the foot of Ben Wyvis, and there is an inexhaustible supply.

Admiralty.—Electricity is to be used for lighting the bow, masthead, and compass lamps of the torpedo-boat destroyers now building.

Tunbridge Wells.—By 19 votes to 8 the Town Council on Wednesday decided to sell the municipal telephones to the National Telephone Company.

Coventry.—The electric light undertaking has made steps towards making both ends meet preparatory to a welcome balance in the future for the relief of the rates.

Limerick.—Two offers have been received for wiring. The Council will advertise for tenders for the resetting of the flags in connection with the lighting scheme.

London Gazette.—The partnership existing between T. C. Collins and H. E. Arkwright, electricians, 35, Electric-parade, Blackheath, has been dissolved by mutual consent.

Portslade.—The Council will oppose Brighton's scheme to supply Portslade with electricity unless the prices and conditions of supply are previously submitted for their approval.

Ipswich.—At the last meeting of the Guardians it was proposed to substitute gas for electric lighting at the workhouse. After a lengthy discussion, the proposition was withdrawn.

Auckland.—A committee will visit the Durham Electric Supply Company's electric supply station at Durham City, and also inspect the electric light and tram undertakings at Gateshead.

Auckland.—The Rural District Council have agreed to an application of the Durham County Electrical Power Distribution Company for consent to a provisional order by the Board of Trade.

Southgate.—The compulsory area for the provisional order for electric lighting for which the Council have decided to apply will be identical with the compulsory area decided upon in November, 1900.

Swindon and Highworth.—The Guardians have obtained sanction to borrow £1,900 for fittings and machinery to be provided for the purpose of lighting by electricity the workhouse and infirmary of the union.

Agency.—Messrs. Ashmore, Benson, Pease, and Co., Limited, have appointed Mr. J. Gray, A.M.I.E.E., Waterloo-chambers, 19, Waterloo-street, Glasgow, as their agent for Scotland for the A.B.P. accumulators.

Colliery Plant.—According to the Pittsburg correspondent of *New York Commerce*, the Westinghouse Electrical Company have booked contracts aggregating £200,000 for electrically equipping British collieries.

Sheffield.—The Electric Light Committee are recommending a number of important increases of salaries in the clerical and superintendent's staffs, raising the present salary list from £3,190. 4s. to £3,402. 16s. per year.

Monmouth.—The earnings of the electric light department for October were £44. 10s. more than in October last year. The Corporation have decided to wire the houses of all new customers for the light by Corporation labour on easy terms.

Clacton.—The Urban District Council intend to apply for sanction to borrow £15,225 for the electric lighting scheme. Quantities will now be taken out, and tenders for the whole of the works included in the specification will be advertised for.

Wimbledon.—The District Council have decided to apply for a provisional order to authorise the supply of electrical energy by the Council for public and private purposes within the parish of Merton, which is in the rural district of Croydon.

Mexborough.—The electric lighting plant laid down a few months ago is taxed to its utmost capacity to supply the rapidly increasing number of customers. The Urban Council have applied for sanction to borrow a further £2,500 for extensions.

Redding.—The local co-operative society have fitted 115 incandescent lamps and a Bruce Peebles and Co.'s dynamo at their central premises at Reddingmuirhead. The Wholesale Co-operative Society, Morrison-street, Glasgow, had the contract.

Boxhill.—Major J. Stewart has held an enquiry into the application of the Town Council for sanction to borrow £16,000 for electric lighting extensions. There were now 285 consumers, representing 15,033 8-c.p. lamps, including public lighting.

Connah's Quay.—A syndicate proposes to apply for parliamentary powers to erect electric generating stations and lay mains for the supply of electricity throughout Flint, Mold, Connah's Quay, Buckley, Holywell, and Hawarden, and ask the co-operation of the Council.

Mansfield.—At the last meeting of the Guardians a letter was read from the town clerk of Mansfield on the subject of electricity, both for lighting and motive power. The prices on the whole compared favourably with those of other towns. The subject was adjourned.

Peterborough.—Messrs. Crompton and Co., Limited, have secured a contract from the Corporation for the supply and erection of one 120-kw. and one 240-kw. traction generator, coupled to Willans engines, also a traction switchboard and a "Chemsford" reversible booster.

Durham.—The salary of Mr. J. J. Smith, the manager of the electric light works, has been increased by £25 per annum. The cost of current during the quarter ended Sept. 30, 1902, was 3·67 per unit The number of units sold amounted to 41,384, and 283 tons of coal were used.

Greenock.—We are informed that Mr. W. M. Nelson has resigned his post of borough electrical engineer to the Corporation of Greenock in consequence of having obtained an appointment with the Brisbane Tramways Company. Mr. Nelson will relinquish his present duties at the end of the month.

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Salisbury.—The London and South-Western Railway Station at Fisherton has been lighted with powerful electric arc lamps, with which not only the station, but the line from Castle-street Bridge to Skew Bridge, is illuminated. The installation was put in by the Salisbury Electric Light Supply Company.

Inverness.—The Town Council are considering the question of getting power for the municipal electric lighting scheme from the Caledonian Canal Mr. Davidson, canal engineer, has prepared a memorial to the Canal Commissioners containing a recommendation that the water be got from the canal at the Bucht.

Electricity in Mines.—At last week's meeting of the Executive Council of the Miners' Association of Great Britain it was stated that Mr. W. W. Hood had been appointed representative of the association on the Home Office Departmental Committee on Electricity in Mines. Mr. W. W. Hood succeeds his father, the late Mr. Archibald Hood.

Wolverhampton.—The last report of the Lighting Committee shows a net profit of £507. 13s. 11d., in addition to which a sum of £405 6s 4d. has been expended out of revenue in respect of the cost of changing over the system of supply. The increase of units sold was 66 per cent., as against 23 per cent. for the corresponding week of last year.

New Firm.—Messrs. Walmsley Bros., of Empress-chambers, Blackpool, have commenced business as electrical engineers and contractors. They ask for trade catalogues. Mr. A. R. Walmsley, we learn has had considerable experience in manufacturing, central-station, and installation work. The firm will specially devote its attention to private plants.

Salford.—The Chairman of the Electricity Committee said at the last meeting that he had been looking through the accounts, and the amount of current consumed up to the end of September, and he had reason to believe if the demand increased as the winter months went on that they would have a clean slate to present to the Corporation at the end of the year.

Saltburn.—Amongst the investments reviewed at the eleventh annual meeting of the Cleveland Trust, Limited, was the electric light undertaking at Saltburn, which is now being worked at a profit. Steps are being taken with a view of the sale of the installation to a private company, and it is expected that this will be carried through at the beginning of next year.

Coatbridge.—The Municipal Buildings Committee recently asked Mr. W. A. Chamen, the electrical engineer of Glasgow, and Mr. Draycott, of the Scottish House-to-House Electricity Company, to inspect the wiring and lamps in the municipal buildings consequent upon the change of system of lighting from alternating to continuous current. Mr. Chamen will shortly report on the subject.

Cromer.—An order of quarter sessions having been obtained for the diversion of the footpath affecting the site of the electric light station and storeyard, the committee have given instructions for the purchase to be completed and the land tax on the site to be redeemed. They are taking steps to push on the construction of the electric light works, and are negotiating for a loan for the purpose.

Nernst Lamps.—In connection with a notice which has recently appeared warning users against infringements, we are informed that Mr. G. Braulik has made special agreements under which he is prepared to supply the trade with these lamps, and to guarantee purchasers against infringement. We have received from the same firm a list of Braulik shunt arc lamps for continuous current.

Tottington.—The Council are corresponding with the electric power company who have statutory powers to pass through Tottington and supply electricity in bulk at prices stated in their Bill of 1901, less 20 per cent., and also with the Bury Corporation for terms for supply of electricity for purposes of energy and lighting. An appeal is being made for funds in order to light the parish church with electric light.

Derby.—The Electric Lighting Committee's last report contained an estimate of the expenditure on capital account for the six months ending March 31, 1903, which has been prepared by the electrical engineer and approved by the committee, amounting to £3,500, including mains, £1,000; motors, £1,500; transformers, £400; meters, £400; sundries, £200. Application is to be made for sanction to the borrowing of the money.

Battersea.—In connection with the water supply to the boilers at the central electric generating station by means of artesian wells, it is found that the sum paid to the Southwark and Vauxhall Water Company in respect of water supplied to the boilers during the past year amounted to £124, or 7½d. per 1,000 gallons. This sum will increase yearly, and Messrs. Potter and Co. have obtained a contract to bore for wells at a cost of £647.

Rugby.—A short time ago the Urban District Council agreed to adopt a scheme for the supply of electric light to the town. The school authorities had decided to cease manufacturing their own light and to accept a supply from the Council. They have since advised the Council that they have decided to continue their own supply. The Council are now considering what effect this decision will have if they carry out their original intention.

Hackney.—The Electric Lighting Committee have decided to provide, owing to the rapidly-increasing demand for electric lighting and power, one 1,500-kw. steam dynamo, at a cost, including foundations, condenser, pipework, and cable connections, of £25,500. Work in connection with the extension of distributors to the amount of £900 was sanctioned. Prepayment meters are to be installed at small consumers' premises, the charge to be 4½d. per unit to cover meter rent.

York.—The Electric Lighting Committee having received a request from the Technical Instruction Committee to make a reduction in the charge for electricity supplied to the public library during the half-year ending June 30 last, a sub-committee has been appointed to reconsider the present method of charging for electrical energy (especially with reference to the charges made to the various committees of the Corporation), and to report thereon to the committee at an early date.

Lower Bebington.—Mr. Horsfall, electrical engineer, has been asked to further report with regard to the purchase of electrical energy in bulk, giving an estimate upon the whole scheme, based upon such purchase at the borough boundary at a given charge, such energy to be distributed through the Council's own mains. He is to omit all reference to a destructor as a factor in the scheme, but to provide for interest, sinking fund, and depreciation, and other usual outgoings of such an undertaking.

Eton.—The Urban District Council have decided to adopt the proposal made by the Windsor Electrical Installation Company with regard to pumping for six months, provided that they produce a plan for adopting electrical power to the existing machinery that satisfies Mr. Bailey Denton. No change is to be made in the staff now employed at the pumping station during the experiment, and a committee has been empowered to obtain plans from the Windsor Company, and to communicate with Mr. Bailey Denton.

Stock Exchange.—The Stock Exchange Committee has appointed Nov. 25 as a special settling day for the Calcutta Electric Supply Corporation's further issue of 20,000 shares of £5 each (issued at £1 premium), £2 paid, of which £1 is capital and £1 premium, Nos. 40,001 to 60,000. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the British Electric Traction Company's further issue of ordinary shares of £10 each fully paid, and 6 per cent. cumulative preference shares of £10 each fully paid.

Edinburgh.—The electric lighting department, under the direction of Mr. Newington, the resident engineer, is at present engaged on an improvement of the system of distribution of the electric light. The city has been mapped out into 20 or 30 districts, and fuses will be placed in the distributing network at points midway between the feeding centres, so that in the event of a fault occurring the fuses round the faulty place will automatically disconnect this section, and so the supply of the rest of the city will not be interfered with. There will be something like 70 of these fuses, which are to be placed in pillar-boxes standing about 4ft. above the edge of the pavement.

Cookham.—On Sunday evening last the electric light was switched on in the parish church (Holy Trinity) with great civic pomp. The installation has been expeditiously and most satisfactorily carried out by Mr. F. H. Headley, of St. Austell, Cornwall, under the supervision of Mr. E. H. Prosser. The system of lighting comprises no fewer than 76 8-c.p. lamps, arranged in artistic groups of three suspended from the fine old oak beams above the nave. The power necessary is obtained from a 4-h.p. Crossley horizontal gas-engine, which drives a four-pole dynamo. These, with the switchboard, are accommodated in a small brick building on the north side of the church, the interior being heated by hot water. The cost of the installation (£200) has been collected, so that the church is without any debt whatever in connection with this great improvement. It is estimated that the cost of lighting the church will not exceed 1s. 6d. an evening service; thus a very considerable saving on the cost of lighting by means of candles will be effected.

Accidents.—The electric light partially failed for about an hour on Tuesday at Edinburgh, owing to a "short circuit" in the mains in the Lauriston district, which was, however, soon repaired. In Horsham last week a similar occurrence took place. A link, which had been temporarily disconnected for test purposes, remaining inadvertently unattached, and one side of a street was not lighted until half an hour after the usual time. Both accidents were made much more of in the local Press than the occasion warranted. The electrical engineer submitted a report to a meeting of the Dundee Tramways Committee on Wednesday regarding the electric explosions which recently took place at Panmure-street and West Port. Upon his recommendation it was decided to protect premises, where the mains extend beyond the boundary wall or enter compartments which are not fireproof, with a cut-out device in the street service boxes; that water should not in any circumstances be brought near the source of an electric fire until the current had been cut off; and that in the case of a fire in an electric street box water should not be applied at all.

Death from Electric Shock.—Dr. G. Danford Thomas held an inquest on Wednesday, at Marylebone Coroner's Court, on the body of Evan Samuel John Withers, aged 26, an electrical engineer, lately employed by the Metropolitan Electric Supply Company at their generating station, South-street, Marylebone, where, on the preceding Monday evening, it was stated he received a fatal electric shock. The evidence showed that strips of copper, each about 20ft. long, were on Monday evening being lowered, for the purposes of a new switchboard, from the ground floor at the central station through a hole into the basement, where electric mains were laid. The strips were passed over a sliding board by the deceased working at the top, and were received by two labourers below. Fifteen had thus been safely passed down, and when the next was being lowered it appears to have come into contact with one of the mains, cut through the insulating material ⅛in. thick, and thus became charged with electricity. The result was that the deceased, who had hold of the upper strip, received a shock that proved fatal, Dr. J. P. Simpson testifying that death was due to asphyxia consequent upon the electric shock. Mr. Reginald Todd, chief electrical engineer to the company, said that such a mishap was only to be avoided by the exercise of care in keeping the copper strips clear of the charged cables. He thought that in future operations of the kind some protection might be put over the mains. There was, however, ample space in which to move the copper strips clear of the cables. The jury, in returning a verdict of accidental death, suggested that the company should ascertain whether any precaution could be adopted with a view of guarding against similar mishaps in the future.

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City of London Union.—The Local Government Board consider that less expensive fittings than those suggested for the Bow Infirmary should suffice for a poor-law institution. They also insist that advertisements be issued. The offer of the Charing Cross Electricity Supply Company to supply current at 3¾d. per Board of Trade unit has been accepted, and the supply of the City of London Electric Lighting Company will be discontinued.

London County Council.—At this week's meeting of the Council it was agreed to lend the Stepney Borough Council £1,935 for street-lighting purposes. Notices under Electric Lighting Acts and Orders have been agreed to from the Brompton and Kensington Electricity Supply Company of intention to lay high-tension mains along Drayton-gardens, and from the St. Pancras Borough Council of intention to lay mains along Woodsome-road and York-rise, Grafton-street, Gower-street and University-street, and George-street.

Newcastle-Emlyn.—At a recent meeting of inhabitants the report of Mr. Alfred Lewis, electrical engineer, Merthyr Tydfil, on electric lighting was discussed. Mr. Lewis advised that a sum of £2,500 be raised, which with the sum of £360 odd, the surplus of the different eisteddfodau, would be more than sufficient to carry out satisfactorily the scheme as laid down by him in his report. With the £360 already referred to, a sum of £1,440 was promised at the meeting, and a committee was appointed to canvass for further subscriptions.

Leeds.—The first annual social and prize distribution of the city electric lighting department cricket club was held on Saturday evening, Mr. Dickinson, the manager, presiding. The chairman, after an interesting speech, distributed the prizes to Messrs. Oddy, Newby, and Wildman, who have attained the best averages during the past season. The members moved a hearty vote of thanks to the chairman for the valuable assistance he had given as president of the club, after which the rest of the evening was spent in dancing.

Wakefield.—The whole of Tetley House is to be lighted by electricity, with the exception of the caretaker's house and the relief pay station. Fresh tenders have to be prepared. The Council's electrical engineer is about to deal with tenders for putting down floor plating and erecting railings in the engine-house. As soon as the question of the site for the proposed new sub-station at the bottom of Kirkgate is settled with the Lancashire and Yorkshire Railway Company, tenders for providing the necessary transformers and gear will be called.

Lowestoft.—The Mutford and Lothingland Rural District Council have notified the Council of their intention to apply for a provisional order to supply electricity in the following parishes—viz., Ashby, Barnby, Belton, Blundeston, Bradwell, Burgh Castle, Carlton Colville, Corton, Flixton, Fritton, Gisleham, Gunton, Herringfleet, Hopton, Kessingland, Lound, Mutford, Oulton, Pakefield, Rushmere, and Somerleyton. We understand that the Town Council's proposed application for powers outside the borough will not be proceeded with at present.

Swansea.—Sanction has been received to the borrowing of £20,300 for the municipal telephone scheme. The work of laying the cables and connecting subscribers' premises will now be pushed forward at once. The consent has been received within one month of the enquiry. Mr. Henry Coles has been engaged to draw up specifications and supervise the installation of the electric light in the women's infirmary and porter lodge block at a cost of £12, this price to include the drawing up of the specification for electrically lighting the men's infirmary block, which is shortly to be carried out.

Fleetwood.—The question of electric lighting at Fleetwood has again engaged the attention of a sub-committee of the Urban Council, and a further special test of the electric lighting mains has been made by Mr. C. H. Wordingham. In a report giving details of tests made by him of 27 public street lamps, he says that the pressure supplied to six lamps was below the limit allowed by the Board of Trade. A copy of the report has been forwarded to Mr. O. Hansom, the resident engineer of the electric lighting syndicate, together with a letter regarding the condition of the public street lamps.

Barnstaple.—A writ has been issued in the High Court of Justice by a well-known Barnstaple ratepayer for a declaration that Barnstaple Town Council are not entitled, in connection with their electric light undertaking, to wire houses or supply lamps in the various houses in the borough in accordance with the circular issued some time since by that authority. The grounds of the application are that these powers are in excess of those granted by the Barnstaple electric lighting order. An injunction against the Council will probably be applied for forthwith. The town clerk has been instructed to enter an appearance to the writ, and to engage counsel to defend the action.

Partnership.—The Birmingham Electrical Fittings Company, Birmingham, have taken Mr. Percival West into partnership. The firm will continue to carry on the business in the same name, with works and offices at Coleshill-street. We are informed that Mr. West has had practical experience of electrical and mechanical works in this country and in America. The company are now considerably extending their plant and machinery so as to embrace all kinds of electrical appliances and accessories, at the same time continuing their specialities of main switches, switchboards, and fuseboards, notably of the "Johnson patent" board, of which they hold the sole license to manufacture.

Chesterfield.—The Corporation have decided, upon the advice of their engineer, Mr. B. L. Acland, to purchase another 200-kw. dynamo and other necessary plant for increasing the generating power of the station, which is situated at Brampton, and also to extend the boiler-house. The plant will be compounded for dealing with either lighting or traction load. At the present time the plant is working with a maximum load of 300 kw., and there will be a probable load of 350 kw. before Christmas, out of an available 400 kw. (the capacity of the present plant). The total amount involved in the proposed expenditure is £6,335. The price for current will be reduced from 7d. and 3d. to 6d. and 3d. per unit.

Cardiff.—The Parliamentary Committee are conferring with Sir William Thomas Lewis with reference to the already reported application to the Cardiff Railway Company for permission to lay electric cables on their property. It is proposed to borrow £86,701 for lighting purposes. Most of that sum has already been spent on plant, etc., in the power station at Roath, but because the powers for borrowing related to electric traction the Local Government Board refused to sanction the loan for lighting. It is now suggested that the Tramways Committee should borrow the money, put down the machinery, and sell the current to the Lighting Committee at cost price.

Walthamstow.—The accounts for the first year's working ending Sept. 30, 1902, of the electricity supply undertaking have now been made up. The total receipts are £6,680, and the working expenses £2,915. After paying interest and sinking fund charges, which amounts to £2,738, there is a profit of £1,027, an extremely good result. Mr. F. A. Wilkinson, the electrical engineer, reports there are applications in hand for 28,486 8-c.p. lamps, and that motors of 100 h.p. are connected. The new extensions will be completed in the course of the next few weeks, and the total plant capacity of the works will then be 810 kw. It will be remembered that Westinghouse gas-engines and producer plant are in use at Walthamstow.

Newport.—A new scale of charges will come into force on Jan. 1, 1903. Current will be supplied for lighting purposes to dwelling-houses and places of worship at 5d. per unit, and to shops, theatres, public-houses, halls, schools, offices, infirmaries, hospitals, and general buildings from 5½d. per unit for the first 2,000 units to 3d. for the sixth 2,000 units. Consumers entering into a contract for a minimum quantity of 16,000 units per annum, 3d. per unit net. Power consumers using not less than a given amount of current for power to be supplied with energy for lighting purposes at special rates from 4d. per unit net for not less than 8,000 units for power to 2d. per unit for not less than 50,000 units. It is estimated that on the present basis of demand these rates will result in a decrease in the receipts of the Corporation of about £600 per annum, but it is also thought that the increased demand for current will much more than make up that amount in the first full year.

King's Lynn.—The engineer's last report states that during the month applications were received for 196 additional 8-c.p. lamps or equivalent, making a total of 13,851 lamps and 367 consumers. The working costs for September this year, compared with the same month last year, were as follows: units generated, September, 1901, 24,867; September, 1902, 25,132; units sold to private consumers, September, 1901, 6,252; September, 1902, 8,834; units sold at power rates, September, 1901, 43; September, 1902, 1,479; cost of fuel, stores, repairs, and wages in station, September, 1901, £122. 12s. 1d.; September, 1902, £98. 8s. 1d.; cost per unit generated, 1·1830d., 0·9395d. A number of new applications have been received. Consideration of the engineer's report on the extension of plant at the works has been adjourned for the purpose of obtaining additional information. An application for current at the docks will be agreed to and a main laid so soon as the necessary permission is obtained from the dock company.

Ayr.—The engineer's last report gives the number of consumers as 598; number connected during month were five—total, 603. Lamps connected as per last report, were 24,596, including 329 connected during the month—total, 24,925. The units generated as per last report were 326,942, including 109,549 units generated during month—total, 436,491. The units for corresponding period last year were 221,231, showing an increase of 215,260. The question of lighting the Esplanade has been referred to the Attractions Committee for consideration and report. The engineer has submitted two estimates as follows: for arc lighting by 16 10-ampere arc lamps complete with all necessary cables laid and jointed, and fitted with hoisting and lowering gear and all necessary apparatus, £582. 2s. 10d.; for incandescent lighting by 32 small posts each fitted with two 32-c.p. lamps, together with all switches, connections, and underground cables, £494. 10s. 4d. The annual cost of running each of these from dusk to 11 p.m. would be: for arc lighting, £96; incandescent lighting, £115. The engineer very strongly advises the use of arc lamps.

Dingwall.—The Town Council have resolved to introduce electric light for public and private lighting. Wayleave will be granted to Major Blunt, the vendor, in connection with the supplying and distributing of the same within the municipal boundaries, the price to be 6d. per unit for private and street lighting, the latter to be subject to a rebate of 20 per cent.; prices to be subject to revision after every period of 10 years at the instance of the Town Council or the undertaker, the revision to be made by an arbiter appointed by the Board of Trade, whom failing, by an arbiter to be appointed by the sheriff of the county, the maximum price never to exceed 6d.; the Town Council to consent to a provisional order if found necessary on the terms of the agreement. The Town Council may, on giving 12 months' notice, purchase the part of the undertaking situated within the burgh within six months after the expiration of the period of 42 years, in terms provided by Section 2 in the Electric Lighting Act, 1888, which is declared to apply to the agreement, the undertaker in that event to supply electricity at a price to be agreed upon.

Carnarvon.—The County Council has adopted the following report of the special committee appointed to consider the question of the increasing popularity of electricity, and to suggest steps for safeguarding the Council's interests: "It is recommended that the County Council desires to point out the anomaly that exists wherein, under the Light Railways Act, county councils are empowered to construct light railways, but have no power to utilise the power in supplying towns or hamlets through which such railway passes with lighting, and this Council desires to express its approval of the Bill of Mr. Walter Long giving county councils additional powers, and urges the inclusion therein of provisions for the removal of the anomaly above mentioned; that a copy of the foregoing be sent to the President of

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the Local Government Board, the President of the Board of Trade, the President of the County Councils' Association, etc." The County Council has assented to an application to be made by Mr. Assheton Smith for a provisional order for electric lighting, at the same time reserving the right to require the insertion in the order of such clauses as will protect public interests.

Wrexham.—Mr. W. O. E. Meade-King has held an enquiry into the application of the Town Council for sanction to borrow £11,000 for the purposes of electric lighting. The Corporation have an agreement with the Wrexham and District Electric Traction Company for the supply of power for their undertaking, which is now nearing completion. Further machinery is also required as a stand-by in connection with the extension of the electric lighting and motor power within the borough, and in case of a temporary breakdown. The details of the application are as follows: overspent on previous loan of £20,000, £2,200; chimney, £1,500; and one 300-kw. steam dynamo and high-speed engine, £3,100. The smaller items are for new boiler, superheater, automatic stoker, steam and exhaust pipe, switchboard additions, motor and generator set, and additional distributing mains. Mr. W. H. Trentham and Mr. J. W. M. Smith supplied the inspector with particulars of the new chimney, which is to be of the same height as the present one and built of special radiated and perforated bricks, which are supposed to lessen the weight of the bulk and give more hold. The new water-tube boiler is required to give increased power.

Tiverton.—Mr. J. Siddals, the borough engineer, has submitted a report on a scheme prepared by him for providing an electric lighting installation in connection with the Corporation gasworks. He recommended that the installation be worked by gas-engines driven by producer gas, and that they should provide for a minimum of 2,000 8-c.p. lamps, which would probably have to be increased in, say, 10 to 15 years to a maximum of 6,000. They would require for this machinery to give 100 h.p. to 150 h.p. to commence with, and the station would have to be designed to allow of an increase to 300 h.p. He estimates the total cost at £8,900, which included site, building, producer gas plant, two 100-b h.p. gas-engines, two dynamos, battery, switchboard, distributing mains, services, and meters. Taking the demand 2,800-c.p. lamps, he estimated the annual cost of working at £400; repairs and upkeep, £240; and sinking fund, £470—total, £1,110. The receipts from 2,000 lamps, at an average of 8s. per lamp, £800; and when the demand rose to 3,000 the cost of working would be raised £40 for full, and the income would be £1,200. The Lighting Committee have decided, before adopting the scheme, to enquire on what terms private companies and firms would be willing to take over the borough's provisional order.

Newport (Mon.).—On Nov. 7 the Mayor (Alderman Hy. John Davis) laid the foundation stone of a transporter bridge which is to be erected between Brithdir Wharf and Crow Point. The transporter will consist of two towers of open lattice girder work, 254ft. high, on each side of the river, with the girder framework of a suspension bridge over the river, high above the wharf level. Passing over the top of the towers, and moored to anchorages of solid masonry on each side, will be stout steel wire cables supporting the centre of the bridge. The distinctive feature of the bridge is that without climbing or exertion, simply by walking or driving on to a car, the pedestrian or the loaded cart can be conveyed swiftly and comfortably from one side of the river to the other at the level of the road. The car is suspended by 30 steel wire cables from a platform which runs on low rollers along the girders of the bridge about 160ft. above; and by means of a winding rope and drums, worked by electric motors, the platform and car will be drawn from side to side of the river. The estimated cost is £90,000, and the contract for the foundations and the erection of the bridge has been let to Mr. Alfred Thorne, of Westminster, for £59,062. Mr. Arnodin is the patentee of the system, and he and Mr. R. H. Haynes, Newport's able borough engineer, are joint engineers for the scheme.

Allgemeine Electricitaets-Gesellschaft.—In their report ended June 30, 1902, which is to be laid before the ordinary general meeting on Dec. 5, the directors deal with the present depression of the electrical industry in Germany, and say that the industry is at present in the centre of a universal downward movement, and they are of opinion that the electrical crisis is rather the cause than the consequence of the present general economic debility. As causes are given abnormally large investments in industrial undertakings which bore no correspondence with the wealth of the country nor with the demands made by the current rates of interest; insufficient investigation of these undertakings, and over-capitalisation of the same; unwarranted enlargement of factories by a reason of orders which came from undertakings controlled by them, and which represented single orders which would not be repeated; and, further, the development of a business organisation which was not warranted by the demand; also they expect that the outcome will be an increased activity to utilise the forces in hand in finding new application. The directors are of opinion that it will be some time before a healthy condition will be established. In order to regulate the present misproportion of supply and demand, they think that it will require a closer union of the large firms in order to bring prices up to a profitable level. After all this lamenting they declare a dividend of 8 per cent., and owing to a rebate of taxes extending over various years, the sum of £60,000 will be credited to the reserve fund. Although the company's factories had satisfactory work, they have looked for new fields, amongst which we note the manufacture of Riedler and Stumpf's steam-turbines, the development of their wireless telegraphy, extension of their metal and indiarubber works, motors, etc. They also draw attention to the fact that, after many years of troublesome work, the Nernst lamp was a success and was being used extensively. During the last year 16,418 dynamos and motors, of 153,241 kw. and 208,200 h.p., were produced. A rolling-mill is to be added to their metal works, also the manufacture of iron and steel wires for armatures. One hundred apparatus for wireless telegraphy have been sold during the year. The gross profit is stated at £361,163; the expenses, £281,702; the dividend will absorb £240,000; directors' fees, £6,000; bonuses to employés and institutions connected with the same, £12,000; pensions and sick fund, £12,000; leaving about £12,000 to be carried over.

PROVISIONAL PATENTS, 1902.

Nov. 3.

23933. Improvements in supports or hangers for overhead electric wires. Tom Percy Bentley, 6, Bank-street, Manchester.

23949. Improvements in electrical influence machines. August Eckstein and Herbert John Coates, Peel Works Adelphi, Salford, Manchester.

23951. Protection for electrical conductors or live rails applicable to railways or tramways. Taggart Aston, Heathcote, Gweedore, co. Donegal, Ireland.

23952. A double wall plug for electric lighting. Harry Hubbard, 6, Richmond-gardens, Shepherd's Bush, London.

23969. Improvements in projectors for alternating-current lamps. August Engelsmann, 111, Hatton-garden, London. (Complete specification.)

23971. Improvements in or relating to electric motors. Oscar Henry Pieper, 111, Hatton-garden, London. (Complete specification.)

24006. Improvements relating to the manufacture of Rontgen tubes. Carl Heinrich Florenz Müller, 45, Southampton-buildings, Chancery-lane, London.

24013. Improvements in and relating to the attachment of carbon filaments in incandescent electric lamps. Ferdinand Fanta and Philip Ernest Butler, 1, Queen Victoria-street, London.

Nov. 4.

24031. Improvements in and relating to electric cars. Thomas Turner Hindle, 689, Blackburn-road, Bolton.

24033. Improvements in oiling vertical electric motors, which are worked intermittently as in the case of driving centrifugal machines direct by an electric motor. James Wright Macfarlane, of the firm of Watson, Laidlaw, and Co., 154, St. Vincent-street, Glasgow.

24035. Mica-insulated cable. Walter Claude Johnson and Sydney Paterson, Electric Cable Works, Old Charlton, Kent.

24068. Improvements relating to arc lamps. Albert de Puydt, 34, Castle-street, Liverpool. (Date applied for under Patents Act, 1901, June 10, 1902, being date of application in Belgium. (Complete specification.)

24075. Improvements in and relating to conduct wires for overhead electric tramways. John Whitehead and Herbert John Whitehead, 36, Temple-street, Birmingham.

24089. Improvements in electric switch lampholders. Philip Johnstone Spenser Tiddeman, 99, Cannon-street, London.

24099. Improvements in or relating to alternating-current generators. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (The General Electric Company, United States.) (Complete specification.)

24100. Improvements in and connected with electric brakes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (The General Electric Company, United States.) (Complete specification.)

24101. Improvements in methods of and apparatus for transforming electric energy. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24102. Improvements in surface-contact structures. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24104. Improvements connected with trolley wires for electric trams and the like. Alfred Ernest Le Rossignol, 24, Southampton-buildings, Chancery-lane, London.

24109. Improvements in regulators for arc light systems. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Incandescent Arc Light Company, United States.) (Complete specification.)

24111. Improved method of and means for reflecting electric light especially suitable for shop-window illumination; applicable also for other uses. The Alliance Electrical Company, Limited, and William Gillham, 165, Queen Victoria-street, London.

24112. Improvements in or relating to alternate-current traction systems. William Morris Mordey and Arnold Greaves Hansard, 45, Lincoln's-inn-fields, London.

24122. A new and improved arc lamp. Peter Heinrich Felix Spies and Clive Bennett Tutt, 6, Lord-street, Liverpool.

24128. Improvements in electric motors, the invention being applicable to electric fans. Albert Bernard Holson, Church-street, South Lambeth, London. (Date applied for under Patents Act, 1901, Nov. 4, 1901, being date of application in United States.) (Complete specification.)

24132. Improvements in dynamo-electric machinery. Malcolm MacLaren, Westinghouse-building, Norfolk-street, Strand, London.

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24148. Improvements connected with electric fuses. William Beedie Esson, Norfolk House, Norfolk-street, Strand, London.

24149. Improvements connected with electric fuses. William Beedie Esson, Norfolk House, Norfolk-street, Strand, London.

Nov. 5.

24172. Improved system of electric traction. Joseph Galloway, 62, St. Vincent-street, Glasgow.

24192. Improvements in and connected with the trolley collectors, trolley poles, and trolley stands employed in overhead systems of electrical traction. William Ellison Rowlands, 10, St. George's-crescent, Liverpool.

24205. Improvements in switch lampholders for incandescent electric lamps and the like. John Hewett, 5, Budge-row, London.

24212. Improvements in brush-holders for dynamo-electric machines. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24220. Improvements in connections for electric conducting wires. William Peto and Thomas Oliver Kent, 65, Chancery-lane, London.

24235. Improvements in heating by means of electricity. Israel Jegor Bronn, 4, South-street, Finsbury, London.

24236. Process for obtaining metallic sulphides in electric furnaces. Israel Jegor Bronn, 4, South-street, Finsbury, London.

24238. Improvements in telephone systems. Alfred Ekström, 4, South-street, Finsbury, London. (Complete specification.)

24247. Improvements relating to electric switches. Carl Bennett Auel and Matthew Adam McLean, Westinghouse-building, Norfolk-street, Strand, London.

24260. Improvements in or relating to trolleys for electric railways with overhead conductors. Eugene Limauge, 111, Hatton-garden, London. (Complete specification.)

Nov 6

24325. Improved apparatus for testing the efficiency of electric lamps. Reginald Page Wilson and George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London.

24328. Improvements in electric incandescent lamps. Frank Eustace Wilkins Bowen, 6, Bream's-buildings, Chancery-lane, London.

24330. Improvements in apparatus for the generation and application of electric currents for electrolysis. Francis Edward Elmore, Birkbeck Bank-chambers, South-ampton-buildings, Chancery-lane, London.

24331. Improvements relating to electrolytic cells. Philippe Auguste Guye, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

24340. Improvements in and relating to electric heating apparatus. Martin Petersen, 322, High Holborn, London. (Complete specification.)

24361. Improvements in and connected with electricity meters Ernest Schattner, 55, Chancery-lane. London.

24367. Improvements in and relating to condensers. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

Nov. 7.

24374. Improvements in and relating to electromotors. John Maclean and Hope Lyle Galloway, 96, Buchanan-street, Glasgow.

24383. An improved device for use in connection with electrical contacts. Malcolm Sutherland and Elias Marcuson, 61, Chandos-street, London.

24410. Improvements in and connected with electrically-energised pendulum clocks. George Daniel Granger, 1 and 4, Mitre-court-chambers, Fleet-street, London.

24429. Improvements in insulated electrical conductors. John Pitman Hooper, 24, Southampton - buildings, Chancery-lane, London.

24455. Improvements in controlling devices for electric motors applicable to the motors of elevators and the like. Waygood and Otis, Limited, 55, Chancery-lane, London. (Otis Elevator Company, Incorporated, United States.) (Complete specification.)

24457. Improvements in current collectors for trackless electrical cars with overhead conductor. Herbert John Haddon, 18, Buckingham-street, Strand, London. (Br. Wiesengrund, Germany.)

24459. Automatic electrical cut-out. David Robertson Bruce, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24462. Improved manufacture of cores for arc lamp electrodes. Charles Denton Abel, Birkbeck Bank-chambers, South-ampton-buildings, Chancery-lane, London. (Gebrüder Siemens und Co., Germany.)

Nov. 8.

24478. Improved central exchange telephone systems. Bertil Brander, 7, Hillaries-road, Gravelly-hill, Birmingham.

24498. An improvement in the construction of pendant, bracket, and standard fittings and globes for gas and electric lighting. Thomas Ford and Frank Ford, Victoria Works, Emily-street, Highgate, Birmingham.

24511. The guard for an electric tramcar. Thomas W. Wilson, 90, James-street, Devonport, Devon.

24517. A new and original method of constructing electrical heating and cooking apparatus and resistances for general electrical work Max Hankin, 15, Copthall-avenue, London.

24531. A new or improved "detector" or appliance for use in testing for electric currents. Charles Oliver, Birkbeck Bank - chambers, Southampton - buildings, Chancery-lane, London.

24538. Improvements in prepayment electricity meters. Frederick John Beaumont, 173, Fleet-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 27.

1901.

15536. Apparatus for the reinforcing and standardising of filaments of glow lamps. Fanta.

22031. System for obtaining variable speeds in direct-current electric motors. British Thomson-Houston Company, Limited. (Essberger.)

22034. Regulating rotary electric converters. Hobart.

22035. Damping devices for rotary electric converters. Hobart.

22542. Electric air compressors. British Thomson-Houston Company, Limited. (Batchelder.)

23773. Drums for holding electric cables. Sutcliffe.

24011. Electrical apparatus, including telephone and like apparatus. Justice. (Barton.)

24149. Cam gears for quick-return movements especially applicable to electric igniters for explosion engines. O'Gorman.

24633. Apparatus for use in driving dynamos on railway and other vehicles. Beaumont and Hill.

24666. Dynamo-electric generators for igniting the charges in gas and oil engines and for other purposes Reid and Shepherd.

24937. Polyphase alternating-current induction motors. Langdon-Davies and Soames.

25426. Controlling of electric circuits. De Ferranti.

26600. Telegraphic and telephonic systems. Maiche (Date applied for under International Convention, July 19, 1901.)

26659. Electric light brackets or pendants. Wallwork and Wallwork.

1902.

452. Electrical ignition apparatus for internal-combustion engines. Abel. (Soc. Anon. des Anciens Etablissements Panhard et Levassor.)

4999. Electric igniting plugs for internal-combustion engines. Hadfield.

16843. Clocks, particularly electric clocks. Butcher.

17173. Electrical station indicators for use in connection with railway trains. Losádi.

17994. Electric interrupters. Nilson. (Date applied for under International Convention, May 1, 1902.)

17995. Driving mechanism for electric road vehicles. Nilson. (Date applied for under International Convention, May 14, 1902).

17997. Controllers for electric motors. Nilson. (Date applied for under International Convention, May 15, 1902.)

17998. Electro-gasoline vehicles. Nilson. (Date applied for under International Convention, May 15, 1902.)

19522. Electric heating stoves. Veritys, Limited, and Ebbutt.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7½-8
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	102-104
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	15-16
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2¼-2¾
—— 5 per cent. Debentures	100 ..	101-106 p.c
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent, 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16¼-17½
—— 4½ per cent. Preference	5	5¼-5¾
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20¼-21½
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14¼-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105
Electric Tramways.—		
Anglo-Argentine, 1-250,007	5	4¾-4⅞
—— Permanent 6 per cent. Debenture Stock, 1888	100	127-132
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12¾-13¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12¼-12¾
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1¾-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4¾-5¼
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
—— 4 per cent. 1st Mortgage Debentures	100	100-103
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14¼-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14¼-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4⅜
—— 4 per cent. Debenture Stock	100	95-99
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	11¼-12
—— " " " "	10	11¼-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	106-108
—— " " Prov. Crts.	100	105-107
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10⅝
—— 5 per cent. Cum. Pref.	10	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8¼-9½
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	16s.	13/16
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c.	87 p.c
Electric Railways.—		
Central London, Ordinary	100	106-109
—— 4 per cent. Pref.	100	106-109
—— " " deferred	100	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-119
City and South London, Consolidated Ordinary	100	74-76
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	123-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¾-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	93-96

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	¼-⅜
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	106-109
Bournemouth and Poole, Ordinary	10	12¼-13½
—— 4½ per cent. Cum. Pref.	10	10-11
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	10¼-10⅜
—— 7 per cent. Preference	5	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7-8
—— Nos. 20,001-30,000	5	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " £10 Ord.	6	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	107-110
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5¼-6
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	13¼-14¼
—— 5 per cent. Debenture Stock	100	125-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104-107
County of London and Brush Provincial, Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6-6¼
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	3	1¾-2¼
—— 6 per cent. Pref.	5	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15¼-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	110-115
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6½
Notting Hill Electric Lighting	10	14-15
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oriental, 1879	1	—
—— £5 Shares	5	—
—— £4½ Shares, New	4½	—
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¾-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	14¼-15½
—— 7 per cent. Pref.	5	8¼-9¼
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3¼-4⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3¼-4⅛
Westminster, Ordinary	5	11¼-12½
—— 5 per cent. Cum. Pref., 110,101-138,241	5	6-6¼
Telephones.—		
National Telephone, Preferred	100	92-94
—— Deferred Stock	100	57-59
—— 6 per cent. Cum. First Pref.	10	12¼-13½
—— 6 per cent. Cum. Second Pref.	10	11¼-12¼
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100	95-98
—— 4 per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	¼-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 25	873	658	+ 214	+ 5,787	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	Nov. 8	5,052	4,127	+ 925	+15,630	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	" 7	765	664	+ 101	+ 3,713	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	" 6	343	271	+ 72	+ 162	16½	—	Mar. 31	41,818	5,809,190	753,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	" 8	205	184	+ 21	− 255	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 9	1,572	1,342	+ 229	+ 3,629	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	Oct. 26	3,208	1,090	+2,118	+82,937	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57*
Bristol Tramways Company	Nov. 7	4,581	3,653	+ 928	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	" 8	7,122	6,975	+ 147	+10,209*h*	12	12	,, 31	335,086	41,188,383	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	" 9	3,489	2,505	+ 984	+19,259	12½	9½	,, 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,210	—
Cork E. T. and L. Company	" 6	563	416	+ 146	+ 5,863	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	4,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	" 8	189	170	+ 19	+ 71	4½	—	,, 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 9	92	82	− 10	+ 624	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	" 7	3,752	3,372	+ 380	+2,005	46	46	,, 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	" 7	758	742	+ 16											
Dundee City Tramways	" 5	768	625	+ 143	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	" 8	12,662	13,705	−1,037	−13,672	104	95	,, 31	582,146*c*	155,243,378	11,935,699	0·90	11·71	5,597	7·51
Halifax Corporation	Oct. 22	1,139	1,028	+ 111	+ 2,225	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	Nov. 8	1,016	804	+ 212		48	48	Sept. 30	29,901*h*	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	" 8	1,721	1,576	+ 145	+ 2,522	19	9½	,, 30	72,331*h*	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	" 1	9,831	9,166	+ 665	+33,175	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	" 9	1,465	1,390	+ 75	+ 892	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	" 9	4,036	—	—	—	46½	—	Mar. 25	191,337	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	" 6	969	780	+ 189	—	11	—	,, 31	23,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	" 9	1,022	952	+ 70	+ 2,772	19	17	,, 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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Supplement to "The Electrical Engineer,"

NOVEMBER 14, 1902.

THE DESIGN OF CONTINUOUS-CURRENT DYNAMOS.*

BY HENRY A. MAVOR, CHAIRMAN.

Following up the paper on this subject read by the present author at the International Engineering Conference, Glasgow, 1901, there are some points to which he proposes to give further elucidation. As in the case of the former paper, it is not proposed to enunciate any new theories, or to discuss the bases of dynamo design. The present investigation has to do rather with the application to practical design of the results of the calculations and experiments of others. The generally accepted constants and formulæ may be by this means subject to such criticism as to lead to modification of generally accepted views, and therefore such an investigation is not without its uses.

Referring back to the congress paper, the author there suggested that the essential part of the dynamo is the region occupied by the armature conductors in the magnetic field, and suggested the name "active belt" for this region, which is bounded by the peripheral surface of the armature, the surface of the core at the bottom of the slots, and the ends of the core. He pointed out that an examination of the dynamo in terms of the energy generated in this active belt shows that machines of widely varying size, output, and speed give a remarkably constant value in watts generated per cubic centimetre of active belt at unit velocity in unit field.

In an interesting paper read before the British Association in Belfast this year by Prof. Silvanus Thompson, the professor gives the results of calculations on a large number of machines considered from this point of view, and confirms the value given in the congress paper referred to. This value is often exceeded, but the statement originally made that five ergs per second per cubic centimetre at unit velocity in unit field may be counted upon as a safe load is fully confirmed. The application of this method of study to machines of smaller sizes has shown that this value must be subjected to considerable modification, the reason being that in the smaller machines the losses on the armature are relatively more important than in the larger sizes. On machines of 24in. diameter and upwards it appears that the output may safely be given in watts per revolution—that is to say, that a given carcase will give an output directly, or nearly directly, proportional to the speed of rotation of the armature. In modern designs of large machines it is not difficult to determine this output, both with regard to the commutating conditions and to the temperature of the armature.

The design of the smaller machines, for which the market is very rapidly increasing, is not less worthy of close attention, and it would appear, judging from the machines now on the market, that this part of the subject has not yet received the attention which it deserves. A very interesting series of articles at present appearing in the journal *Traction and Transmission*, by Mr. Henry M Hobart, is dealing somewhat fully with this subject, and should be read by all interested in dynamo design. In this connection it is interesting to note as a forecast of the probable development in this country, that in America the year's census of work, according to the American *Electrical World*, is 9,182 continuous-current machines of 428,601 h.p., giving an average of only 35 kw. per machine for the year 1900.

Confining, as before, our attention to the armature, the points requiring consideration in the design of the machine arise primarily from the commutating conditions, and from the limit of temperature rise imposed. The commutating conditions on small machines can be fairly safely dealt with on the lines indicated in the congress paper, and it will be found that this part of the question is much more easily solved than the other. The temperature rise in the armature is taken to be due to the following expenditures of energy on the material of the armature: (1) hysteresis in the core; (2) eddy currents in the core; (3) hysteresis in the teeth; (4) eddy currents in the teeth; (5) eddy currents in the winding; (6) $C^2 R$ losses in the winding. These are all losses which may be expressed in watts, to be deducted from the effective watts of the machine.

The subject of hysteresis and eddy currents has been discussed with great fulness in various treatises on magnetism and on dynamo design, and it is not proposed here to enter into any discussion on these subjects, but to assume relations between those losses and the induction, periodicity, and weight. It is quite certain that the constants deduced from the study of these phenomena in the past must be subjected to some considerable modification, and the story is not yet told of all that takes place in a piece of iron under changing magnetisation, and in a copper conductor in a changing magnetic field, but the constants now in general use have proved sufficiently near the truth to warrant their being used for our present purpose, and we may, therefore, follow to a logical conclusion the assumptions involved in those constants, reserving to ourselves the right to retrace our steps and amend our constants when they prove inconsistent with the results of experience. We are just as much warranted in doing this as we are in accepting the tests of tensile strength of steel and cast iron, and to all appearance the electrical data are even more reliable than the physical data to which we have referred.

It is customary to treat hysteresis and eddy currents in the core and hysteresis in the teeth as being proportional to the periodicity, or the rate of change of magnetisation in that core, that is to say, to the speed. Eddy currents in the teeth are usually taken to be proportional to the square of the speed. The eddy currents in the winding are usually assumed to be negligible in machines in which the winding is embedded in slots and tunnels, and to be also of comparatively small importance on smooth-cored machines where the conductors are well laminated. These losses appear as heat, producing a rise of temperature in the armature. The cooling effect of the circulating air round the moving armature tends to dissipate the heat, and a point is found when the heat production in the armature is balanced by the radiation from it, and the temperature becomes approximately constant. It is customary to specify this constant temperature at something between 70deg. and 90deg. F. above the temperature of the surrounding air. On small machines this is an exceedingly uncertain standard, because it is difficult to ascertain what is the temperature of the armature. It is difficult even to ascertain what is the temperature of the surrounding air. There is a further difficulty that a very insignificant variation in the condition or distribution of the material in a small machine very materially modifies the temperature rise. As, however, no more satisfactory standard of comparison has been generally adopted, we shall also assume for the purpose of the argument that it is practicable to forecast the temperature rise of the machine, and to measure it when it occurs. For practical purposes, speaking generally, there is no very great difficulty in doing so. The exceptions which frequently arise are usually due to ascertainable abnormalities. Assuming for the present that the proper constants have been ascertained for determining each of the losses, we may symbolise them by

* Paper read before the Glasgow Local Section of the Institution of Electrical Engineers.

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$A_1 n$ = hysteresis and eddies in the core in watts.
$A_{11} n$ = hysteresis in the teeth in watts.
$A_{111} n^2$ = eddies in the teeth in watts.
A_{1111} = watts lost in the winding.

The radiation of heat from the armature is taken as protional to the square root of the speed. The constants are determined for any given rise of temperature by experiment. The expression for the total lost watts radiated by the armature takes the form

$$A_v \sqrt{n},$$

and the copper loss is ascertained by deducting the iron losses from the value $A_v \sqrt{n}$.

Thus $$A_v \sqrt{n} - A_1 n - A_{11} n - A_{111} n^2 = A_{1111}.$$

That the text of the paper be not unduly defaced by formulæ, they are relegated to an appendix which gives constants and formulæ: (1) for the determination of core and tooth losses; (2) radiation from the surface of the core; (3) the watts generated by the machine, its output, and efficiency.

The total watts generated in the winding of a dynamo, or absorbed in the winding of a motor armature, are directly proportional to the square root of the watts lost in the winding, the square root of total cross-sectional area of the copper, the volume of the core, the induction in the air-space, and to the rate of revolution and inversely proportional to the square root of the length of each turn of the winding.

Thus $$W = \frac{\sqrt{A_{1111}} \times \sqrt{Q S_c} \times \pi D L B_n 10^{-6} \times n}{\sqrt{2L \times \frac{D 7{\cdot}44}{P}}}$$

(See Appendix III.)

This formula for total watts symbolises the fact that the total output of the armature varies as the square root of the loss in the winding and directly as the speed. Now, if the loss in the winding be relatively small, the output will, for practical purposes, vary directly with the speed. This is the case in large machines. In small armatures, on the other hand, the winding loss is relatively large, and it is worth while to look for the conditions which give maximum output This can with a little labour be done for any machine by a simple graphic method.

Plotting the values of $\sqrt{n}$, n, and n^2, multiplied by the relative constants, to scale we get a diagram for any armature giving the value of A_{1111} (Fig. 1).

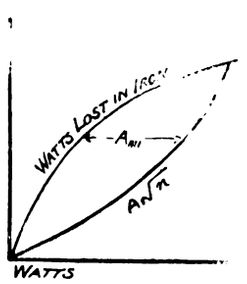

FIG. 1.

Again plotting values of W and n, we get the diagram shown in Fig. 2.

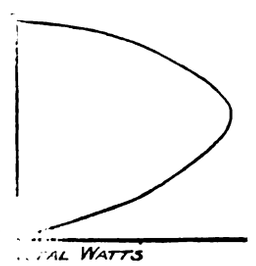

FIG. 2.

The form of this curve is interesting. It shows that there is for every machine a maximum possible output for a given rise of temperature, and that this maximum is at a definite speed of rotation. The position of this curve and of its maximum may be varied by several means. For low speed the total watts and the efficiency are greater with a deep slot and high inductions. For high speed the total watts and the efficiency are greater with a shallow slot and low inductions. The ratio between the iron and the copper can be adjusted to suit the conditions of work to which the motor is likely to be subjected. If, for example, it has to run constantly with a varying load on outside supply paid for by meter, it is evident that the iron losses should be kept low and the copper losses high, whereas if the machine is to run at full load it should be designed to give the output under the most favourable conditions of combined iron and copper losses. Attention to this point results in a very considerable saving in cost of working. A reference to the formulæ in the appendix will show how the values of these losses have been determined. The losses in the core are seen to depend upon its weight, the core induction, and the periodicity of magnetic reversal (see Appendix I.).

It is convenient to find expressions deriving the core induction from the induction in the air-space, and this is contained in a formula given in Appendix I.). A high value of the induction keeps down the quantity of material in the active belt, the number of turns of wire required, and the reactance voltage. On the other hand, the induction in the air-space is limited by the necessity for mechanical clearance and by the size of the carcase. The author has not gone into the investigation of the highest permissible value of the induction in the air-space. This maximum will be found to depend with any given form of magnet on the relation between the length of the path through the magnet and the space available for wire. It is now almost universal to demand a fixed brush position for all loads, and therefore it is of the highest importance that the values of the induction in the air-space and teeth should be kept as high as practicable.

The range of speed variation by shunt regulation depends on the reduction of the field strength, so that it is advantageous on this ground also to have the initial strength as high as possible. It will be seen that the value of the core loss is not susceptible of any very great variation, that a reduction in the quantity of material with consequent increase in the induction does not materially affect the loss in the core. We therefore turn to A_{11} and A_{111} as the quantities susceptible of the most effective change. A_{11} and A_{111} are seen to depend upon the weight of the teeth. Here again it is convenient to derive this weight directly from the slot depth, and a formula has been arranged and given in Appendix I.) deriving the dimensions of tooth and slot from the slot depth, the induction in the air-space, and the maximum induction in the teeth. The factor which is susceptible of the most effective variation is the slot depth, and diagrams showing the effect of the variation of the slot depth take the form shown in Fig. 3, which is worked out for a machine of 10in. diameter.

The value of the induction in the teeth, though susceptible of considerable variation, cannot be reduced so as to materially affect the result. Considerations of commutation called for a high value of the tooth induction, as well as of the induction in the air-space, so as to provide a "stiff" field and to throttle or minimise cross induction and consequent shifting of the diameter of commutation with change of load. The limit to the tooth induction appears to be fixed by the risk of the leakage field into the slot, causing eddy currents in the conductor. The values of the induction in the air-space which appear to be adopted in current practice, and as indicated in the paper by Prof. Silvanus Thompson already referred to, appear to be not very far from the value chosen in the congress paper—viz., about 6,000 to 8,500 lines per centimetre. The value of the tooth induction commonly adopted is a maximum of 20,000 to 22,000 lines per centimetre. Speaking generally, the changes which can be made have the following effect:

Increase of core induction, slot depth, air-space induction, and tooth induction all have the same effect upon the output curve of the machine as increase in speed, and increase in slot depth produces by far the most conspicuous change. The iron losses decreasing with decrease in slot depth, a point is reached when the slot becomes too shallow

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to hold the wire, and a limit is reached in this direction. If the wire be outside the slot, the risk of eddy-current loss must be taken into account.

Turning now to the value $A_v \sqrt{n}$. The radiation factor is susceptible of some variation. The demand for enclosed motors—which we may say in passing does not seem to have any good theoretical justification, but like so many demands which have become common, and which have been accepted by the designers of machines without

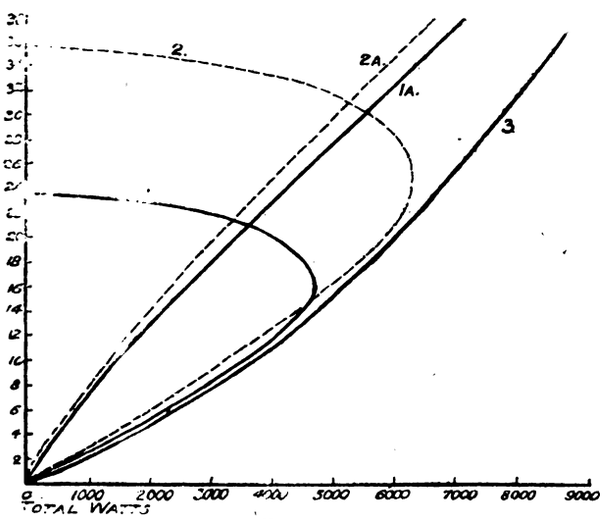

FIG. 3.

sufficient consideration or resistance to outside influence, appears to be entirely injurious — this requirement of enclosure of the motor, which prevents circulation of air, and thus prevents the armature from getting rid of its heat to the moving air, restricts the output of the machine quite unnecessarily. Under certain circumstances it is necessary to protect the motor from moisture, but the most injurious kind of dust which can lodge on an armature is the dust from the commutator and brushes.

Turning now to the question of efficiency, this may be e considered from the points of view of use of material and of conversion of energy. Taking the use of material first: if we insert the value now given for W, the total watts of the machine in the value of K (see Appendix III.), we get:

K = ergs per second per cubic centimetre per second $\times 10^7$

$$= \frac{\sqrt{A_{111}}\, Q S_v \times 10^{-5}}{\pi d s \times \sqrt{2L + \frac{D\ 7{\cdot}44}{P}}},$$

which brings out very clearly the importance of the cross-sectional area of the copper on the machine. $Q S_v$ is this factor. The energy per cubic centimetre of the active belt is proportional to the square root of this value, and inversely proportional to the square root of the length of each turn and to the depth of the slot.

The author has for some time been using the method of consideration first published, so far as he is aware, by Mr. Henry M. Hobart in his paper in *Traction and Transmission* in October, 1902, in which he lays great stress upon the importance of a high value for the cross-sectional area of copper in the active belt ($Q S_v$). While admitting to the full the truth of Mr. Hobart's remarks on this point, it must not be forgotten that the insulation of armature conductors has to be considered as a question of mechanical clearance and protection as well as of specific insulation, so that it is conceivable that a high value of Q would result in greater risk of breakdown from the armature conductors coming into contact with one another in handling. This is a point which can only be settled by experience, and the arguments used in favour of multiple coverings on cables apply with still greater force to armatures—*i.e.*, that a covering in many layers of a lower specific insulation is better than a covering of one layer of higher specific insulation. This accounts for the practice of covering armature conductors with several layers of tape, and, in addition, insulating the slot itself by means of paper, or binding paper to the conductors themselves. The use of a comparatively thick

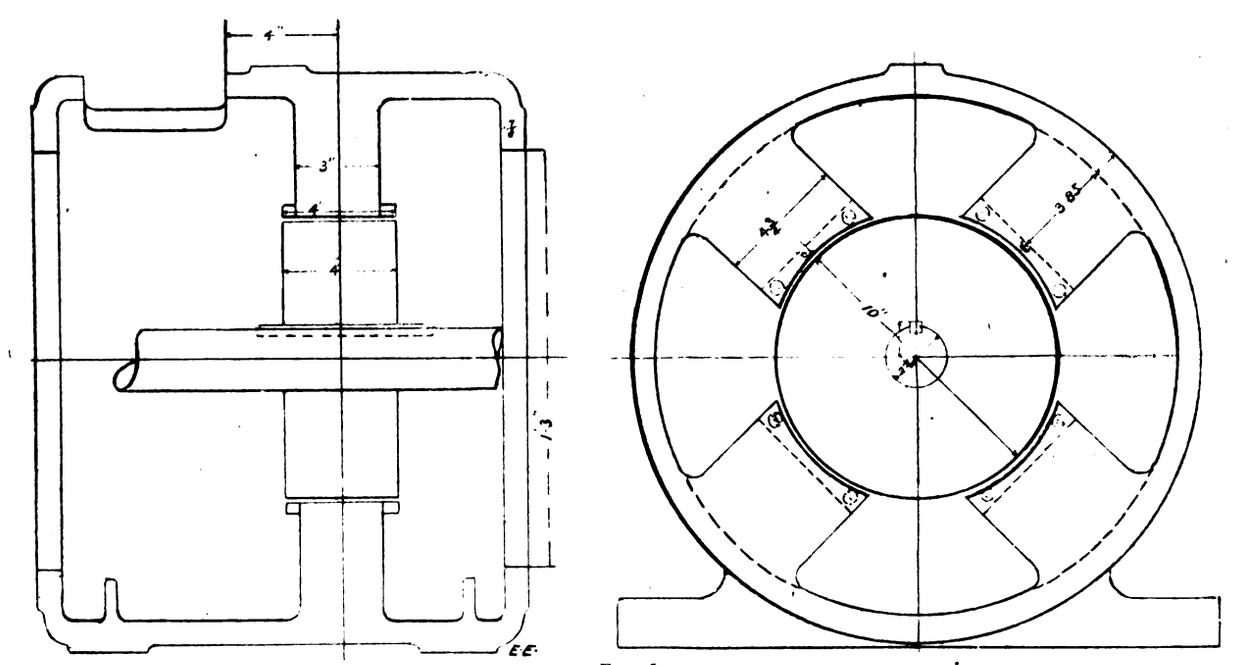

FIG. 4.

A good hard commutator and high quality of carbon brush make very little dust, but a certain amount of wear on the carbon brush is unavoidable, and the carbon dust is a conductor, whereas most of the dust floating in the atmosphere consists of oxides, silicates, and other non-conducting matter. Artificial methods of ventilating the motor shell are possible, and in cases where the motor must be protected from damp may be found useful, but the best way of procuring a circulation of air is, where it is possible, to expose the motor freely to the atmosphere. Ventilation of the cores of small machines is an expensive, and on very small machines an impracticable, expedient.

layer of paper is much more effective and safer than of a thinner layer of mica, which, though of a much higher insulating property, is much more liable to mechanical damage.

The efficiency of conversion of energy is the ratio between

$$\frac{\text{Total watts generated less watts lost in machine}}{\text{Total watts generated plus watts lost in iron}} = \frac{W - A_{1111}}{W + A_v \sqrt{n} - A_{1111}}$$

Here, again, the importance of keeping down the iron

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loss is clearly brought out, and the following diagrams show the great importance of this factor in a small machine.

Fig. 3 is to summarise the argument of this paper. It contains five curves, and has reference to a machine the carcase of which is shown in longitudinal and in cross section in Fig. 4. Fig. 3, Curve 1, represents the total watts generated in the armature, which is 25·4cm. in diameter, 10·16cm. long, with a slot depth of about 2·38cm., and was run at a speed of 1,000 revolutions per minute, giving an output of 4,600 watts, with a temperature rise of about 70deg. F. above the temperature of the surrounding air. Curve No. 2 represents the total watts generated by a similar armature with a slot 1·6cm. deep, which was run at the same speed and gave approximately the same output. Curves Nos. 1A and 2A represent the calculated outputs of two armatures, respectively with the same windings as 1 and 2, but with no slots—*i.e.*, smooth cores with different depths of winding. Curve No. 3 is the approximate envelope of all possible curves of output for this carcase. This curve may be slightly varied by variation in the inductions, but within practical limits it is not subject to much variation, and shows the maximum output obtainable from the carcase at all speeds. The magnet winding and air-space induction is the same in all the cases.

A study of this diagram will throw considerable light on the problem of estimating the possible output from any carcase, and also upon the probable effect of speed of rotation on the output of any given machine carcase. It will be evident that as the iron losses become less important, as they do in the larger sizes, the envelope will tend to become fuller in form, and as the speed of the larger sizes of machines is limited by the strength of the material, the rate of rotation is reduced, the upper part of the curve becomes of less importance, and the lower part of the curve approaches more and more nearly to the straight line, which is consistent with the experience that on the larger sizes the watts generated are nearly directly proportional to the speed of rotation.

Symbols used in Appendix.

B_a = induction in air-space in C.G.S. lines per centimetre.
B_c = induction in core, lines per square centimetre.
B_t = induction in teeth, in C.G.S. lines per centimetre.
c = total current, in amperes.
E = total E.M.F. of armature, in volts.
G = sections in commutator.
d = diameter of core measured to the middle of the active belt, in centimetres.
d_1 = internal diameter of core discs, in centimetres.
d_2 = diameter of core to bottom of teeth, in centimetres.
D = diameter of core over all, in centimetres.
L = length of core, in centimetres.
m = armature turns per section of commutator.
n = revolution per second.
p = paths through armature.
P = number of poles in the machine.
Q = $\frac{\text{copper area in slot}}{\text{area of slot}}$.
S = depth of slot in centimetres.
S_v = area in centimetres of one slot × number of slots.
x = $\frac{\text{pole surface} \times P}{\pi D L}$.
y = ratio of $\frac{\text{iron in core}}{\text{total cubic content of core}}$.

APPENDIX I.—Formulæ and Constants for determining Core and Tooth Losses.

Hysteresis and Eddies in the Core.

$A_1\ n$ = weight of core discs × $B_c^{1·6}$ × periodicity × 3·25 × 10^{-8} in pounds.

Weight of core discs = $·0168\ y \frac{\pi}{4} (d_2^2 - d_1^2)$ L.

Weight of one cubic centimetre of iron = ·0168lb.

$$B_c = \frac{B_a\ x\ \pi\ D\ L}{P\ y\ (d_2 - d_1)} L$$

$$\text{Periodicity} = \frac{P\ n}{2}$$

Hysteresis in Teeth.

$A_{11}\ n$ = weight of teeth × $B_t^{1·6}$ × periodicity × $1·85 \times 10^{-8}$.

Eddies in Teeth.

$A_{111}\ n$ = weight of teeth × $B_t^{\ 2} \times \left(\frac{P\ n}{2}\right)^2 \times 3·84 \times 10^{-12}$.

Weight of teeth is derived from—

$$\text{Belt volume} = \pi \left(\frac{D}{2}\right)^2 - \pi \left(\frac{D - 2\ S}{2}\right)^2 = \pi\ S\ (D - S)$$

$$\text{Width of tooth at bottom} = \frac{B_a\ x\ \pi\ D}{B_t\ y\ x} = \frac{\pi\ D\ B_a}{B_t\ y}.$$

$$\text{Width of slot} = \pi \left(D - 2\ s - \frac{B_a\ D}{B_t\ y}\right)$$

$$\text{Volume of slots} - S_v\ L = L\ \pi\ s \left(D - 2\ s - \frac{B_a\ D}{B_t\ y}\right)$$

Volume of teet

$$= L\ \pi\ s\ (D - S) - \left(D - 2\ S - \frac{B_a\ D}{B_t\ y}\right) = L \pi\ s \left(S + \frac{B_a\ D}{B_t\ y}\right)$$

$$\text{Weight of teeth} = ·0168\ y\ L\ \pi\ s \left(S + \frac{B_a\ D}{B_t\ y}\right).$$

APPENDIX II.—Formulæ and Constants for determining Radiation from the surface of the Core only for a rise of 70deg. F. above an atmospheric temperature of 70deg. F.

These constants are believed to be reasonably accurate, but they have to be carefully checked by actual results for various types of carcase.

Partially enclosed armatures without ventilating space—

$A_r \sqrt{n}$ = watts radiated from core surface

$$= \pi\ D\ L \times ·0073 \times \sqrt{\pi\ D\ n}.$$

Open machines, armatures with ventilating spaces—

$A_v \sqrt{n} = \pi\ D\ L \times ·0152 \times \sqrt{\pi\ D\ n}.$

Open machines, armatures without ventilating spaces—

$A_v \sqrt{n} = \pi\ D\ L \times ·01 \times \sqrt{\pi\ D\ n}.$

Totally enclosed machines—

$A_r \sqrt{n} = \pi\ D\ L \times ·0073 \times \sqrt{\pi\ D\ n}$ for 90deg. rise.

Formulæ and Constants for determining Radiation from the whole surface of Core and End Winding for a rise of 70deg. F. above an atmospheric temperature of 70deg F.

Partially enclosed armatures without ventilating spaces—

$$A_r \sqrt{n} = \pi\ D \left(L + \frac{2\ D}{P}\right) \times ·00565 \sqrt{\pi\ D\ n}.$$

Open machines, armatures with ventilating spaces—

$$A_v \sqrt{n} = \pi\ D \left(L + \frac{2\ D}{P}\right) \times ·01 \sqrt{\pi\ D\ n}.$$

Open machines, armatures without ventilating spaces—

$$A_v \sqrt{n} = \pi\ D \left(L + \frac{2\ D}{P}\right) \times ·008 \sqrt{\pi\ D\ n}.$$

Totally enclosed machines—

$$A_v \sqrt{n} = \pi\ D \left(L + \frac{2\ D}{P}\right) \times ·00565 \sqrt{\pi\ D\ n}, \text{ for 90deg. rise.}$$

APPENDIX III.—Formulæ and Constants for Determining Winding Data.

$$\text{Length of end winding} = \frac{4\ D}{P} \sqrt{1 + \frac{\pi^2}{4}} = \frac{D\ 7·44}{P}.$$

$$\text{,, one turn complete} = 2\ L + \frac{D\ 7·44}{P}.$$

Resistance of one turn

$$= \left(2\ L + \frac{D\ 7·44}{P}\right) \frac{2\ m\ G}{Q\ S_v} \times ·2 \times 10^{-5}.$$

$$\frac{\text{Copper area}}{\text{Slot area}} = Q;\ \text{area of each conductor} = \frac{Q\ S_v}{2\ m\ G}.$$

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Specific resistance of copper at 130° F., taken at $\cdot 2 \times 10^{-5}$.
Weight of copper on armature

$$= \frac{Q S_v}{2}\left(2 L + \frac{D\ 7{\cdot}44}{P}\right) \cdot 0194.$$

* A_{111} = watts lost in winding

$$= \left(\frac{c}{p}\right)^2\left(2 L + \frac{D\ 7{\cdot}44}{P}\right)\frac{2 m G}{Q S_v} \times \cdot 2 \times 10^{-5} \times m G$$

$$\therefore \frac{G m c}{p} = \frac{\sqrt{A_{111}} \times \sqrt{Q S_v} \times 500}{\sqrt{2 L + \frac{D\ 7{\cdot}44}{P}}}$$

and $$EC = \frac{G m c}{p} \times \pi D L \times B_{a\,r} \times 10^{-8} \times 2 \times n$$

$$\therefore EC = \frac{\sqrt{A_{111}} \times \sqrt{Q S_v} \times \pi D L B_{a\,r} \times 10^{-5}}{\sqrt{2 L + \frac{D\ 7{\cdot}44}{P}}} = W.$$

$$K = \frac{W}{\pi D L s \times \pi d n \times B_{a\,r}} = \frac{\sqrt{A_{111}} \times \sqrt{Q S_v} \times 10^{-5}}{\pi d s \times \sqrt{2 L + \frac{D\ 7{\cdot}44}{P}}}.$$

ELECTRICITY FROM REFUSE—THE CASE FOR THE MODERN DESTRUCTOR †

BY W. FRANCIS GOODRICH.

It has often been said that the destructor maker places too high a value on refuse as a fuel, and that with a view to leading innocent and trusting municipalities up to business, extravagant promises have been made concerning light from dust. Experience has shown exactly how far and under what conditions the destructor may be relied upon as a power producer. Experience has also shown its weaknesses, and if we are to gain knowledge worth having we must be even more ready to detect weakness than to congratulate ourselves upon success, for we can only hope to approach perfection by the elimination of weakness.

Why was the old low-temperature type of destructor of little use for power production, and why was it the cause of endless annoyance and litigation? Broadly speaking, for one and the same reason—worked at a low rate of combustion limited by natural draught, low-temperature gases only came into contact with the boiler; 15 years since it is safe to say that the temperature of the gases entering the boiler never exceeds 800deg. F., frequently falling as low as 600deg. F. Now, in our best modern practice gases enter the boiler at a temperature of 2,000deg. F., or even higher, and in a well-managed plant the minimum temperature can be kept at 1,600deg. F. Continuity of high temperature is the essential for securing steady steaming, and in designing a destructor combined with an electricity works this is the cardinal point to be borne in mind.

At the Glasgow convention of the Municipal Electrical Association Mr. J. S. Highfield argued in favour of the system of erecting cells in pairs, so that one out of the two cells should always be in full work while its fellow is being charged and clinkered. This arrangement is an essential feature of the Beaman and Deas destructor, with which is also provided one combustion chamber common to both cells, where the gases must commingle before reaching the boiler. Why did Mr. Highfield thus argue? We may assume that he had found by actual experience that this design, with the alternate system of working, conduced to easy maintenance of high temperature, and so steady steaming. In the ordinary arrangement of single cells, either in single row or back to back, one cell does not help its neighbour, excepting, of course, that the gases intermingle in the main flue. So far as the cells themselves are concerned, there is isolation of heat, and it may be assumed that there will be a difference in temperature of fully 1,000deg. F. in a cell which is being clinkered and charged and its neighbour in full work. It is, therefore, difficult to ensure that continuity of high temperature which is necessary for steady steaming. The same may be said of the system of placing one boiler between two cells, for with the boiler between it will be obvious that the one cell cannot assist its fellow in the maintenance of high temperature during clinkering and charging, and so you may have a cell in full work on one side of the boiler, while on the other side is a comparatively cool cell, which after being charged must while in a cool condition distil a large volume of green gases; this volume should obviously be caused to intermingle with a high-temperature volume to secure thorough cremation, but instead comes into immediate contact with the comparatively cool surface of the boiler plates or tubes.

To approach as near as possible to this desired continuity of high temperature and to render it as easy as possible for such continuity to be secured, I am led to believe that we must not place so much reliance upon what may happen *beyond* the furnace or cell that is, in the main flue or combustion chamber, as the case may be; we must rather begin at the beginning, and so design the plant that there shall be a continuity of high temperature *in the cell itself*; if easy continuity of high temperature can be secured *in the cell*, then we need not trouble about what may happen after. To attain this object there must be no isolation of heat: a hot cell next to a cool one is not to be recommended; to secure the object in view there is a system which provides four cells in one cell if I may so put it. I refer to Meldrum's system of continuous grate with divided ashpits. As one-fourth only of the cell or grate is clinkered and charged at a time, three-fourths *of the cell* as a cell is always in full work. Thus when grate No. 1 is clinkered and charged, the gases as distilled must pass over and intermingle with the large high-temperature volume passing from grates Nos. 2, 3, and 4. When No. 2 is clinkered and charged it is in a zone of active fire, No. 1 grate is discharging its volume of high-temperature gases over the idle grate, the whole volume of which must then pass over and commingle with the volume passing from grates Nos. 3 and 4. When No. 3 is clinkered and charged as with No. 2, it is also in a zone of active fire, having 50 square feet of active grate on its left and 25 square feet also on its right. When No. 4 is clinkered and charged it is true, as we are occasionally reminded, that it is next to the combustion chamber, but 75 square feet of active grate on its left discharge their high-temperature volume over the idle fourth; and it must not be forgotten, firstly, that the combustion chamber beyond is kept at a high temperature, because, as you will have seen, three-fourths of the cell is always in full work, and secondly—and this is a point of great importance—no *large* volume of green gases ever enter the combustion chamber, the refuse being fed in small quantities by shovel, and not by the ton or load.

Feeding by shovel in small quantities into an active cell means rapid distillation and also rapid ignition; the gases from such small charges of refuse being naturally small in volume, the temperature as a whole does not materially suffer. I think you will readily appreciate the striking difference between feeding refuse in small quantities into a hot and *active* cell and the system of dumping a heavy charge into a cool and *idle* cell. There can be no doubt that the regenerative system by which heated air is supplied for combustion is of material advantage in the maintenance of high temperature. Prof. Watkinson, of Glasgow, and other eminent authorities, have clearly shown how efficiency may be promoted with steam-boilers and coal, and it has been demonstrated again and again in burning refuse that the use of heated air not only tends toward giving a better fuel efficiency, but it has a most beneficial effect in the cell in promoting rapid ignition and easy continuity of high temperature. In rainy weather when refuse is brought in heavily charged with moisture, the use of heated air is an obvious advantage in a combined works especially, because in rainy weather with dull periods the big demand for light is often very exacting, and instead of decreased efficiency of the destructor, greater efficiency would be welcome, but while this is impossible,

* Where the output is calculated from the radiation from core only, substitute $2 L + \frac{D\ 7{\cdot}44}{P}$ in value of A_{111} for watts lost in slot winding only.

† Abstract of paper read before the Manchester Local Section of the Institution of Electrical Engineers.

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yet no means should be wanted for preventing any material loss of efficiency. With Meldrum's patent regenerator the air is heated on an average to a temperature of 350deg. F., although, as will be observed in test D at Lancaster, an average of 478deg. F. was obtained. It is interesting to observe also that the use of the regenerator does not prevent the inclusion of an economiser; both can be installed, and both will give an excellent efficiency.

It has been said that thorough cremation and really efficient power production are not compatible, and that they cannot take place coincidently; extremists have told us that if due attention is given to the primary purpose purpose of the destructor it will be of little service for power production. Seriously as this has been urged, and to the detriment of useful combination, it is an argument which will not stand. It is true that if the steam-boiler was placed in the very best position for heat absorption the destructor would be inefficient as a destructor, but it is equally true that the destructor which is most satisfactory as a destructor is the one which is so designed that the products of combustion are subjected to immediate high-temperature contact, and of sufficient duration to secure their perfect cremation. In this process a large volume of high-temperature gases is produced which pass to the boiler, and that continuity of high temperature, which is of the utmost value from a sanitary standpoint, is at the same time the justification of the destructor as a power producer.

I have already referred to Mr. Highfield's admirable paper read at the Glasgow convention of the Municipal Electrical Association last year. In the main I am in agreement with Mr. Highfield. I should like to observe that, so far as I have been able to judge, quick-charging appliances and mechanical devices for the handling of refuse cannot be recommended. Mr. Highfield advocates "quick-charging appliances," which I understand to mean apparatus having for its object the rapid charging of a quantity of refuse at each operation. That being so, then I must say that although such a device is exceedingly desirable from a sentimental and highly sanitary standpoint, it does not conduce to that easy maintenance of high-temperature working which we must aim at and ensure if the destructor is to fulfil either its primary or its secondary object. I have had many opportunities of watching what I believe to be the most expeditious charging device yet produced—an arrangement by which from 30cwt. to 45cwt. of refuse can be tipped in a few seconds direct from the van into the cell. Previous to tipping the van load into the cell the clinkering process has taken place. No device has yet been introduced for rapid clinkering; it is an arduous job occupying, say, 15 minutes, after burning down a similarly heavy charge. During this time the cell isolated from its neighbour becomes comparatively cool directly the load is tipped, falling as it does into a compact mass, the levelling or spreading process begins, the cell still cooling, still inactive, and by the time all is ready for active treatment the cell is cool; it has been idle for from 20 to 25 minutes. Look into the cell, and you will observe an appreciable lack of temperature, such as is wanted, firstly, for thorough cremation and, secondly, for power production. In ordinary top or back feed systems the same principle applies, excepting that the labour of levelling is reduced by reason of the smaller charges, but whether the charge weighs 15cwt. or 40cwt. the fact remains that by reason of a large volume of green gases passing into the main flue or combustion chamber the temperature as a whole must be affected, and the steam pressure fluctuate accordingly. If you recognise refuse as a fuel, then you must be prepared to so charge or feed it that perfect cremation is ensured, and that easy continuity of high temperature is conduced to. We have often heard that the secret of properly burning coal is to fire "a little at a time and often." I submit that this is also the best way to burn refuse. No one would think of dumping one ton of coal on to a grate. On the other hand, we know full well that in the destructive distillation of coal it is best from every point of view to introduce the fuel regularly in small quantities, so that thorough ignition is secured and a high combustion temperature.

There is another aspect of the charging question, and that is the economic aspect, upon which I need not dwell at any length, there being ample evidence that mechanical charging, generally speaking, adds from 30 to 50 per cent. on the cost of labour per ton destroyed over all systems where manual labour alone is employed. The average cost per ton of refuse burned for labour only at electricity works in the provinces is only a fraction over 1s. per ton, but if the London installations are also included, the average is inflated to 1s. 8d. per ton. An analysis of the comparative rates of wages paid in town and country shows that the extra cost is only to a slight extent due to the higher rate of wages paid, but that it may in the main be attributed to the elaborate mechanical devices installed with a view to saving labour, but which are in actual practice found to involve increased labour cost. There can be no question that in order to obtain the greatest possible advantage from a destructor in combination with an electricity works, the electrical engineer should have supreme control. In saying this I do not disparage that excellent body of public officials—municipal engineers and surveyors. I think it was Prof. Kennedy who once said that the man who is responsible for running the engines should control the steam production. That remark puts the case concisely, and I think reasonably.

Out of a total number of 160 towns in Great Britain where destructors have been adopted up to the present time, no less than 45 towns have decided to combine the destructor with the electricity works. When it is borne in mind that no less than 43 of these combined installations have been decided upon during the past three years, it must be admitted that remarkable progress has been made. The actual destroying capacity of the destructors already adopted in combination with generating stations may be put at upwards of 1,400 tons of refuse daily. At the risk of wearying you with a few figures, I would observe that out of the 45 combined works in question no less than 24 have adopted Meldrum destructors, 15 of these being of the Meldrum front or hand-feed type, one only of the top-feed type, and eight of the Beaman and Deas type, which patents are, of course, controlled by Messrs. Meldrum. It will be observed that the figures here given in each instance cover a period of not less than one month, and in the case of Darwen and Shoreditch a whole year. The installations at Darwen, Wrexham, and Shipley are of Meldrum's hand-feed type, Accrington being one of the Horsfall Company's more recent installations, Partick the latest combined plant erected by Messrs. Manlove, Alliott, and Co., Limited, and Shoreditch also erected by this company.

Town.	Period.	Units generated per ton of refuse destroyed.
Partick	Aug., 1902 (one month)	..... 20·1
Accrington	Nov., 1901 ,,	 20
Shipley	Jan., 1902 ,,	..... 37·4
Wrexham	Nov., 1901 ,,	..... 37·8
Darwen	One year	 33
Shoreditch	One year	 20

Mr. R. W. Smith Saville, the borough engineer of Darwen, has kindly given me permission to state that for the year ending March 31, 1901, the average evaporation per pound of refuse was 1·251b., taken over a total quantity of 10,000 tons; further, that 2,940,000 gallons of water was evaporated with the coal-fired boilers at a fuel cost of £1,250, and that the destructor boilers gave a *net* evaporation of 2,520,000 gallons, which quantity would have involved a further expenditure of £1,050 for coal had the refuse destructor not been combined. Mr. J. A. Priestley, of Nelson, made a number of careful and very exhaustive tests with the Meldrum destructor in that town, which plant is now combined with the electricity works. These figures are well worth careful study and comparison. A short extract from three tests is here given:

(A) *Extract from Figures of Test made at Nelson, Dec.* 20, 1900.

Duration of test	9½ hours.
Grate area of cells	100 sq. ft.
Heating surface of boiler, one Lancashire type, 30ft. × 8ft.	986 sq. ft.
Refuse consumed per hour	5,703lb.
,, ,, ,, square foot of grate per hour	57lb.
Water evaporated per hour from and at 212deg. F.	8,650lb.
Water evaporated per pound of refuse from and at 212deg. F.	1,516lb.

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Average percentage of CO_2	12·21%
Average temperature of combustion chamber	2,200deg. F.
Percentage of clinker	21·18deg.

NOTE.—The boiler was not clothed when this test was made.

(B) *Extract from Figures of Test made at Nelson, April* 25, 1901.

Duration of test	8 hours.
Refuse burned per hour	6,853lb.
,, ,, square foot of grate per hour	68½lb.
Water evaporated per hour from and at 212deg. F.	13,442lb.
Water evaporated per pound of refuse from and at 212deg. F.	1·96lb.
Water evaporated per square foot of heating surface from and at 212deg. F.	13·6lb.
Average percentage of CO_2	14·40%
Average temperature of combustion chamber	2,227deg. F
Percentage of clinker	29·06%

NOTE.—The boiler was covered with non-conducting composition.

(C) *Extract from Figures of Test made at Nelson from Feb.* 19 *to March* 16, 1901.

Duration of test	473½ hours.
Refuse consumed per hour	2,902lb.
Refuse consumed per square foot of grate per hour	29lb.
Water evaporated per hour from and at 212deg. F.	5,379lb.
Water evaporated per pound of refuse from and at 212deg. F.	1,850lb.
Water evaporated per square foot of heating surface per hour from and at 212deg. F.	5·5lb.
Average percentage of CO_2	13·16%.
Average temperature of combustion chamber	19·59deg. F.
Percentage of clinker	30·20%.

The figure of these three tests are of great interest. Tests A and B were short tests undertaken in order to determine actually what could be done under forced conditions, while test C was an extended test under easy conditions. If the rate of combustion and evaporation is compared in all three tests, there will be found ample evidence of useful elasticity. Again, even under entirely opposite conditions the fuel efficiency of the refuse does not materially suffer, the average temperature of the combustion chamber is uniformly high, as is also the percentage of CO_2. Figures such as these under both forced and easy conditions afford an excellent opportunity for fair judgment. Mr. Priestley does not put forward test B as showing what may be relied upon for every hour of every day, and no destructor maker would be so foolish as to submit the figures of an eight hours' forced test as being average results. In my opinion the real value of a test of this kind is to show what can be done in case of emergency, and the fact that a plant is so flexible without material sacrifice of efficiency is in itself a very remarkable testimony as to its usefulness. The few figures here given of test D at Lancaster serve to show that, good as they undoubtedly are, the Nelson figures are only typical of what can be done in other northern towns. I would direct your special attention to the high average percentage of CO_2—15·5 per cent., and also the high average temperature of the air supply for combustion 478deg. F.

(D) *Extract from Figures of Test made at Lancaster, Feb.* 7, 1902.

Duration of test	12 hours 26 minutes.
Grate area of cells	100 square feet.
Type and size of boiler	Lancashire, 30ft by 8ft.
Water evaporated per hour from and at 212deg. F.	9,820lb.
Water evaporated per pound of refuse from and at 212deg. F.	1·63lb.
Average percentage of CO_2 in flue gases	15·5 per cent.
Average temperature of combustion chamber	Over 2,000deg. (copper could always be melted).
Average temperature of heated air from regenerator	478deg. F.

Sufficient data is available to show that with a well-designed and well-managed plant at least 30 units per ton of refuse burned may safely be relied upon the whole year through; this is a reasonable estimate, as will be seen by comparing the figure with the averages over extended periods.

If the destructor is to be relied upon for constant use, the whole plant must be so designed and arranged that so far as is possible uninterrupted working is conduced to. Here, again, comes in the question of simplicity, and as simplicity is generally conducive to efficiency and reliability, it demands careful attention, and one must not be enticed away from the main issue by various devices more or less complicated which in theory seems helpful. Destructor makers must stand on their own legs; they have no right to expect municipalities to experiment for their benefit at the expense of the ratepayer. Many consulting engineers now specify an elaborate and complete system of by-pass flues, and some even duplicate flues; others insist that even with two installations, each complete in itself, the arrangement shall be such that easy interchangeability is possible—*i.e.*, so that either boiler can be worked with either cell and *vice versâ*. This is all very necessary up to a certain point; it is perfectly correct to thus provide against all possible contingencies, but it does not conduce to simplicity. Five years ago consulting electrical engineers, generally speaking, were uncompromisingly opposed to the combination, but now the situation has entirely changed, and the consulting profession look upon the destructor as a valuable adjunct to the generating station. There are still one or two consulting engineers who are not yet wholly converted, but it will not be long before they also fall in line and advocate the combination. They must move with the times, and offer their well-informed and enthusiastic municipal clients what they want and what they will have.

Needless to add, in connection with a combined plant careful provision must be made in the general arrangement of the buildings to prevent dust from reaching the engine-room. In the early days of the combination no doubt there was cause for complaint, but one hears very little, indeed, now about the presence of dust in the engine-room. There can be no doubt that the mechanical handling of refuse produces and liberates more dust, perhaps, than is the case with any system with which manual labour alone is employed. The constant dumping of refuse into lifts and in and out of transporting appliances simply means the constant release of volumes of dust into the atmosphere, which, even apart altogether from any damage caused to machinery, is exceedingly disagreeable, even if not dangerous. It is difficult to keep a destructor house even reasonably clean under the best of circumstances, and it is, therefore, necessary in designing a combined works to so place the destructor that so far as is possible it shall be isolated from the power-house.

I cannot pretend to deal at any length with the oft-debated boiler question in this paper, which I am afraid is already too long. The information available up to date all goes to show that the Lancashire boiler has given excellent results, which may perhaps be best summarised as follows:—Taking eight Lancashire towns, four having boilers of the Lancashire type in connection with destructors and four employing water-tube boilers, the average results in horse-power obtained (on a basis of 20lb. of steam per indicated horse-power) per ton of refuse burned works out thus: Lancashire boilers, 186·6 i.h.p. per ton of refuse; water-tube boilers, 143·8 i.h.p. per ton of refuse. For constancy of steam pressure the Lancashire boiler has the advantage owing to the considerable reserve of heat units in the water, and the available figures serve to show that its record for steady steaming is a very satisfactory one indeed. Of course, the choice of boiler has often to be determined by the space available; further, in the early days of a small combined station capital expenditure may be kept down by the inclusion of water-tube boilers arranged for supplementary coal firing.

AN AMERICAN UNIVERSITY POWER AND LIGHTING PLANT.

BY FRANK C. PERKINS.

At the University of Chicago there are 25 college buildings which require electric current to a greater or less extent, for the operation of small motors, as well as for supplying the necessary lights. The current is conducted to these various buildings through underground tunnels of different lengths, ranging up to two-thirds of a mile, and the buildings are all heated by steam from the power-house, carried in pipes also located in the tunnels. The water for the bathrooms as well as the radiators are heated by low-pressure steam, and high-pressure steam is provided for use in the cooking departments. The experimental

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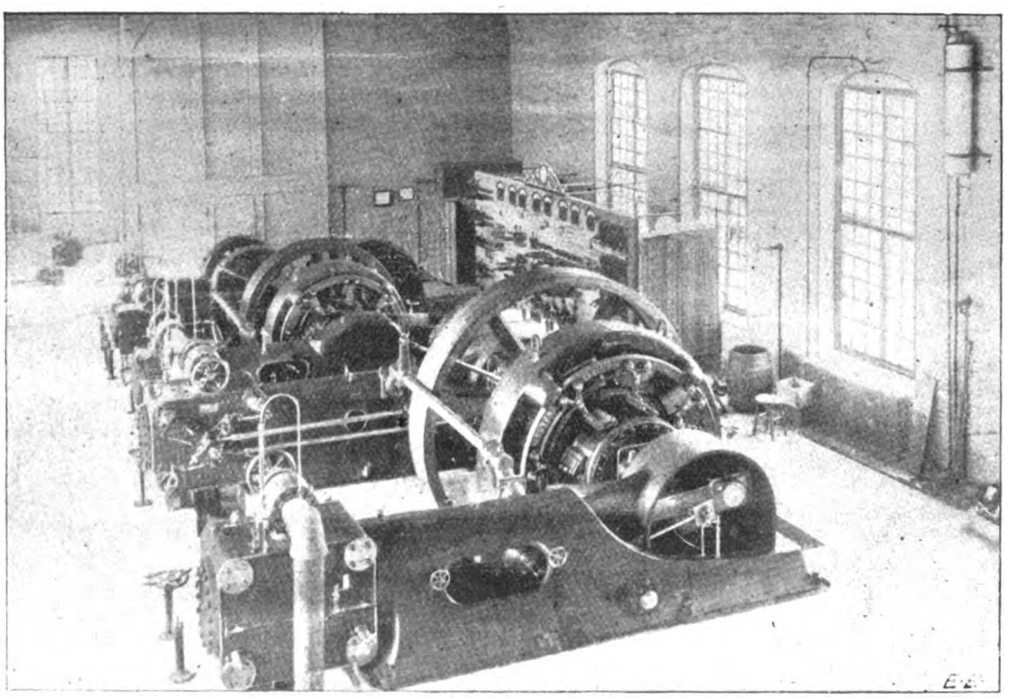
laboratories are supplied with both direct and alternating current, and electric motors are used for operating the electric elevators, ventilating fans, and other motors about the university. The underground tunnels are 8ft. or 10ft. in width and from 4ft. to 6t. in height, and connect both the boiler-room and the engine and generator room with the different buildings. The tunnels have arched brick tops with brick walls and a concrete floor. The air supply under pressure is carried in 2in. pipes in the tunnel, and the high-pressure steam in three 8in. pipes. The steam for heating is conducted through several mains 1ft. in diameter, two 8in. pipes being used as returns It was considered unnecessary to cover the pipes in the tunnels with heat-insulating material. As the tunnel is very hot, arrangements are made to cool any section for repairs by the use of two electric motor-driven exhaust fans, which are made portable by being mounted upon trucks. One outfit forces the air into the tunnel, the other exhausts it. A motor of a greater capacity than 1 h.p. is used for driving the ventilator on each truck, and several hundred feet of cable is arranged on a reel for connecting to the electric service. Lead-covered cables are used for mains and feeders in the tunnels for supplying the current to the various buildings. The cables are placed in ducts in the tunnel bottom, which is covered with a wooden flooring.

The power-house has an octagonal stack 150ft. high and a diameter of about 10ft. The brick building containing the power plant is only one storey high, nearly 50ft. wide, and about 300ft. long, with provisions for a total length of over 400ft. when more boiler capacity is required. The power-house contains three large rooms, the longest being about 250ft. in length and used for the boiler plant. The engine-room is about 75ft. by 50ft., and the machine shop about 50ft. square. The entire power-house is served by an electrically-operated travelling crane of 60,000lb. capacity, the same crane passing over the dividing walls of the boiler-house, engine-room, and machine shop, which do not reach to the roof. The boiler-house is equipped with one-half of the boiler plant at present; the whole installation consists of 20 horizontal tubular boilers, each about 16ft. long and 6ft. in diameter. The total boiler capacity when complete will be 2,500 h.p., each boiler supplying 125 h.p. Underfeed stokers are employed, and the air is heated before being forced into the boilers as a means of further economy and to aid in the smokeless operation of the plant. The burned gases are carried through a tunnel to the chimney, the economisers and air-heating pipes being installed to collect the heat from the gases as they pass out through the chimney. The whole boiler plant is thoroughly up-to-date, and is equipped with all of the necessary measuring instruments for testing purposes, daily records being kept of coal and water used. The testing instruments also allow of the analysis of the combustion gases, and an econometer is installed of the recording type.

The electrical generating plant in the engine-room consists of a motor-generator or compensator and three direct-connected sets of 350 kw., 250 kw., and 60 kw. capacity. The latter unit is operated by an Ideal single-cylinder engine operating at a speed of 275 revolutions per minute. The two larger units consist of Western Electric direct-current generators connected between the cylinders of double-cylinder Ball engines. In case of repairs being necessary, either cylinder of either engine may be disconnected and the engines operated by the remaining cylinder. The lighting service is wired on the three-wire system, the generators being wound for 250 volts, with a compensator in circuit of 20 kw. capacity, consisting of two motors of 125 volts each. The power service is on the two-wire distribution system at 250 volts.

The switchboard is constructed of 2in. Vermont marble, mounted in panels on a steel framework of the usual form, and the various feeder panels and generator panels are equipped with the usual measuring instruments, rheostats, switches, and automatic circuit breakers.



Chicago University Power and Lighting Plant.

When the additional 600-h.p. generator and engine are installed, the total output of the plant will be about 1,500 h.p., and provision has been made for another compensator of the Western Electric type of 100 kw. capacity. The machine shops are equipped with electrically-operated machine tools of the latest types, and an alternator is provided, which is driven by a direct-current motor, for supplying the necessary alternating current for testing purposes.

Railway Metal Telegraphy.—Mr. J. Edgar, of Withsdale, has recently been experimenting on a system of telegraphy in which he uses the lines on a railway as his conductors. The experiments, we understand, have been carried out on private metals belonging to the Llayhall Collieries, and they seem to have been successful. Telephonic signals were transmitted from a signal box to the engine driver on the train, but the exact way in which this was done is not mentioned in the reports we have seen. Owing to the patent not being completed, the inventor is not yet able to give any technical information at the present time.

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NOTES.

Rome-Paris Telephone.—A Rome message states that the trials over the Rome-to-Paris telephone have been most successful This line is the longest in Europe, covering over 1,000 miles. It will be open to the public at the beginning of December, and it is in contemplation to extend the line to Naples.

Literary Notice.—The Sanitary Publishing Company announces the immediate publication of an important work on the subject of public lighting, entitled "Public Lighting by Gas and Electricity," by Mr. W. J. Dibdin, F.I.C., F.C.S. The work it embellished by numerous illustrations, diagrams, and tabular statements, and runs into 528 pages. The price is 21s. net.

Simple Test for Poles.—According to a French contemporary, a good, simple test for the poles of an electric apparatus is a slip of "ferro-prussiate" paper moistened and held on the pole. The negative pole makes a white mark on the paper, which, by the way, is the same as that used for making copies of engineering designs, where the lines appear on a blue ground. Old blue diagrams of this kind cut into slips will serve as test papers.

Electrical Power in India.—The progressive spirit in which the Kolar goldfields have supported the newly inaugurated Cauvery power undertaking, and the great demand there already is for electrical power in this and other districts, has led the Mysore Government to consider the advisability of putting down another water-power installation for the generation of electricity on a large scale. It is proposed to utilise the water passing through the irrigation sluice of the Marikauave reservoir, in Mysore, for this purpose, but no definite scheme has yet been formulated, as the matter is still under consideration.

Berlin High-Speed Trials.—The high-speed trials with electric traction on the military railway between Berlin and Zossen have concluded for this year. The results, on the whole, have been encouraging. The last trial was made with an electric locomotive drawing a passenger train, made up of 11 coaches, and weighing altogether 154 tons. The experiment is said to have given satisfactory results. A further trial was made with the special express cars of the two leading electrical companies in Berlin. Three of these cars, weighing nearly 99 tons, were attached to the electric locomotive, and a speed of about 78 miles an hour is reported to have been attained.

Wireless Telegraphy from Moving Trains.—Some three or four professors of the McGill University in America have been experimenting with a view to seeing how far it is possible to transmit messages by wireless telegraphy from a fast-moving train. This is the first time anything of the sort has been attempted, and the experiments are reported to have resulted in complete success. The professors succeeded in establishing wireless communication between the train and one of the stations on the line between Toronto and Montreal, while the train was running at the rate of 60 miles an hour. According to the report, communication was opened eight miles before reaching the station, and continued a like distance beyond.

Electrical School in Paris.—What is to be called a theoretical and practical school of electricity is to be opened in Paris at 146, Boulevard de Grenelle and 23, rue Frémecourt this month. From the short note which is given of this in our contemporary, *L'Industrie Electrique*, we gather that extensive workshops are being equipped for those attending the courses, which will be held both through the day and in the evening. It is proposed to make a special feature of visits to electrical works in order to make the students conversant with what is being done. Another curious feature from the English point of view is that every Sunday at 10 o'clock free conferences are to take place, open to members of the public, on electrical subjects.

Decomposition of Water Vapour by the Electric Spark.—The *Proceedings* of the Chemical Society contain a brief note on some experiments conducted by Messrs. D. L. Chapman and F. A. Lidbury into the matter. The experiments described show that when electric sparks are passed through water vapour, the decomposition which takes place is considerable. The products of decomposition are partly separated from one another and take up different positions in the tube. The separation which occurs cannot be entirely accounted for by electrolysis for the following reasons: firstly, because hydrogen collects at both electrodes and oxygen in the middle of the spark-gap, and, secondly, because the hydrogen which collects at the cathode is very largely in excess of that required by Faraday's law.

Pacific Cable Rates.—According to a report published in the *Daily News*, the rates for messages over the new Pacific cable will not be very materially altered from the rates now in force. For instance, the charge between the United Kingdom and any part of Australia will remain at 3s. a word, but under the new tariff the rate to New Zealand will be reduced from 3s. 4d. to 3s., and to Fiji from 3s. 7d. to 3s. Also, the charge for a message over the new cable from Canada to Australia will probably not be more than 2s. 4d. a word. With reference to the fact that the cable rate to Australia will not be reduced under the new tariff, it must be borne in mind that the charge of 3s. a word has only been in force for a short time, and, as compared with the previous rate of 4s. 7d. a word, is exceedingly reasonable. It is possible, however, that a further reduction will be made later on.

Electrical Engineers Volunteers.—The members of this corps spent a very pleasant evening at headquarters, Regency-street, Westminster, last Saturday, when the first of the smoking concerts arranged for the winter months was given. Major R. S. Erskine, the commanding officer, was in the chair, and all the other officers and men turned up in uniform—some in the khaki suits they wore in the late South African campaign. A lengthy programme kept the company entertained till a late hour, and we unhesitatingly compliment the corps on the large amount of talent they were able to put forward out of their own ranks. Of the 20 odd items which made up the evening's programme, no less than 12 stood in the name of some member of the Electrical Engineers Volunteers. Their efforts were warmly applauded, and altogether a most pleasant evening was passed.

Purchase of Cables.—Mr. Henniker Heaton in the House of Commons on Tuesday asked the Postmaster-General "whether the Departmental Committee appointed to enquire into the cable arrangements between Great Britain and all parts of the Empire ascertained, or endeavoured to ascertain, what revenue was derived from cable messages to and from this country; if so, will he state what is the revenue; and if not, will he take steps to obtain information as to the amount expended by merchants and all others in this country in cabling messages, with a view to considering the question of purchasing the cables at a fair price." Mr. Austen Chamberlain, in reply, pointed out that the committee reported strongly against any scheme for the general purchase of cables by the State, and stated that he was not prepared to advise that his Majesty's Government should enter upon such an operation.

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Institution Subscriptions.—Elsewhere in this issue will be found a report of the last meeting of the Institution in London, at which certain announcements were made as to the rates of subscription to be paid by members, both at home and abroad, in the future. It is interesting to compare these rates with those suggested a short time ago. We are pleased to see that all members, associate members, and associates are to be brought up to a common level for each class as regards contribution to the funds of the Institution. On this point we believe we are correct in saying that legal advice has been taken that the increased contribution can be enforced not only on new members, but on those members who joined years ago, when the rates were considerably lower. We are sure, however, that these old members will only be too pleased to contribute their proportion of the expense of keeping up the Institution and of the distribution of the *Journal*, which is now a *sine qua non* to electrical engineers.

"Science Abstracts."—At the last meeting of the Institution of Electrical Engineers it was announced that arrangements are to be made in future by which a special subscription of 7s. 6d. per annum will be charged to all members, associate members, etc., who require *Science Abstracts* to be forwarded to them each month, or if they prefer it they can receive the section dealing with engineering science only at 5s. per annum. It seems to us that while this will considerably decrease the cost of supplying *Science Abstracts*, which now is forwarded to every member, associate member, and associate of the Institution, it is quite likely that the result of the change will not be to the general good. All the saving that can be made is in the paper and ink required for the additional copies, and in the postage of the same to the members. Under the new scheme, with the more limited circulation the cost of production per individual copy will go up, and the revenue will be uncertain. It seems to us that the better course would have been for the Institution to get other engineering societies to share with them the cost, and at the same time to increase the circulation.

Battersea Telephone Dispute.—As the result of the recent deputation from some of the metropolitan borough councils to the Postmaster-General with reference to the laying of telephone pipes in the public streets, the Battersea Corporation will now give the required consent for the laying of a short junction pipe within their area to connect the Post Office system with that of the National Telephone Company. The final meeting of the conference of the metropolitan councils was held last week, at which the result of the deputation to the Postmaster-General was announced, and it was declared that they had secured all they asked for. Mr. Austen Chamberlain assured the deputation "that those wires which the Postmaster lays down are, and will remain, his property, and he shall never have to buy them back from anyone." This official statement dispels the idea which has been entertained in some quarters that a new interest was being created for the benefit of the National Company, and for which the public in time to come would have to pay. The official statement is only a repetition of the provisions of the clauses in the agreement between the Postmaster-General and the National Telephone Company which were published at the beginning of the year.

Electricity from Refuse.—In the abstract of the paper by Mr. W. Francis Goodrich which appeared in our last week's issue on the production of electricity from town refuse, there were two or three obvious mistakes which require correction. For instance, the water evaporated per pound of refuse from and at 212deg. F. should read 1·516, not 1,516, for the test made at Nelson in December, 1900. In the same way the tests made at Nelson from Feb. 19 to March 16 this year gave an average result of 1·85lb. of water per pound of refuse. The other corrections occur in the last part of the paper, where the indicated horse-power hours obtained per ton of refuse are given for Lancashire boilers and for water-tube boilers. In the proof of the paper which was forwarded to us these figures were given merely as indicated horse-power per ton of refuse, which, of course, was without meaning. Another obvious misprint was made in the table of figures relating to the Nelson test, where the average temperature of the combustion chamber should read 1,959deg. F., not 19·59deg. F., as given. In looking through the paper every attention should be paid to the long test, extending over a month. In getting out estimates for other plant in which refuse destructors are to be combined with an electric lighting plant, these average figures are of the utmost importance.

North-Eastern Railway Conversion.—The tenders for the electrical equipment of the lines of the North-Eastern Railway running from Newcastle to the seaside, and also from Newcastle out in the Ponteland direction, have now been received by the company, but information as to which are to be accepted is not yet forthcoming. In the meantime we understand that the company is contemplating an interesting experiment which could be tried without converting the lines for electrical working. It consists in equipping an individual carriage with its own engine and dynamo from which the motors driving the same are to be supplied. In fact, it resembles in some respects the Heilmann locomotive, which was tried in France unsuccessfully. In this case, however, the prime mover is not to be a steam-engine supplied from an ordinary locomotive boiler, but is to be a high-speed petrol engine capable of developing 100 h.p. The electric generator coupled to this engine will be separately excited, in order that when starting up it may supply at low voltage to the motors. In consequence of this there will be a great saving in energy, which in an ordinary case is wasted in starting resistances. We believe that a carriage so equipped is expected to be able to draw a light trailer behind it. The experiment will be watched with interest by electrical engineers to see how far the petrol engine is economically able to compete with steam as the prime mover.

Royal Society Medals.—The Royal Society has made its awards of medals for this year as follows: The Copley medal to Lord Lister in recognition of the value of his physiological and pathological researches in regard to their influence on the modern practice of surgery; the Rumford medal to the Hon. Charles Algernon Parsons for his success in the application of the steam-turbine to industrial purposes and for its recent extension to navigation; a Royal medal to Prof. Horace Lamb for his investigations in mathematical physics; a Royal medal to Prof. Edward Albert Schäfer for his researches into the functions and minute structure of the central nervous system, especially with regard to the motor and sensory functions of the cortex of the brain; the Davy medal to Prof. Svante August Arrhenius for the application of the theory of dissociation to the explanation of chemical change; the Darwin medal to Mr. Francis Galton for his numerous contributions to the exact study of heredity and variations contained in "Hereditary Genius," "Natural Inheritance," and other writings. The Buchanan medal to Dr. Sydney A. Monckton Copeman for his experimental investigations into the bacteriology and comparative pathology of vaccination: the Hughes medal to Prof. Joseph John Thomson

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for his numerous contributions to electric science, especially in reference to the phenomena of electric discharge in gases. The awards of the two Royal medals mentioned above have received the gracious approval of his Majesty.

Conductivity of Solvents and Solutions.—A paper by Mr. P. Eversheim on this subject is thus briefly abstracted in the November number of the *Journal* of the Chemical Society: The conductivity and dielectric constant of liquid sulphur dioxide has been determined at temperatures from 14·5deg to 157·5deg.; both decrease as the temperature rises and immediately before the critical point the fall is very sudden, but there is no discontinuity. From the dielectric constants found it is shown that the Clausius and Mosotti formula does not lead to a constant value, but is dependent on the absolute temperature. The addition of potassium chloride, potassium bromide, or rubidium iodide to the sulphur dioxide conditions a great increase in the conductivity. The conductivity of these solutions decreases with rising temperature, and shows a sharp fall near the critical point. The dielectric constant of ethyl ether was determined and again it was found that the Clausius and Mosotti expression is dependent on the temperature. The conductivity of a solution of hydrogen chloride in ethyl ether decreases as the temperature rises, and the resistance becomes very great just at the critical point; the resistance has a minimum value at about 20deg. The densities of ethyl ether and ethyl chloride at temperatures from 15deg. to 195deg. have also been determined. The dielectric constant of ethyl chloride and the conductivity of a solution of mercuric chloride in that solvent have been determined at various temperatures, and the relationships are the same as those found for ethyl ether and its solution.

The Sondrio-Lecco Railway.—We referred last week to the absence of any satisfactory news as to the working of this three-phase line in Italy. Curiously enough, immediately after our paper had gone to press, an engineer called on us who has been privileged to go to and fro on the line recently in order to test its working. He reports to us that the equipment has given general satisfaction, and that the only difficulties which have arisen have been due to small details which can be quite easily remedied. He found the service of both goods and passenger trains being worked electrically, and from the figures he could obtain it seems that the undertaking is working quite as economically as if continuous-current motors were used on the trains. The liquid resistances employed in starting and the cascade method of connection are working well. The starting up of the train on which our informant travelled was remarkable for its smoothness, which is, of course, attributable to the even acceleration given by the controller. We gather, however, that the weight of the track is really insufficient for the traffic which has to be carried, and that there have been difficulties in consequence. The high-voltage line wires have given exceedingly little trouble both in transmission from the water-power station to the sub-stations along the route, and also in the lines from which the trains collect their supply of current. We are exceedingly pleased that the above report of good results obtained is to hand, and trust that by the time the Institution goes to Italy next April the few defects referred to will have been quite overcome.

Induction of Sleep by Electric Current.—We recently mentioned in these columns that Mr. S. Leduc had brought before the Academy of Sciences in Paris a method of inducing sleep and anæsthesia by electrical currents. He employs an interrupted current in a low resistance circuit, and sleep is induced by gradually augmenting the E.M.F. in the circuit. From further information we have received it seems that the frequency of the current used is from 150 to 200 periods per second. Besides the interrupter, there is also placed in the circuit a milliampere meter, the period of oscillation of which is much longer than the duration of the interruption of the current. Under these conditions, when the instrument is traversed by an intermittent current the needle undergoes a permanent deviation, which enables the intensity of the currents having the same intermittence and the same duration to be compared. The author has experimented with currents of varying degrees of intensity, but those which gave the best results had from 150 to 200 intermittences in the second with a tension of from 12 to 30 volts. The cathode is made of hydrophilous cotton impregnated with a solution of sodium chloride of the strength of 0 60 per cent., and covering with a plate of metal. This is placed on the shaven head of the animal to be experimented on, while the anode is placed on the hinder part of the back, which is also shaved. The E.M.F. is increased till convulsions take place, and the animal falls on its side and respiration ceases. The handle of the regulator is then brought backwards till respiration returns, and with a certain strength of current tranquil, ordinary sleep is induced. The duration of the sleep is variable, in many instances lasting for two hours or more without any ill effects upon the subject. The return of consciousness is effected by the removal of the current, and no injurious consequences are said to follow.

Possibilities of Telephone Tunnels.—The telephone tunnels in Chicago, of which we have previously written in these columns, have just been completed to the extent of some 12 miles. Experts have described the system as one of the greatest engineering accomplishments ever attempted. The original purpose of the tunnels was solely to carry the wires of the Illinois Telephone and Telegraph Company, but as the construction has progressed the possibilities of the system became more and more apparent, with the result that the company will most probably embark on a freight-carrying business in the city, including the carriage of mails, newspapers, packages, and other articles through the tunnels. In the construction of the tunnels a system of tramways was used to carry away the earth as it was displaced, and to bring materials to the place of operation; and it is now proposed that similar tramways shall be laid down for the freight business. The company has hopes that the franchise will be extended to include the desired privileges; and in that case it will rent storerooms in various parts of the town, dig shafts down to the tunnels, and hoist freight by elevators. It is also suggested that the principal business houses using the tunnels of the telephone company for transport purposes could have bores constructed from the main tunnels to their basements. To make the plan the more effective, the company proposes to double the dimensions of the tunnels in order to make them 12ft. by 14ft. The highest part of the system is 27ft. below the surface and the lowest 40ft., while under the Chicago River the tunnel will be at a depth of 65ft. The present tunnels tap almost all the prominent parts of the business end of the city, and as providing a means of underground transport of freight will probably result in large revenues to the company. Another additional source of revenue will probably be found in renting space to other companies in Chicago in which to lay their telephone and telegraph wires.

Artificial Graphite.—We have before referred to Mr. E. G. Acheson's work in the production of artificial

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graphite, and his experiments in this direction have now led to the formation of a definite method for which a patent has just been granted him in the States. In his previous work Mr. Acheson's first observation was that coke might be freed from its impurities, and its conductivity largely increased, by the direct passage of a heating current. Shortly afterwards he discovered that carborundum and other carbides might be directly transformed to graphite by the employment of sufficient heat to volatilise the non-carbon element. Later observations led to the conviction that the conversion of carbon to graphite by any method of resistance heating depended upon the presence in the carbon of definite proportions of such carbide-producing elements as silicon, iron, and calcium, and that, therefore, the two methods above noted were substantially identical in so far as the chemical reactions were concerned; and that such impurities need not be present in proportion sufficient to react at once with the whole of the carbon, but that the transformation into graphite may be progressive in character, carbides being formed and decomposed, and the volatilised non-carbon element entering into combination with adjacent portions of the carbon. It was also observed that an artificial mixture of carbon with impurities was unnecessary, since non-coking coals and certain varieties of charcoal contain mineral ingredients, proper in kind, sufficient in quantity, and suitably distributed. According to the present disclosure, which is noted in the *Electrical World* by Mr. C. P. Townsend, it is found that in the case of volatile impurities the original distribution is unimportant. If, for instance, petroleum coke in the form of lumps and in rough admixture with iron or iron ore be suitably heated in an electric furnace, the vapours of the metal so permeate the entire mass as to determine its complete transformation into graphite.

King's College.—The council of the above college are appealing for funds for the endowment of the college as a seat of higher education and research in connection with the University of London, and on Wednesday afternoon an influential meeting was held, under the presidency of the Right Hon. the Earl of Selborne, to inaugurate the fund. In the appeal which the council have prepared for circulation, attention is specially drawn to the advantage of London and of the university that a certain number of such complete academic centres should be maintained. In them alone are teachers and students of widely different subjects brought into social and intellectual contact. The special claim to support which the council put forward is based on the strength of the honourable record and usefulness of the college in the past, and it will be acknowledged that the results of its work, unaided by endowment, have been extremely good. As regards the equipment of the college at the present time it possesses extensive workshops and laboratories for engineering and applied mechanics, and when funds are forthcoming it is proposed to double the present accommodation. For electric technology the college has the splendid laboratory given some years ago by Lady Siemens, as well as a set of rooms for engines, dynamos, and other machinery. The department urgently needs extending owing to several valuable gifts of machinery the college has received. There is also a large and very active department for metallurgy, well adapted both for teaching and for research. It is estimated that the minimum sum required to place the college in a satisfactory working position is not less than half a million sterling. Donations in response to the above appeal may be sent to the college bankers, Messrs. Coutts and Co., Strand, or to the Hon. W. F. D. Smith, M.P., treasurer, King's College, London. At the gathering at the college on Wednesday the fund was started with a gift of £5,000 from Mr. Smith, and in the course of the afternoon a message of sympathy with the movement and wishing it all success was received from his Majesty the King and also from the Prime Minister. A resolution pledging those present to assist in raising the endowment fund was adopted unanimously.

Patent Law Amendment Bill.—This Bill, which is intended to remedy some of the defects of the existing patent laws, was read a second time in the House of Lords on Monday afternoon. The two great causes of complaint against the present patent laws are, first, that a patent granted by the Patent Office is more than often practically valueless, because the office has no power to enquire into the question of whether the invention has already been patented; and second, that patents are frequently taken out by foreigners and others solely for obstructive purposes, and who have no intention of working them in this country, or of granting licenses to British manufacturers to use here. As regards the first of these objections, the Amendment Bill provides for a limited official enquiry into the anticipation of an invention, in so far as that anticipation is disclosed by the records of the Patent Office during a period of 50 years preceding the application. The Government hope that this will prove a great reform in the present patent laws, and will give the patentee some security that he is obtaining a good patent. While this is undoubtedly so, the experience of the United States, where the practice is followed, may be taken as authoritative upon the point. This experience is that an enquiry into the anticipation of an invention leads to an enormous delay, sometimes of years' duration, and when the patent is eventually granted it is practically valueless on account of the lapse of time. But on the second question this Amendment Bill provides for a reform which must be exceedingly far reaching in its effect. The clause in question enacts that where it is proved that the reasonable requirements of the public with regard to a patent have not been satisfied, the Judicial Committee, to whom the matter is to be referred by the Board of Trade, may order the patentee to grant licenses on such terms as they think just, or may revoke the patent. This will undoubtedly effectually remedy the evil of foreigners taking out patents in this country for the purpose of obstructing the British trade and the development of particular industries. As to the tribunal to which these cases will be referred, the President of the Board of Trade has chosen the Judicial Committee of the Privy Council. The measure has the full support of the trading community of the country, and it has accordingly had a very smooth course through Parliament. There is little doubt but that it will prove equally beneficial to inventors and manufacturers.

The Diesel Engine.—On the 15th inst. Mr. Geo Wilkinson, borough electrical engineer of Harrogate, read a paper before the Glasgow Technical College Scientific Society on the Diesel engine. The larger part of the matter in this paper is concerned with the construction of the engine generally, on which our readers have been informed in previous articles. The interesting part at the end deals with some new results obtained on trial both in this country and elsewhere, and also gives some information as to the application of one of these engines in a pumping station at Harrogate. Mr. Wilkinson had to report on the cost of driving the sewage pumps in question by means of electric motors, ordinary oil-engines, ordinary gas engines, and the Diesel oil-engine. His report stated that while the capital outlay for electric motors would only be £400, the annual working expenses with current charged at 1¼d. per unit would amount to £649. The

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Diesel oil-engine, on the other hand, would cost £815 to instal, but the annual expense of working the same number of hours was estimated by the author to be about £422. This figure was arrived at on the assumption that the oil used would cost £3. 15s. per ton, whereas they have succeeded in getting Texas oil in the crude state for £2 2s. 6d. per ton. The engine, which has now been at work since March, is of 35 b.h.p. It was subjected to extensive trials by Prof. Ade Clark, of the Yorkshire College, in April and May last. These trial figures are given in the paper, but it suffices here to say that on two consecutive trials at full load the oil consumed per brake horse-power was 0·459lb. and 0·461lb. respectively. The engine was then developing about 40 h.p. The consumption at 16¼ b.h p. only amounted to 0·583lb. The Texas liquid fuel used had a specific gravity of 0·92 at 65deg. F. and a calorific value of 19,150 British thermal units per pound. In the experiment carried out at full load Prof. Clark was able to account for 96·2 per cent. of the total heat. Of this 38·4 per cent. was the indicated power, 28·2 per cent. was taken off by the cooling water of the jackets, while the exhaust gases carried away 29·6 per cent. An analysis of the exhaust gases shows that complete combustion was obtained. It will be interesting to know at the end of two or three years how far Mr. Wilkinson's estimate of annual cost has been verified. We do not doubt the consumption of fuel being as low as has been found on trial, but the question arises as to the cost of repairs on an engine which is so dependent on accurate working of the moving parts as is the Diesel engine.

Clyde Valley Power Scheme.—Similarly with the South Wales electrical power scheme the Clyde Valley scheme is making very good progress, although the former is considerably more advanced and expects to be supplying energy at a much earlier date than the Scotch scheme. The authorised area of supply of the Clyde Valley Company is about 732 square miles, and extends practically along the whole of the Clyde Valley from Lanark to the boundary of Greenock and the outlet of Loch Lomond. To serve this large area the scheme as sanctioned by Parliament last year provides for three generating stations, two of 10,000 kw. and one of 5,000 kw. capacity. Two of these, it is expected, will be in operation within a couple of years, the company having acquired 20 acres of land near Motherwell, the centre of the iron and steel trade, and another 10 acres at Clydebank, which is fast becoming the centre of the shipbuilding and other important industries. The third generating station will be erected at Paisley, another important industrial centre. The contract for the power-house equipment has been placed with the British Westinghouse Company, and the multiphase alternating-current system of supply, which is so largely used in America and also on the Continent, will be adopted. If it were necessary to emphasise the great importance of this undertaking, it need only be stated that at the present time there are less than 20 square miles out of 710, excluding Glasgow, which are supplied with electrical energy, whereas in the area covered by this scheme there are no less than 1,200 works of importance, many of which are only awaiting the advent of electricity in the district to extend and develop their businesses. Under its Bill the maximum rates which the company may charge are 3d. per unit for the first 400 hours use and 2d. per unit for any further quantity. The company is also restricted from supplying energy in the burghs of Govan, Partick, Port Glasgow, Paisley, and Hamilton without the consent of the local authorities, and with regard to the burghs which in the future may become authorised distributors, they are placed in exactly the same position as burghs already authorised. In this way unfair competition between the company supplying in bulk and the municipal supply systems is avoided, but in some cases the company has power to lay mains through the municipal areas in order to reach certain parts of its authorised district of supply. That the scheme will be heartily supported when supply is commenced may be concluded from the fact that most of the directors of the company are representatives of the leading industrial works in Lanarkshire and Dumbartonshire.

Niagara Power Development.—Although in the last few years much has been done in the development of the water power of Niagara, up to the present less than 100,000 h.p. of the four million horse-power which the Falls are estimated to be capable of generating has been harnessed. Practically the whole of the past work in electrical power developments at Niagara has been confined to the United States side of the river, where at the present time a number of profitable electro-chemical industries are thriving on the benefits of a cheap electricity supply. Attention, however, is now directed to the other side of the river, where the Canadian Niagara Power Company are constructing works which will increase the available power by something like 300,000 h.p. This, and other power schemes in contemplation, will give a much-needed stimulant to the manufacturing activities in the Canadian towns which are within a radius of, say, 200 miles from the Falls. The scheme which is being carried out by the Canadian Niagara Power Company was begun last year, and is described somewhat fully in the *Canadian Engineer* for the current month. The waste tunnel is 2,200ft. long, and when finished will be 25ft. high and 19ft. wide, inside measurements. The feeder canal is 300ft. long and 280ft. wide, with a depth of 13ft. at low water. This canal will eventually be spanned by a stone arch bridge, consisting of five spans of 50ft. each and 60ft. wide. The arches will be of steel concrete, and will carry two car tracks for an electric railway which it is contemplated to build. The penstocks leading down to the turbines will be 10ft. 2in. in diameter, and the main shaft connecting the turbines and generators 3ft. 4in. in diameter. When completed, the dimensions of the wheel pit will be 570ft. long, 165ft. deep, and 18ft. wide, inside measurements. The first installation of machinery in the power-house will consist of five 10,000-h.p. turbines with generators of equal capacity, but the full scheme provides for 11 of these large units. An interesting feature of the power-house equipment will be two electric cranes of 50 tons capacity each. Current will be generated at 11,000 volts, and transformed up to 60,000 volts for transmission to Toronto and other Canadian cities. The transformer house will contain 12 transformers of 1,250 kw. each, built by the Canadian General Electric Company. The generators are being built by the General Electric Company, of Schenectady, New York, and are of the internal revolving-field type, three-phase, 25 cycles, and 250 revolutions per minute. The revolving part of each generator is estimated to weigh 162,000lb. Messrs. Escher, Wyss, and Co., of Zürich, are building the turbines, which are of the twin vertical Francis type, having an inward discharge. The weight of all moving parts will be carried by a water-balancing piston, the lower wheel forming another balancing piston. Each turbine will operate under an effective head of 136ft., and is estimated to use 885 cubic feet of water per second. Until the scheme is completed, current from the United States side of the river will be taken for inland Canadian cities when required, but it is hoped that the new works will be available in about 18 months' time from now.

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A CONTRIBUTION TO THE THEORY OF COMMUTATION.*

BY ALEXANDER ROTHERT.

(Continued from page 697.)

We can now turn to the next example—viz., L = ·5—the figures for which are given in the second part of Table I. In this case $x = 1$, L = ·5, T = 10, J = 10. Fig. 5 shows the curves for four different values of L, whilst x, T, and J remain constant throughout. The straight line corresponds

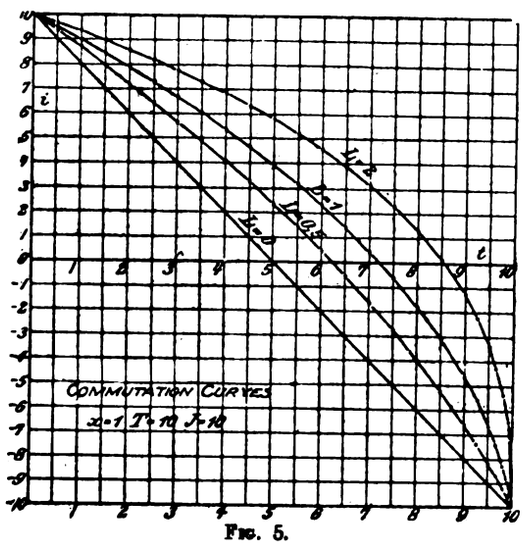

FIG. 5.

to L = 0. Then follow L = ·5, L = 1, and L = 2, corresponding to the first three cases worked in the table. As was to be expected, the curve for L = ·5 is less bent and that for L = 2 more bent than that for L = 1. In the case of L = 2 the current density becomes very great towards the end.† Fig. 6 shows the sparking voltages corresponding to the four cases. These show the effect of increased self-induction strikingly. For L = 2, E_2 for $t = 9{\cdot}95$ is nearly 14 times as great as for L = ·5. At the start, however, E_2 is the same for all four cases—viz., 2. For $t = 0$ we have $E_2 = (J + i)\, r_2 = 2\,J\,\frac{x}{T}$, where $\frac{x}{T} = R$, the contact resistance of the whole brush The number 2, therefore, represents

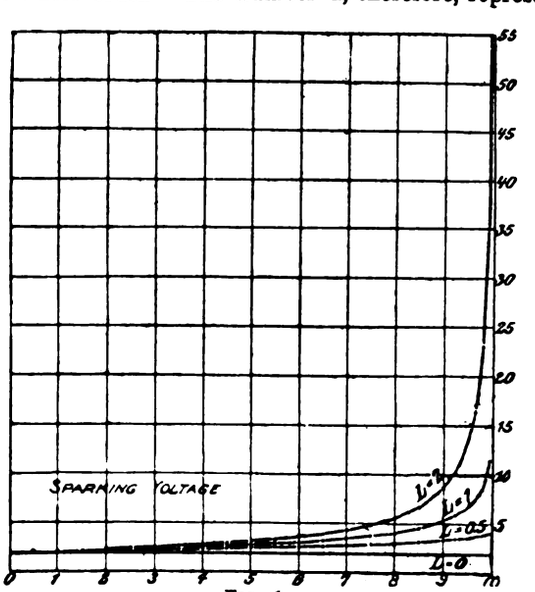

FIG. 6.

the ohmic drop in the brush due to the whole current taken from the brush. This value is naturally independent of the self-induction. I have not drawn in the reactance voltage, as the table shows that it differs only slightly from the sparking voltage. Fig. 7 shows the connection between self-induction, sparking voltage, and current density at the brush tip at the time $t = 9{\cdot}95$. A scale has been chosen at random for the current density, as we are only dealing with relative values.

The last part but one of the table deals with the case where T, x, and L remain unchanged, and J is doubled: $x = 1$, T = 10, L = 1, J = 20. The corresponding curves,

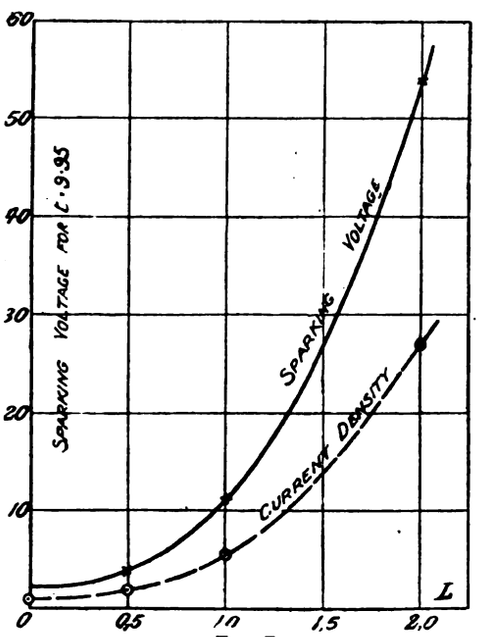

FIG. 7.

together with those shown in Fig. 4, are collected in Fig. 8. We see that these curves only differ in the scale. Corresponding ordinates both for i and for E_2 are doubled. From this we conclude that if $\frac{x}{L}$ remains unchanged, the sparking voltage increases in proportion to the load

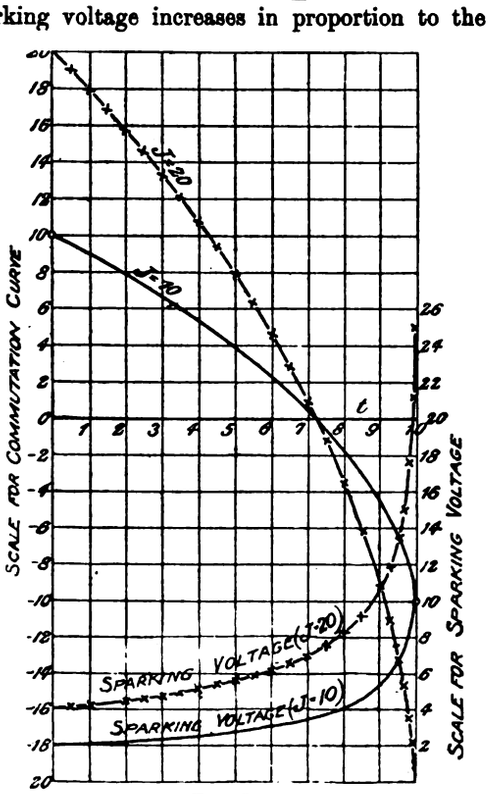

FIG. 8.

on the machine, assuming, of course, that as x has not changed the loading of the brushes has doubled. On this account the amount of sparking will not merely be doubled, but quadrupled. If, on the other hand, the number of brushes had been doubled, x would be $\frac{1}{2}$ instead of 1, and the ratio, $\frac{x}{L}$, would be far more unfavourable. In such cases the above described method can be employed with advantage to determine the effect of such points as number

* Translated from the *Elektrotechnische Zeitschrift* of Sept. 25, 1902, and Oct. 2, 1902.

† Theoretically (according to Arnold), it is infinitely great when $\frac{R\,T}{L} = \frac{x}{L}$ is less than 1. This is clearly shown by the curve for L = 2.

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of brushes, etc., and to decide on the most favourable arrangement.

The following example shows a useful application of the graphical method in spite of its incompleteness. The example shows the effect of resistances inserted between the winding and the commutator. It has been generally believed that such resistances are favourable to good commutation, and at the first glance it would seem that, from the above point of view also, an increase of the resistance of the short-circuited coil could only have a good effect on the commutation. This is, however, not the case. In the case of copper brushes with the brush position altered according to the load the resistances have the same effect as fringing of the field, and allow a greater range of brush shifting. With carbon brushes in a fixed position, however, these resistances act very unfavourably, for they partly discount the chief object of carbon brushes—a maximum possible change in the resistance—by adding a constant amount of resistance. The figures for this case are given in the last part of Table I., the conditions being exactly the same as for the first example: $x=1$, $T=10$, $J=10$, $L=1$. Only those values which differ from the first part of Table I. are inserted—$r_1\ r_2\ (r_1-r_2)$ and $J\ (r_1-r_2)$ remaining the same. The value of r_3 is taken as ·4, instead of zero—*i.e.*, the resistance of connection from commutator segment to winding is taken as double the resistance of one brush ($R=\frac{x}{T}=\cdot1$), there being two such connections in series in the short-circuited coil. The voltage drop in these connections is, therefore, equal to that in the brushes.

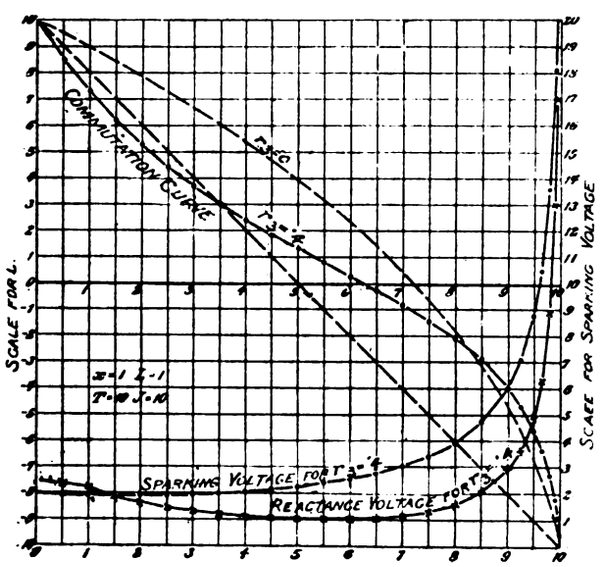

FIG. 9.

In spite of this not very large resistance, the effect is unpleasantly noticeable. The commutation curve, though at first very satisfactory, as shown in Fig 9, becomes, later on, decidedly less favourable than for $r_3=0$. At the end (for $t=9{\cdot}95$) the tangent of the angle of inclination, the reactance voltage, and the current density are approximately double what they were without the additional resistances. The sparking voltage at the end is also about doubled (22·4 against 11·4). Both voltages, but especially the reactance voltage, have the characteristic of at first dropping slightly. The first two points of the latter curve are somewhat uncertain, owing to inaccuracies in the construction.

The favourable shape of the first part of the curve in Fig. 9 is explained by the higher resistance of the short-circuit. In general, the greater the resistance of a short-circuited coil the quicker will the current fall off in it. This fact suggested to me that the required quick drop of the curve might be attained by means of a brush whose resistance was large at the beginning and less at the end. I thought that by this means the first part of the curve would remain as good, whilst the last part would become better. In accordance with this, I selected a brush whose total resistance, $\frac{x}{T}$, remained the same—*i.e.*, one-tenth—but the first two-thirds of which had a specific resistance double as great as that of the last third. Fig. 10 shows this graphically. At the top the reciprocals of r_1 and r_2 are shown as a function of the time, t. Whilst these were represented by straight lines in Fig 4, they are now made up of two inclined lines. The tangent of the angle made by each part of each line with the horizontal is a measure of the specific conductivity of the corresponding part of the brush. As the total resistance of the brush is the same as before, the maximum ordinate of both the lines must be $10=\frac{T}{x}$, as before.

The figures given in Table II.*, and represented graphically in Fig. 10, show that the expectations are by no means realised. The commutation curve is, right from the start, less favourable than in the case of constant resistance. The sparking voltage also reaches a value more than double that for constant brush resistance. Both the sparking voltage and commutation curves consist of two parts, and are no longer continuous. The table shows that the reactance voltage $\left(=\frac{di}{dt}, \text{ L being } 1\right)$ is only slightly different from the sparking voltage. The unsatisfactory result obtained, in spite of the expectations to the contrary, is accounted for by the fact that, in accordance with equation (2), we are dealing with the relation of

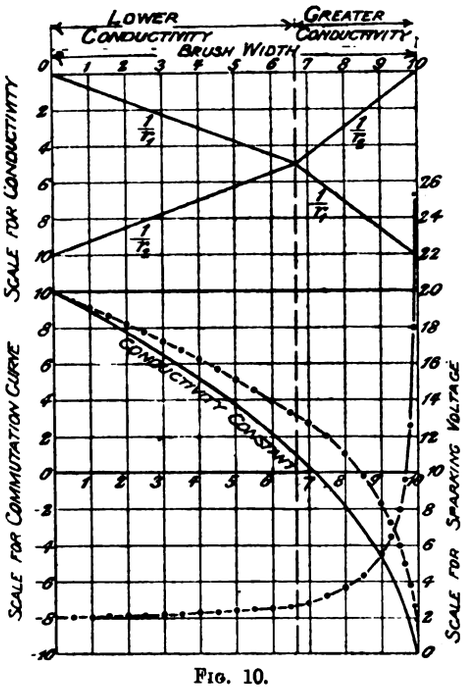

FIG. 10.

r_1+r_2 to r_1-r_2 rather than with the total resistance of the short-circuit path. After this failure, I tried the effect of reversing the conditions, and making the first part of the brush of better conductivity than the last part. The action may be considered as follows: Let segment 2 (Fig. 1) be completely covered by the brush at first. The whole current then passes through segment 2; r_1 is infinitely great. Now let the commutator move gradually forward; r_1 becomes less, r_2 greater. There will be a tendency for more current to pass through segment 1. This will, however, have to overcome the self-induction of the armature coil, which has the effect of allowing more current to pass through segment 2 than corresponds to the ratio of the resistances r_1 and r_2. In other words, it is the reactance voltage, $L\frac{di}{dt}$, which "boosts" the current through segment 2. What happens if, leaving r_2 as it is, we make the resistance r_1 less? Obviously, more current will be able to pass through segment 1—*i.e.*, commutation is accelerated—and the current through segment 1 will increase more rapidly, and that through segment 2 fall off more rapidly; the whole current collection will be shifted towards segment 1. This forecast is completely established by our theory. Table III.* and Fig. 11 show how much more satisfactory the commuta-

* Omitted here.—TRANSLATOR.

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tion is, when, with the same total resistance, the first third of the brush is given twice the conductivity of the last two thirds. The commutation curve lies between the straight line for inductionless commutation and the curve for constant brush resistance. The sparking voltage for $t = 9{\cdot}95$ is only 6·67, whilst it was 11·4 in Fig. 4. We have, therefore, reduced the sparking voltage by more than 40 per cent. by merely making the two parts of the brush of different conductivity.

(To be continued.)

THE APPLICATION OF ELECTRIC POWER IN THE IRON AND STEEL INDUSTRIES.*

BY D. SELBY BIGGE.

(Concluded from page 700.)

Utilisation of Waste Blast-Furnace Gases.

This paper would not be complete without some reference to the great development which has taken place recently in utilising the waste gases from blast furnaces for operating gas-engines, which in their turn can be employed for directly driving blowing engines or dynamos, which latter in their turn would distribute electricity for power purposes throughout the works.

From the results of very carefully made experiments, conducted by Prof. Witz in July, 1898, and Prof. Hubert in April, 1900, it has been found that a Cockerill "Simplex" engine of large size does not use more than about 100 cubic feet of average blast-furnace gas per effective horse-power per hour, which is less than one-fourth the consumption of gas required to develop the same power from boilers and good modern condensing steam-engines; so that there is an immense surplus of power to be obtained from a blast furnace if the blowing engines are worked by gas, which can be still further increased if the gas is properly cleaned for the stoves, and its efficiency thus increased. It is estimated that for every 100 tons of coke used in an ordinary Cleveland blast furnace, after making ample allowance for gas for the stoves and power for the lifts, pumps, etc., and for gas for working the necessary blowing engines, there is a surplus of at least 1,500 h.p., so that by economising gas by cleaning, and developing the necessary power by gas-engines, every blast-furnace owner would have a very large surplus of power for his steel or other works, in the form of electricity or otherwise. It would be impossible to over-rate this new development in power production. In Great Britain really large sources of water power are practically unknown, and the sources from which electricity can be produced most economically will be undoubtedly due to the development of large power gas engines making use of the surplus gases from the blast furnaces, which would otherwise be wasted. Engines have been constructed and are at work of 1,200 h.p., and an engine of this type is now building for no less than 2,500 h.p.

The Development of Electric Power Companies.

During the past two years great activity has been displayed in England in the formation of large electric companies, dealing with extensive tracts of country, and covering under their parliamentary powers vast areas for the supply of electricity in bulk to tramway companies, electric light companies, works' owners, and for manufacturing purposes generally. In certain cases, and under favourable conditions with regard to the district to be supplied, these companies may meet with success, but in many cases the author is of opinion the matter has been rushed into somewhat precipitately. Taking, for instance, a district of a fairly concentrated character, or in which a large number of small works and factories exist, absorbing each, say, 100 h.p. to 200 h.p., it might be found that with the power company supplying them with electricity at 1d. per unit it would be more profitable and convenient to them to obtain their power from the company in preference to laying down their own plant. In cases such as this the power companies should have a good field before them. When, however, the power company enters the field in districts where all the works are of an extensive character, and absorb 500 h.p. to 5,000 h.p. in electric current each, the case changes its aspect, and it will be found that it will be more profitable for the works owners to produce their own power.

On examining closely the cost of production of electricity by works owners in their own works, it is quite clear that with generating stations of 400 h.p. and upwards, equipped with economical and modern appliances in the shape of high-pressure boilers, mechanical stokers, triple-expansion condensing engines working with superheated steam, etc., the cost of production should not exceed ½d. per Board of Trade unit, inclusive of interest and depreciation on the capital outlay. With blast-furnace waste gases this figure would be still less. The author is of opinion that in the case of power stations in works dealing with 1,000 h.p. and upwards, and laid down upon the most modern lines, this cost of production can be reduced to 0·4d. per Board of Trade unit, as shown in the case of Messrs. Dorman, Long, and Co.'s, Limited, works. Some of the cases are taken from plants which have been in operation for some considerable time, and in which the very latest appliances and highest pressures may not be available. It would be most interesting with regard to the above subject to have the experience of those who have had the practical experience of producing their electric power, making use of large gas-engines working with the waste gases from the blast furnaces, and to hear from them at what cost per unit they find they are producing their electric power delivered at the switchboard. Far be it from the author to discourage enterprise in any shape or form, especially as regards the formation of power companies, but that enterprise should be duly tempered with caution in formulating such large schemes. It would be interesting to have the experience of our German friends on this point, as the majority of the large works have their own sources of power supply, and to hear from them the lowest rate at which they are producing their unit of electricity.

Conclusion and Summary.

The cases enumerated above demonstrate in a practical manner the advantages which have actually accrued from the substitution of electricity for steam or other forms of driving. Electricity used as a motive power was, in the days when the author first treated the subject in the form of a paper, comparatively a new departure for the works manager and engineer. The enormous developments and strides which have been made during the past 10 years in this branch of engineering tend in the direction that every works owner and engineer should acquire a thorough knowledge of this subject. We have in Great Britain been somewhat slow in making use of all the advantages which electricity has enabled us to reap. In many parts are to be found the same old low-pressure boilers, which have done service for the past 30 years, with working pressure as low as 15lb. per square inch. In other works are still to be found the same old beam engines constructed in the days of Watt and Stephenson. Works are still to be found in which over 100 small high-pressure and non-condensing engines are distributed with their mileage of steam-pipes throughout the works—little or no attempt having been made to improve this state of affairs. It is in cases such as these the author trusts this paper may be of service, by showing clearly and in a practical manner the actual result which would accrue from the remodelling of the driving arrangements upon the electrical method. In no country have we finer examples before us of the achievements of electricity as a motive power than in Germany, and we must all admire the skill, ingenuity, and, above all, the enterprise of our German friends in this direction. There are many outlying advantages which would accrue were works and industrial establishments driven electrically. There would be an enormous reduction in the smoke produced in large manufacturing centres, and a proportionate increase in a healthier state of things for the inhabitants. In these days, when the idea of coalfields giving out is mooted, there would be a perceptible difference in the quantity of our coal consumption, which, although perhaps

* Paper read before the Iron and Steel Institute.

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unpalatable to the coal owner, would be most welcome to the manufacturer, who aims at the lowest cost of production The application of electric power to the iron and steel, engineering, and manufacturing industries in Great Britain has certainly not developed with anything like the rapidity with which it has progressed in America and on the Continent, and the author has often wished to ascertain the reasons underlying this retarding influence.

Generally speaking, the powers and responsibility vested in the general manager of a works in England are very different to what they are in a works in America. There the position is one of much greater latitude in the scope of innovations and improvements, and of responsibility also. The actual result, therefore, is that improvements and savings are rapidly carried out, and the board of directors look to their manager for the expected improvement and savings, owing to the manager's minute knowledge of the details of the scheme he is putting forward and his great sense of responsibility in the matter. In the author's experience in dealing with firms in England he has most frequently been struck with the small scope of initiative action allotted to the works manager, nearly every innovation and improvement being referred to the board of directors. This in a very large degree appears to be the cause of a retarding influence on electric power progress in our country. In brief, the scope and responsibility vested in the works manager in America is very different to that allotted to the works manager in England. The board of directors' decision is responsible for the results obtained, and the works manager carries out the wishes of the board; on the other side the works manager is directly responsible to the board for the innovations that have been carried out.

There is one point that has most forcibly struck the author in dealing with improvement schemes for works Outside of our own country he has invariably been met with a first question, "What is the saving to be effected under the proposed scheme?" In England the first question put is, "What is the cost going to be?" Both are naturally very important considerations, but many is the time that really great and immediate savings have been left unconsidered by that one glance at the first cost, and the documents have been pigeon-holed and shelved, only to be brought out when absolute necessity, not real enterprise, compelled them to be resorted to again. In the many uses to which electricity has been applied as motive power, none has proved more suitable than its application to shipyards, dockyards, and other works of this description, possessing a great number of scattered and intermittently working machines. Our great dockyards, both at home and abroad, offer a case in which enormous savings could be effected. The reduction in working costs of a number of shipyards with which the author is acquainted has varied between 30 and 60 per cent If this same saving could be effected in similar establishments, such as our Government dockyards, the result would be highly beneficial to the country.

In placing this paper before the Iron and Steel Institute, the author's one endeavour has been to show what are the immense possibilities and advantages to be derived from carefully considered electric power schemes. He has done his best to put the subject forward plainly and in a practical light, and if in the preceding pages he has given data, information, and subjects for thought and consideration to the members of this important institute, his task will have been amply repaid. The author's thanks are due to the following firms for information kindly placed at his disposal: The Lahmeyer Electrical Company, Limited, London; Messrs. Siemens Bros. and Co., Limited, London; Messrs. Laurence, Scott, and Co., Limited, Norwich; Messrs. Richardsons, Westgarth, and Co., Limited, Hartlepool and Middlesbrough; Colonel Crompton, London; Messrs. Ernest Scott and Mountain, Limited, Newcastle-on-Tyne; Messrs. J. H. Holmes and Co., Newcastle-on-Tyne; Messrs. Dorman, Long, and Co., Limited, Middlesbrough; Messrs. Archibald Smith and Stevens, London; the Westinghouse Company, London; Mr. Alexander Siemens, London; Prof. Salomons, Frankfurt; the Allgemeine Electricitäts-Gesellschaft, Berlin; the Compagnie Internationale d'Electricité, Liège; Messrs. Guest, Keen, and Nettlefolds, Limited; Sir James Laing and Sons; Messrs. Short Bros.; Messrs. Craig Taylor; and Messrs. Scott and Co.

INSTITUTION OF ELECTRICAL ENGINEERS.

The opening meeting of the new session of the Institution of Electrical Engineers was held on the 13th inst. at the Institution of Civil Engineers, Great George-street, Westminster. Mr. J. Gavey was in the chair.

The minutes of the general meeting held in May last having been read and confirmed,

The CHAIRMAN said he had an announcement to make which he was sure would be received with the universal expression of regret of the meeting. They were all there that night in the hopes of hearing a most instructive and attractive address from their President, but unfortunately the members of the Council were suddenly startled that day by the announcement that the President was too ill to be present in the evening. Under the circumstances, and notwithstanding the fact that Mr. Swinburne himself was in favour of his address being read by a deputy, the Council, after very serious consideration, had come to the conclusion that the reading of the President's address without the President would be something like the play of "Hamlet" with Hamlet left out. They had therefore determined to postpone the reading of the address to a later date. He thought the meeting would join with him in expressing its feeling of regret at the attack of illness from which Mr. Swinburne was suffering. He hoped that the illness was not a dangerous one, but merely sufficient to incapacitate the President being there that night. He suggested that the meeting should unite with the Council in an expression of deep regret at the unavoidable absence of Mr Swinburne, and this was agreed to in silence.

The Chairman next moved a vote of condolence with the relatives of the late Sir Frederick Abel, the late Mr. John Hall Gladstone, and the late Prof. Sidney Short, all of whom were members of the Institution, and had died during the recess. The motion was carried *nem. con.*

The next announcement made by the Chairman was that the hon. treasurer of the Institution, Prof. W. E. Ayrton, who had held office for so long a time in various capacities, had felt himself compelled, owing partly to ill-health and partly by the pressure of other duties, to resign his office as hon. treasurer. Mr. Gavey was sure the announcement would be received with considerable regret. They all knew their dear old friend Prof. Ayrton. They had followed his career with interest and good feeling, and they all knew what a useful member he had been to their society. He was one of the very early members of the Institution, and not only had he helped them in their debates, but he had devoted a vast amount of attention to the interests of the society, both at the Council meetings and at committee meetings, and also in his capacity as hon. treasurer. The Chairman asked the meeting to unite in a very hearty vote of thanks to Prof. Ayrton for the length of honourable service he had rendered to the Institution. The vote was agreed to with acclamation.

The Chairman said he was happy to announce that Mr. Robert Hammond had been elected to fill the honorary office of treasurer in succession to Prof. Ayrton.

Mr. Gavey then gave some particulars of the intended visit of the Institution to Italy next year The party would travel *viâ* the Lucerne-St. Gothard route, leaving London on Thursday, April 2. It would arrive at Como on April 3, and leave there on April 6 for Milan. The members would finally disperse at Milan on April 9, the day before Good Friday, when they would be able either to return home or extend their visit to other parts at their pleasure. He was sure this would prove a very interesting visit. In Southern Italy their co-engineers had availed themselves to the utmost of the great water powers that were stored up in the lakes, and not only would it be a most instructive, but, from the picturesque point of view, a most pleasing and interesting journey. The Chairman further announced that it was intended to visit America in the year 1904, and he read a letter received by the Council from the American Institute of Electrical Engineers extending an invitation,

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expressed in the warmest terms, to the members of this Institution to visit the United States and hold a joint meeting either there or in Canada. Mr. Gavey said it was originally suggested that the meeting should either be held in Montreal next year or in the United States in the following year. The Council had decided to accept the invitation of the American Institute for the year 1904. He understood that the meeting would, however, be held in Canada, and that further information would reach them soon from the McGill University in Montreal. Incidentally he mentioned that the St. Louis Exposition would be open at the time of the visit.

The Chairman next referred to the deputation from the Institution which had recently waited on the President of the Board of Trade with reference to the regulations under the Electric Lighting Acts. The matter was not yet ripe for a definite announcement, but the result of the deputation would be stated at a future date. The Council had also been in correspondence with the Home Office in connection with the Factory Act, and they had been assured that a full opportunity would be afforded for the discussion of the new regulations before they were adopted. The Council was also urging upon the Secretary of State to assist the profession in regard to the employment of young persons in factory works. The President of the Institution of Electrical Engineers had been appointed *ex-officio* to serve on the committee nominated by the Home Office to enquire into the question relating to the use of electricity in mines.

The Chairman next approached what he described as a burning question—*i.e.*, the subscription rates and the issue of *Science Abstracts*. He explained that the Council felt that it was imperatively necessary to increase the funds at its disposal. From enquiries made earlier in the year it appeared that, generally, the members were prepared to support the Council in the measures it considered necessary to adopt, and a new scale of subscriptions was recommended. In drawing up this scale all subscriptions had been unified up to the present maximum, and it was thought reasonable to differentiate between home members and those residing abroad on account of the greater privileges enjoyed by the former. Thus it was proposed that the revised rates should be as follows: Home members, £3. 3s. per annum; members residing abroad, £2. 2s.; associate members and associates, home £2. 2s., abroad £1. 11s. 6d. As regards students, under the previous regulations a student, after remaining as such for three years, was compelled to become either an associate or associate member, but it was now proposed to divide the grade of student into two classes—student junior and student senior. For the first three years of a student's connection he would pay £1. 1s. annually, but after three years, if he were not eligible for election as associate member, he might remain for another three years, or until he could qualify for election, for the annual payment of £1. 11s. 6d. A meeting of the full members of the Institution would shortly be called, and these proposals put before them. As regards *Science Abstracts*, it was proposed to supply each complete issue to those members desirous of having it for an annual payment of 7s. 6d., or for the engineering portion alone 5s. per annum, instead of distributing it gratis as heretofore.

A list of some of the papers promised for this session having been read, the Chairman presented the premiums and prizes awarded by the Council as per the list published in the annual report.

The meeting then adjourned till Thursday, Nov. 27, when Sir Oliver Lodge will read a paper on the subject of "Electrons."

The President's Address.

We have great pleasure in announcing, from enquiries made, that Mr. Swinburne has quite recovered from his recent indisposition, and is able to attend to his daily business duties as usual. The statement in our last issue that the President's address would be delivered at a meeting of the Institution to-night was rather premature. The further postponement of the address, however, has nothing whatever to do with Mr. Swinburne's present state of health, and as soon as a day can conveniently be arranged a meeting will be held, and the address read by the President himself.

WIRELESS TELEGRAPHY.

On Tuesday last, before a meeting of the King's College Engineering Society, Prof. Ernest Wilson delivered an interesting lecture on wireless telegraphy, illustrated by experiments which were most successful. While the lecture was intended to be of an elementary order, the subject was carried up to date, and the difficulties of successful wireless telegraphy were fully gone into. In the earlier part of the lecture Prof. Wilson showed that with an oscillatory circuit of circular form transmission by electromagnetic induction was quite possible, but that the range of such transmission was limited. He instanced the Post Office system of telegraphing between the north coast of Ireland and Rathlin Island as a practical example of the induction telegraph. The range of this system was, however, so limited that the Post Office engineer, in establishing a system of wireless telegraphy between Howth, in Ireland, and Holyhead, had recourse to electrostatic transmission. In this case the oscillating circuit of both the transmitter and receiver were opened out, and took the form of vertical wires. He then explained how the presence of these oscillatory effects could be indicated by means of a spark in a spark gap, or by the glowing of a vacuum tube. An interesting experiment on the tuning of a receiving circuit by altering the capacity in the same was then shown. Prof. Wilson proceeded to explain the action of the coherer, which enabled much more feeble disturbances to be recorded. A more delicate detector still was that depending for its action on the effect of these high-frequency currents on small magnets. In 1897 Mr. Rutherford succeeded in signalling over a distance of 1½ miles by means of magnetic detectors, but unfortunately he did not pursue the investigations far enough. He used a number of exceedingly fine magnets inside a coil of two circuits, of which one circuit was connected to the vertical mast of the receiver and the other on to a telephone. When the high-frequency currents received by the mast passed round the one circuit the magnets lost a certain amount of their residual magnetisation, and gave an audible signal in the telephone. In the same year Prof. Wilson experimented with this type of receiver, and he showed a model that was then used. An experiment carried out at the lecture consisted in slowly varying the current in a magnetising coil round such a system of small magnets, when it was found that there were two distinct parts of the magnetisation curve at which the signal given when an oscillatory discharge took place in the room was most loudly heard in the telephone. This, Prof. Wilson explained, was at the steep parts of the curve, in which the magnets were in a most unstable state. This type of magnetic detector is now being used by Mr. Marconi in his long-distance experiments. On the question of the tuning of wireless telegraphy, in order to give secresy, Prof. Wilson explained in detail the various attempts which have been made, and also the difficulties underlying the same. He showed that, owing to the large amount of energy employed in long-distance transmission, it was, as far as is known at present, impossible to prevent the signals being received at points near the sending station, even with untuned receiving circuits. He also showed how, when such a station tried to prevent its messages being read by sending at the same time two sets of signals, only one of which had sufficient energy to reach a distant source, the messages could be divided out from the confusing signals. This could be done by a combination of damping and tuning the receiver, and was actually accomplished by an experimenter recently, when Mr. Marconi's experiments between Cornwall and Italy were being carried out.

Coming to the commercial use of wireless telegraphy, the lecturer stated that it was mostly applicable to signalling from the shore to ships at sea. This class of work would be completely disorganised if stations were at work on the land using a large amount of energy in order to transmit signals over enormous distances.

The conclusions from the lecture were that, as has been pointed out before in our columns, secresy in wireless telegraphy has yet to be attained; also, that it is quite easy for any system of wireless telegraphy to be completely

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upset by a rival undertaking, or even by the cosmic effects. For instance, it was found when listening at a receiving station, that when sun spots were frequent signals were received which could only be attributed to the electromagnetic disturbances caused by these sun spots. Such disturbances would interfere with wireless telegraphy considerably. The lecturer concluded by hints at various fields in which wireless transmission of energy would be most useful, such as the direction of torpedoes and the more effective warning of ships as they approached dangerous shores. On the motion of the chairman of the society, a hearty vote of thanks was then passed to Prof. Wilson.

TUNBRIDGE WELLS TELEPHONES.

With respect to our article on the above subject in last week's issue, there was an inaccurate statement as to the issue of a new license to the National Telephone Company. The Postmaster-General writes to us that "no new license for the Tunbridge Wells area was issued on Aug. 11 last, but that on that date a formal deed was executed by which the National Telephone Company accepted as a condition of their license the conditions specified in Section 3 of the Telegraph Act, 1899, so far as their exchange system in the Tunbridge Wells area is concerned." The portions of this section of the Act applicable to the present case read as follows:

"*Provisions as to Existing Companies*: (3)—(1) Where an existing company have before the passing of this Act, under a license from the Postmaster-General, provided a system of public telephonic communication in any exchange area, and it is proposed to grant a new license to a local authority or to another company to provide public telephonic communication in the same exchange area, or any part thereof, then, if the existing company consent to it being made a condition of their license: (*a*) that they will not give favour or preference to any person whomsoever within the area specified in the new license, and will not, within that area, as a condition of giving a service, require from any person the grant of any facility except for the purpose of supplying telephonic communication to that person; and (*b*) that their charges shall not, within the area specified in the new license, exceed the maximum rates or fall below the minimum rates authorised in that behalf by the Postmaster-General within that area, it shall be a condition of the grant of the new license that where it is proved to the satisfaction of the Postmaster-General that the existing company have incurred or contracted to incur, in the area specified in the new license, material expenditure in laying down underground wires, and have by agreement with any local authority within that area acquired powers for that purpose, those powers shall continue for the period specified in the new license for the duration thereof, but, subject as aforesaid, on the terms and conditions specified in the agreement (including any provisions thereof for determination on breach of covenant), except so far as they may be varied by any subsequent agreement with the local authority."

Sub-Sections 2, 3, and 4 do not apply to the present case, but Sub-Section 5, which reads as follows, does: "(5) If the license of an existing company is under the provisions of this section extended in respect of any exchange area for a period of not less than eight years beyond the term existing at the passing of this Act, the company shall, at the request of any other licensee of the Postmaster-General providing public telephonic communication in the whole or any part of that exchange area, and under such circumstances and on such terms and conditions as may, within six months from the passing of this Act, be prescribed by an order of the Postmaster-General, made with the approval of the Treasury, afford all proper facilities for the transmission of telephonic messages between persons using the system of the company (either in the whole or in part of the exchange area, as the Postmaster-General may prescribe) and persons using the system of such other licensee, provided that the licensee so requiring intercommunication shall in any such case afford similar facilities"

These regulations for intercommunication were summarised in our previous article.

The above extracts do not make it at all clear why there should have been such a long delay in the execution of the deed referred to by the Postmaster-General. In our opinion, the condition of the granting of the new license enabling such a deed to be executed could only have been inserted in the Corporation license if the National Telephone Company agreed to the provisions (*a*) and (*b*). This is the reading of the clause, and if our view is correct, the delay in executing this deed has given the company more than two years in which they have not fulfilled their obligations under these provisions. In fact, at Tunbridge Wells the policy of the company and their actions have during this time been directly opposite to that laid down in these preliminary provisions to the extension of the period of their license. The result of the delay has been against the Corporation undertaking.

On Thursday, 20th inst., a large and important deputation waited on the Postmaster-General to protest against the transfer of Tunbridge Wells municipal telephone undertaking to the National Telephone Company. Amongst those present were Messrs. T. Lough, M.P.; Luke White, M.P.; D. J. Schackleton, M.P.; Alderman R. S. Robinson, L.C.C.; Alderman Pink, J.P., Alderman Putland, and Councillors G. Abbott, W. Bournes, and C. W. Strange from Tunbridge Wells; the Lord Mayor of Manchester, Councillor Royle; Alderman Southern, J.P., chairman of the Manchester Telephone Committee; Councillor Carpenter, of Portsmouth; Councillor W. Clark, of Halifax, chairman of the executive committee of the National Chamber of Trade; Councillor Dickinson, of Blackpool; Councillor J. Brown, chairman of the Hull Telephone Committee; Councillor J. B. Rowe, chairman of the Eastbourne Telephone Committee; A. R. Bennett, M.I.E.E., and a number of other gentlemen, either telephone users in the Tunbridge Wells or interested in municipal telephones in other towns.

Mr. T. LOUGH, M.P., introduced the deputation, which he said could be divided into two parts—*i.e.*, those representing the opposition in Tunbridge Wells to the agreement which had been signed by the Corporation, and those gentlemen who had come from other towns in order to protest against the precedent which would be established if such an agreement was assented to by the Postmaster-General. He held that the secresy of the preliminary arrangements set a bad example to the municipal life of the country. The hurried proceedings of the Corporation of Tunbridge Wells infringed all the formalities of municipal procedure. He asked that the Postmaster-General would at least grant a delay of one year before giving his consent to the agreement, which was voted upon immediately after an election, which should have been fought on the question. The new members elected, and who practically carried the agreement, had all in their election addresses said that they would not sell the undertaking.

Alderman R. S. ROBINSON, L.C.C, then gave a brief history of the telephone in the Tunbridge Wells area for the past three years. This covered the opposition to the original inefficient system of the National Telephone Company, which led to the municipal exchange being started. In that time the number of subscribers within the area had gone up from 120 to about 1,800, which showed what a great field there was for a good telephone service. His *résumé* included the facts given in our last issue. He proceeded to state that 196 subscribers who now paid £2. 10s. per annum and 1d. per outgoing call, had now signed agreements to pay a minimum sum of £5 per annum in future. Thirty-two of the subscribers on the £3. 10s. rate had agreed to the same minimum subscription, and 120 of the flat-rate subscribers had agreed to pay £6 per annum. He proceeded to show that with the increased income of £320 per annum so obtained, and with the additional lines which could be constructed in consequence of the consulting engineer returning his commission, the undertaking would be financially successful in the future. The reason for the estimates having been exceeded was the undue development of the long lines to outlying villages; the users of

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these lines were there to protest against the Corporation undertaking being sold. In conclusion, he urged upon the Postmaster-General to definitely refuse his sanction to the agreement, as the permission for any such transfer would be a total reversal of the declared and settled policy of the Government.

Alderman PUTLAND then spoke on the unsatisfactory clauses in the proposed agreement as far as security for the due performance of the financial obligations of the company was concerned.

Mr. LAWSON DODD urged the fact that the agreement had been rushed through the Council, and that even at the second meeting the report of the financial state was not received in due time to enable it to be considered. He thought that the half-crown which the Corporation would receive per flat subscriber was too small a sum for the privileges granted. In Glasgow the Corporation received twice that amount per subscriber.

The LORD MAYOR OF MANCHESTER then read the resolutions which had been passed by his Council, which objected to the transfer on the ground that it defeated the recommendations of the Telephone Committee and the provisions of the Telegraph Act of 1899.

Alderman SOUTHERN, the chairman of the Manchester Committee, in reply to Mr. Austen Chamberlain, said that the effect of the transfer, if allowed, would be bad for municipal telephone enterprises throughout the country. Already a flood of literature had been sent out exaggerating what was termed the failure of the Tunbridge Wells undertaking. This suggested failure was not supported by facts, and he urged that the matter of transfer should not be decided until next year's elections had taken place.

Mr. AUSTEN CHAMBERLAIN, in reply, said that he recognised the importance of the deputation, and that the interests involved were not confined to Tunbridge Wells, but affected several of the great corporations in the country. The details of the agreement were a matter of great importance, and he was not surprised at the interest evoked. His decision, whatever it might be, would have a far-reaching effect, and he must have a reasonable time for consideration. He had already stated that nine days were not long enough to enable him to arrive at a decision, but at the same time he recognised that the parties interested were entitled to an answer at the earliest possible date. He could not hang up the matter for a year, as had been suggested. As far as the local grounds for refusing his consent was concerned, he did not consider it the duty or proper of the Postmaster-General to constitute himself a court of appeal over local matters. He felt that he was only entitled to deal with Tunbridge Wells through their recognised mouthpiece—the Corporation. He had endeavoured to ascertain from some of the speakers how this agreement, if it should be assented to, would affect other parts of the country. It had been said that there was a fear lest this transfer should be cited as a failure of municipal telephony, and hence pressure should be brought to bear to reverse the telephone policy of other corporations. He hardly thought that this would be the case. His point of view was that he could not undertake to protect Tunbridge Wells against the acts of the elected members of the Council. Even if, after considering the information laid before him, he came to the conclusion that the undertaking would be successful, he should hardly like to take the responsibility of forcing his opinion on the majority of the elected members. What he had to consider was the effect of the proposed sale on the policy of the Post Office. The company had obtained an extended license in consequence of competition being established, and they wished to enjoy this extension when the reason for it had been removed. In fact, he had to decide on the national question of how the agreement affected national interests, and how it would operate if the Government should decide to take over the whole telephone system in the United Kingdom. He had other deputations to hear on the matter, after which he would give his decision with as little delay as possible.

The deputation then passed a vote of thanks to the Postmaster-General for his courteous hearing.

In the afternoon a meeting of the representatives who had attended the congress from all parts of the kingdom was held in Cannon-street Hotel, in order to decide how best to take joint action in further opposing the agreement in question.

STREET LAMP TESTING.

Mr. J. W. Bradley, the engineer to the city of Westminster, has had carried out during the months of April, May, August, and September last some interesting photometric tests on the street lamps under his care. No less than 14 different systems of lighting were employed, amongst which, however, must be included three arc lighting installations supplied by three separate electric lighting companies. The other luminants include Suggs' high-pressure incandescent gas-burners, the Welsbach self-intensifying gas lamp, the Scotch Snell lamp of the same type, the Kitson oil lamp, and a number of different incandescent gas lamps with different consumptions of gas per hour, ordinary flat-flame burners and ordinary incandescent electric lamps. The value of the figures obtained, and as published by Mr. Bradley, is considerably lessened by the fact that in the publication a number of details as to the carrying out of the tests are omitted. All that is given is the date of testing, the height of the lamp from the street level, the candle-power, and, in a number of instances, the normal consumption of the light-giving agent in question. No reference is made as to the distance from the light at which the readings of the photometer were taken, which position has a considerable effect on the result. This is especially so with arc lighting, as the polar curve from arc lamps is by no means a circle, as might be assumed from the figures in the tables before us. The arc lamps used in Westminster are presumed to consume 500 watts, and from the 50 tests made the average candle-power comes out at 670. The average height of the columns is 22ft., and Mr. Bradley estimates that the lamps would have to be placed 107ft. apart, or 49 to the mile, in order that the pavement midway between two consecutive lamps should have a light equal to one candle placed 3ft. away. The nearest approach to the arc lamp in the Westminster area is the Suggs high-pressure incandescent gas. With these, 15 readings on three different dates give an average of 494 c.p. The highest reading obtained was 686 c.p., and the lowest, with all the mantles in order, 391. Although this variation is large, immediately one or two mantles become defective the candle-power drops to a much lower figure. The same thing applies if the pressure increasing gear is out of order. It must be remarked, however, that high variations are also found in the readings obtained in the electric arc lamps. These variations appear to us to be due to want of regulation—in other words, the measurements were not made on the current and voltage of the individual lamp being experimented with. Mr. Bradley estimates that on the same basis for the minimum lighting at the point midway between two lamps, the Suggs high-pressure gas-burners would have to be placed 93ft. apart on columns 14ft. 6in. high. The flat-flame burners, consuming 18·48ft. per hour, would have to be placed 31ft. apart, while the incandescent mantles, taking 4·2 cubic feet of gas per hour, would be placed 30ft. apart. The last two figures for consumption and distance show how much the incandescent mantle has improved gas-lighting. Without, however, the consumption of the Suggs high-pressure burners, and the cost of renewing, with the upkeep of the pressure-increasing gear, no comparison as to the relative costs can be made. We presume that Mr. Bradley is holding over these figures until he makes a report to the whole of the Council of the city of Westminster on the subject. Unless he then gives more details as to how the tests were carried out and the state of the atmosphere at the time, we are afraid that the supporters of the rival systems of lighting will none of them be satisfied.

Bermondsey.—Messrs. Peek, Frean, and Co. have let to Société Gramme, Paris, the entire contract for the power and light installation at their factory, including engines, motors, dynamos, and wiring.

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SOME NOTES ON AIR-PUMP DESIGN.

BY C. L. BROWNE.

(Continued from page 693.)

Before dealing with the considerations which determine the capacity of an air-pump for any particular duty, it will first be necessary to decide upon the type of air-pump to be used. The single-acting vertical air-pump, when supplied with foot valves, has by far the highest efficiency as a pump, the average efficiency being about 50 per cent., while an efficiency of 60 per cent. may be obtained with a well-designed specimen. These figures compare very favourably with the results given by the double-acting horizontal type, which rarely exceeds an efficiency of 35 per cent. Strictly speaking, the vertical air-pump is always to a certain extent double-acting, since the volume of the pump rod displaces a portion of the contents of the pump during the down stroke; and where a trunk is used the air-pump may be made to deliver as much of its contents on the down stroke as on the up stroke by making the sectional area of the trunk equal to half that of the pump barrel. This practice, however, tends to make the bucket valves less sensitive.

The high efficiency of the vertical single acting air-pump is due to the small clearances between the top of the bucket and the head's valves, and between the bottom of the bucket and the foot valves, and to the fact that the direction of the flow of water through the pump remains unchanged. The water also collects readily below the bucket during the up stroke of the pump, and, being retained by the foot valves, is projected with certainty through the valves in the bucket. The closure of these valves is sure and rapid, being positively closed by gravity.

It will be instructive to follow the action of this pump under working conditions, with a view to an appreciation of the requirements to be met in its design. The water which has accumulated during the down stroke against the foot valves in the passage between the foot valves and the condenser commences to flow slowly into the pump as the bucket rises, and provided that the difference between the pressure in the pump barrel and that in the condenser be sufficient, this flow will continue until the level of the water falls, so that it no longer touches the top of the passage. This will allow the air and vapour to pass into the pump along with the water, the momentum of the water still flowing through the foot valves helping to keep them open. The air will bubble up through the water above the foot valves, its rate of flow through the water in the pump barrel increasing as the water gradually comes to rest. The height of the column of water which will enter the pump is determined by the difference in the pressures above and below it, being slightly increased by the amount of water driven through the foot valves by its own momentum. It is also evident that the pressure in the condenser will not force the air downward through the water into the pump, but as soon as their respective positions are reversed—that is, the water above and the air beneath it—the difference in their specific gravities will operate to produce a rapid ascension of the air through the water. The falling of the level of the water below the top of the passage between the condenser and the air-pump, by allowing the air and vapour to pass along it, will at once tend to make the pressure below the foot valves equal to that in the condenser, and the water will gradually come to rest, since the head of water above the foot valves checks its onward movement. The bucket will now be coming to rest at its upper stroke limit, discharging into the atmosphere the water and air above it, and a downward current setting in through the foot valves closes them and prevents the further entrance of air. Thus the final pressure of the vapour and air between the water in the barrel of the air-pump and the bucket when the latter is at its upper stroke limit, will be less than that in the condenser by an amount due to the head of water above the foot valves. The bucket now descends, and the contents of the pump are projected through the bucket valves.

The cycle of operations described above will be slightly modified by the design of the pump, the cross area, shape, and length of the passage into the air-pump, the ratio of the displacement of the pump to the volume of water to be handled per working stroke, and also by the speed of the bucket. The two latter factors will be fully dealt with later.

In order to facilitate the flow of water and air into the pump, the condenser should be placed as near to the main engines as is convenient, and the piping should be arranged, if possible, with a continuous drop from the engine to the air-pump foot valves. All pockets or cavities where air can lodge or eddies be formed should be scrupulously avoided. Where a horizontal air-pump is worked by a prolongation of the low-pressure cylinder piston rod of the main engine, this result cannot be obtained, a circumstance which in part accounts for the less satisfactory vacuum obtained in horizontal air-pumps so driven. Apart from the increased back pressure induced by a long exhaust-pipe range, where the shell is thin and the diameter large, as in mild-steel exhaust piping, it is liable to take up the vibration both of the main engines and also of the condenser pumps. Should the strokes of the pumps happen to synchronise with the pulsations of the exhaust steam, this vibration is apt to cause considerable annoyance. The length of the passage from the condenser to the foot valve of the air-pump and the head of water therein have a direct influence upon the speed at which the air-pump bucket may be driven, since, apart from the head, the absolute pressure in the condenser, which is necessarily feeble, is the only means of setting in motion the column of water of this length, and of driving it through the foot valves in the wake of the ascending bucket, the speed of which is limited by the degree of acceleration which may be imparted to the water during the upward stroke of the pump. In any case the foot valves should be placed below the lowest level of the condenser. It is evident that if the vacuum in the condenser is already good, it will require a well-designed pump to create a difference in pressure sufficient to lift the foot valves and draw the water through them, for it must be remembered that the pressure in the barrel of the pump must vary during one stroke from below that of the condenser, when the foot valves are open, to above that of the atmosphere, when the contents of the pump are being discharged through the head valves.

With the above conditions in view the foot valves should be light, free from friction, and of such a design as to respond rapidly to the pressure tending to lift them off their seats. The clearance also between the bucket and these valves when the former is at its lower stroke limit should be as small as possible, since, apart from the beneficial effect which small clearances exert on the vacuum which may be obtained in the pump, a large clearance increases the depth of water which will always lie on the foot valves, and consequently augments the pressure necessary to lift them. A number of small valves are better than a single large one. Not only are they less sluggish in action, but small sight doors may be arranged for their convenient inspection and renewal, and this is a matter of much importance if the pump is to be maintained in good working order. It is good practice to cast the grids beneath the valves at a small angle with the direction of the water passing through them, so that the entering water tends to rotate the valves upon their seats, and thus materially prolong their life.

Indiarubber has been largely used for air-pump valves, and where this substance is employed it should be carefully selected for the purpose, since a rubber factory will turn out, perhaps, 100 different qualities of indiarubber. The Admiralty stipulate that the indiarubber supplied to them for this purpose shall consist solely of Para caoutchouc, white oxide of zinc, and sulphur, the proportion of oxide of zinc not to exceed 70 per cent., nor that of the sulphur 1¾ per cent. The manufactured article must also stand a dry-heat test of 270deg. F. for one hour, and a wet-heat test of 320deg. F. for three hours, without showing any signs of deterioration. Where mineral oils are used for cylinder lubrication, indiarubber is not to be recommended, since these oils cause a more or less rapid decomposition of this material, a much better article, where mineral cylinder oils are used, being the substance commercially known as "vulcanite." Vulcanite is a special preparation of indiarubber, in the manufacture of which the latter is allowed to absorb from 35 to 40 per cent. of sulphur, and is

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exposed for some hours to a temperature of from 135deg. C. to 150deg. C. It is light, strong, and durable, and is entirely unaffected by oil. It is not, however, as pliable as indiarubber, and when used for pump valves takes the form of a flat disc, and, being threaded on a stud, works against a flat metallic guard.

There are numerous designs of pump valves, composed of various substances, but unless they fulfil the following requirements—namely, that they are light, require but little headroom, give ample passage for water compared with the space they occupy, and offer but little resistance in moving away from or returning to their seats—they are useless for the purpose under consideration. Most rules given for determining the opening through the foot valves express this area in terms of the air-pump displacement per given time. The quantity of water which passes through these valves, however, does not always bear a strict relation to the displacement of the pump in various designs. For instance, the quantity of water required to pass through these valves per cubic inch per minute displacement of the air-pump is less with a surface condenser than where jet condensation is resorted to. If the opening is too large, the valves will be sluggish in action; if too small, the momentum of the water passing through the valves will interfere with their proper action. The *mean* velocity of the water through the foot valves should not exceed 500ft. per minute when the air-pump is working under full load. In practice this area is made a little less than that through the bucket valves, which latter area will be considered in connection with bucket speed.

The design and arrangement of the head valves is of equal importance if the pump is to give a high efficiency. They should be placed at the highest point in the pump, and the top grid plate designed so as to render impossible the accumulation of any air beneath it. The head valves should always be covered with water, so as to prevent the leakage of air into the pump. The depth of this water need not exceed ½in. or 1in. at most, otherwise it will offer an unnecessary resistance to the lifting of the head valves. For the same reason the opening to the hot-well should be long and shallow, so that the water will not accumulate on the valves, but will readily drain away. This point is of more importance with a jet condenser, where a relatively large quantity of water is handled. It is good practice to cast ribs between the head valves on the grid, so that each individual valve is covered by a separate pool of water, by which means a leaky valve may be conveniently traced while the pump is at rest. Where the discharge to the hot-well is above the level of the head valves a cover is, of course, necessary, otherwise these valves may with advantage be left open. In well-designed pumps it will usually be found that the *maximum* velocity of the water through the head valves does not greatly exceed 800ft. per minute.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

535. A 5-h.p. enclosed motor is satisfactory in every respect except that it makes a loud humming noise when running, similar to a small steam horn. In this case the noise is very inconvenient, and it is important that it should be stopped. In some books it is stated that the trouble can be overcome by filing away the ends of the pole-pieces, but this method has been tried and makes no appreciable difference. I should be glad if some of your readers would suggest some method of overcoming the difficulty. Would an increased number of slots in the armature make any difference?—W. F. S.

536. After running on full load for about five hours the collecting rings of a single-phase alternator are found to be distinctly shaded in sections, corresponding in number to the poles on field magnets—the shadings being alternately of a dull and of a polished appearance. Can any reader explain this phenomenon? It may be mentioned that the rings are quite cool after the run.—C. S.

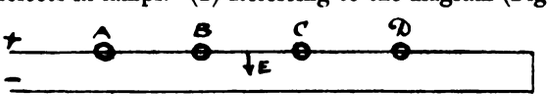
Question No. 529.—With four arc lamps burning in series on a 220-volt direct-current circuit, it is found that some lamps consume the carbons faster than the others. Why is this, and how could they be made to all consume evenly?

ANSWERS.

Best Answer to No. 529 (*awarded* 10*s.*).—A comparatively high rate of carbon consumption in a lamp may be due to either of two primary causes: (1) a greater current; (2) a higher resistance. Either of these will cause a higher temperature in the arc, and consequently a faster rate of carbon consumption, and as the heat developed depends upon current^2 × resistance, a small change in current will have a more marked effect than a similar small change in resistance.

The current in one lamp will be different from that in another if there is some defect in the insulation of wiring or lamps, which provides a shunt to some part of the proper path of the current, while the resistance of a lamp arc will vary as the length of arc.

The most convenient way of classifying the faults which we may expect to find is as under: (1) defects in wiring; (2) defects in lamps. (1) Referring to the diagram (Fig. 1),



we may find that lamps A and B have a high consumption of carbon compared to C and D. If, now, we change A and B to the positions occupied by C and D, and put C and D in place of A and B, and run the lamps in this order for a day and note the carbon consumption, we will probably find that A and B have now a low while C and D have a high rate. This would clearly prove that there is a leak at some point, such as E between points B and C on diagram, either from E to earth or to the other wire if these are adjacent. The fault must then be found by examination of the wire in that locality and put right. If again we find that the rates of consumption in each pair are unaltered by the change, the lamps are at fault, and we shall treat of them later on. We may find that A burns faster than B, which burns faster than C, which burns faster than D. In this case it is almost certainly the wires which are at fault, a steady leakage going on all along the line; if so, rewiring is the only remedy. By changing the lamps as above we may find whether this is the correct reason or whether the lamps are to blame.

2. If we find that the rate of consumption in a lamp is high no matter where it is placed, we have two causes from which to select the right one: (*a*) excessive friction in working parts; (*b*) an undue preponderance of series over shunt coil.

(*a*) Suppose that the four lamps are switched into circuit and that B has excessive friction, its arc will not be quite so long as the others at striking, since the friction will oppose the upward motion. But B will not feed until its arc is longer than the arcs of the others, since the friction is now opposing the downward motion, and as all subsequent motion is downwards, the arc will always be longer than the others. We thus have in B's arc a higher resistance, temperature, and rate of consumption of carbon.

(*b*) Precisely the same effect will be obtained if the series coil is too strong. The core will be held too high and the arc will be too long. But in this case the length of arc will be greater at feeding as well as at other times.

We can thus distinguish between these two by measuring the length of arc at striking. Station a man at each lamp with instructions to take hold of and keep firmly in position the carbon-holder whenever the arc is struck, suitable precautions being taken against risk of shock.

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Switch on the lamps, and after a few seconds switch off again and proceed to measure the distance between the carbons If B's length is below the average, friction is the cause of its high consumption; if above the average, the series coil is too strong. The former may be remedied by purely mechanical means, the latter by deducting one or two turns from the series coil until the arc is of the normal length.

If we find that the rate of consumption of carbon in B is abnormally low no matter where B is placed, we have again two causes from which to pick the right one: (*c*) defective insulation in the lamp; (*d*) weakness of series coil field.

(*c*) This would mean that there is some path by which part of the main current travels other than the arc and the shunt coil. Bad insulation of the terminals or some such thing would be the cause of diminishing the current through the arc, and, consequently, the rate of consumption.

(*d*) This is just the reverse of (*b*) in the preceding case; the arc will always be short and the consumption low.

The remedy for (*c*) is to test the insulation resistance between terminals with shunt coil connections detached and carbons separated, and find the weak spot, if there is one, by testing different parts. Once the defect is found it is easy to put it right. The cause of a weak series field may be either a short-circuit in the winding or an earth or an insufficient number of turns. Unwinding the coil will reveal if any fault exists. If it does, the remedy is plain; if it does not, add a turn or two to the series winding.

In the foregoing we have assumed that if one lamp burns at a different rate from the other three, the three are right and the one is wrong. But this is not a safe assumption, especially in an old installation. We would, therefore, require to corroborate our results by observations of the light given per watt by each lamp. Of course, there are many methods of detecting the above-named faults, but we have endeavoured to use as few instruments as possible. Some sort of testing set is all that is required. The tests for length of arc should, of course, be repeated several times and the average taken. It will be safe to assume that, of the reasons named, defective insulation is certain to be the cause of any great variation in the consumption of carbon.—D. R.

Answer to No. 529 (*awarded* 7*s.* 6*d.*).—The reason for the carbons of the lamps burning unevenly is that they are not all consuming the same amount of energy. This is due to the distance between the carbons, when burning at normal arc, differing in the various lamps—*i.e.*, one set of carbons having a greater gap between them will have a greater resistance—and as the lamps are in series, and therefore the current in each lamp the same, the lamp having the greatest space between the carbons will consume the larger amount of energy. There are various ways of overcoming this difficulty, but the best method is to insert an ammeter in the circuit, then take off the covers of the lamps so as to give easy access to the regulating screws on the braking arrangement; next connect a voltmeter, reading 40-70 volts, to the terminals of each lamp, and note the readings. The lamps having the greatest terminal voltage must then be adjusted at the brake, so as to reduce the distance between the carbons when at normal burning position, or the lamps having the lower voltage must be altered so as to give a greater distance between the carbons at normal arc. Which of these alterations should be made will be indicated by the reading on the ammeter; thus if the current taken is greater than normal, the latter alteration should be made, and if the current is less than normal the former adjustments made. These readings will have to be noted and the regulators altered, until, when taking the normal current, the voltage at each set of lamp terminals is the same. The regulating screws must then be locked, and the lamps should burn without further trouble. It may be that in adjusting the lamps some parts are noticed to have worn or corroded. These should be replaced; also the flexibles and series and shunt coil wires examined to see that they are not broken and are making good contact. These latter causes account for much of the trouble with lamps

If the instruments indicated above are not handy, rough adjustments may be made without them, merely judging by the normal position of the plungers and the measurement of the space between the carbons at that position. In the accompanying diagram V is a voltmeter; F, fuse; S, switch; R, resistance; A L, arc lamps; A, ammeter. All lamps should be taken down and examined periodically; in manufacturing districts, say, not less than once a year.

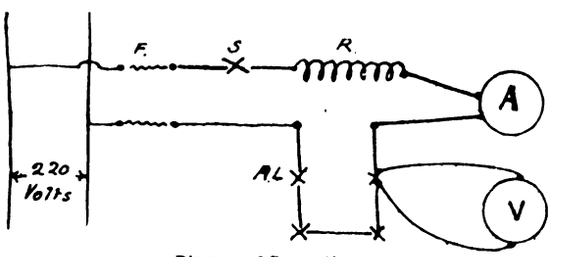

Diagram of Connections.

This alone and proper attention in carboning the lamps and cleaning the rods regularly will result in satisfactory working.—E. T. W.

Answer to No. 529 (*awarded* 5*s.*).—As the question states "some lamps consume the carbons faster than the others," there is, presumably, no suspicion of inequality in the carbons, but that the fault lies with the lamps. It often happens, however, that the lamps are blamed when the cause of the trouble is due to the carbons. If it is found that the lamps are working badly, no doubt a little attention will soon put them right. Examine the lamps when burning to see if the arcs all keep to the normal length. It will in all probability be found that the lamps consuming the carbons quickest have the longer arcs. Should this be the case, they must be adjusted. In nearly all arc lamps there is some method of regulation. The Brockie-Pell, for instance, has an arrangement by which weights may be added or subtracted to assist or retard the action of the shunt coil as may be required, and the Crompton-Pochin may be regulated by means of the feed-pin. In some lamps, again, there are springs, the tension of which can be altered by means of lock nuts, etc., thus bringing the arc to its normal condition. A very common cause of irregularity with lamps that are fitted with a dash-pot to prevent hunting is in this part of the mechanism. Occasionally, the piston is stiff through dirt, or want of alignment; sometimes, also, there is a small screw and washer in the piston which requires careful adjustment. These points if attended to will certainly lead to a better state of affairs. Each lamp, however, should be overhauled, care being taken that the carbons are of right size and length, and the lamps properly trimmed. The most satisfactory method would be to have the lamps down, placed in proper test boxes, and magnified images of the arcs thrown upon a screen. Should this be inconvenient, the job may be done quite well while the lamps are in position, using a pair of dark spectacles to view the arc. In any case alteration should be made a little at a time, and the result carefully noted. It will be found that although the longer arcs will consume the carbons quicker, and that there will not be so much throttling of the light rays by the negative carbons as in the case of the shorter arcs, the increase of light will not be so great as might be expected owing to the veiling of the crater by the flare when the arc is long.—M. M.

Answer to No. 529. (*awarded* 5*s.*).—Whenever arc lamps are burning in series across 200 or 220 volt mains they require to be most carefully adjusted. If the carbons in one or two lamps burn out sooner than the rest, the carbon clips will be burnt away, and probably the shunt coils of those lamps will burn out unless a careful watch is kept and they are recarboned in time. Besides damage to the lamps themselves, there is the waste of carbons which takes place. The carbons in the lamps that burn at a slower rate than the others have to be thrown away so that they may all start again with equal carbons, otherwise lamp trimming will be always going on. To ensure that all the carbons burn away at an equal rate, see that all the carbons are of uniform quality and the same length. It is also as well to test them to make sure that all the carbons are of exactly the same diameter.

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But the most likely cause of "C. I. S.'s" trouble is that the arcs are of different length. To get all the arcs of a uniform length it is necessary to take them down in batches or three or four sets of four and carefully adjust them. If possible, have an ammeter in circuit and a voltmeter that will read the voltage across each arc. The voltage across the arc of a continuous-current open-type arc lamp should be about 43 volts. During the testing make a note of the time, current, and voltage, especially noting the exact length of carbon rod consumed in a given time. Different makers of arc lamps recommend different lengths of arcs, and the mechanism for altering the length of arc differs slightly in each type; $\frac{3}{16}$in. is a good distance to work with between positive and negative carbons. With the aid of a piece of ruby glass note exactly the length of each arc and mark those which have too long or too short an arc. If the arc is too long, adjust the balance weight so that the carbons are fed together sooner, and if the arc is too short, adjust the weight in the opposite direction. In the Brush lamp the round lead discs are moved away from centre or towards the centre of the lamp, as the case may be. In the Korting-Mathieson lamp more lead weights are added or taken off. If "C. I. S." had stated the maker's name, I might have been able to give full particulars as to what required doing. In burning lamps in series of four or five across incandescent lighting mains, if the mechanism of one of the lamps sticks and fails to feed the lamp at the proper time, the arc goes out, and the remainder in series with that lamp all go out unless an equivalent resistance is automatically inserted. Also if the dash-pot allows the carbons to be fed together too quickly, there will be violent pumping going on. The remedy, of course, is obvious.—W. A. T.

Answer to No. 529 (*awarded* 5*s.*).—It is not stated in the question whether the arc lamps are open or enclosed, but in all probability they are of the latter type. Assuming, then, that they are enclosed lamps, the unequal rate of carbon consumption can be attributed to the following cause: In the enclosed arc lamp the arc is enclosed in an inner globe, from which free access of air is excluded. The primary object of thus enclosing the arc is to reduce the consumption of carbon, as, owing to the absence of a plentiful supply of oxygen, the rate of combustion of the carbon is greatly prolonged. Now, it is very probable that those lamps that consume their carbons too fast are not properly protected from the air. The inner globes may be cracked, or perhaps the joints are faulty, and in that way allow the air to come in contact with the arc, with the result that the carbons are consumed at a much quicker rate than those which are properly protected. Whether this is the case or not can be readily determined by examining the globes when trimming the lamps, and also by noticing the lamps when burning, as when air comes in contact with the arc it becomes unstable and makes a "hissing" noise.—F. W. S.

Question No. 530.—I wish to use a three-phase motor as a transmission dynamometer to find the exact power taken by various machines. What is the most accurate method of measuring the power applied, and the various losses (hysteresis, friction, etc.) in the motor? All measurements but speed to be electrical. Answers should deal with both synchronous and induction motors.

Answer to No. 530 (*awarded* 7*s.* 6*d.*).—To measure the power applied to the motor we need some form of wattmeter suitable for measuring alternating currents, such as the Siemens workshop wattmeter. If two of these are available the readings can be made more quickly, but the power can be measured with only one wattmeter as described below. First, assuming we have two wattmeters, the thick wire coils are placed in two of the mains supplying the motor, and their fine wire coils are joined across these two mains respectively and the third main, as shown in Fig. 1. The sum of the readings of the two wattmeters then gives the mean value of the power supplied to the motor, whether it is wound in "star" or "mesh" fashion. The proof of this for the star winding is as follows: Let i_1, i_2, i_3 denote the instantaneous currents in the three mains reckoned positive when flowing from left to right in Fig. 1, and let v_1, v_2, v_3 stand for the instantaneous potential differences between the neutral point and the three mains respectively, reckoned positive when acting away from the neutral point.

Then instantaneous power $= W = v_1 i_1 + v_2 i_2 + v_3 i_3$.

But by Kirchoff's law, $i_1 + i_2 + i_3 = 0$.

Therefore $i_3 = -i_1 - i_2$.

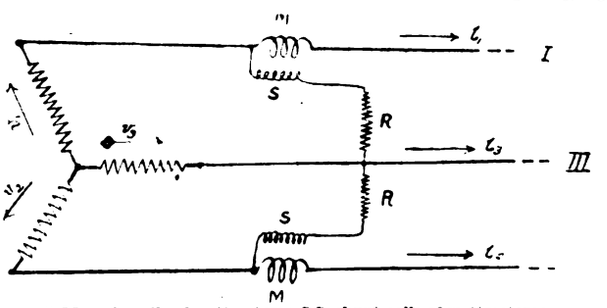
Substituting this value for i_3, we get

$$W = (v_1 - v_3) i_1 + (v_2 - v_3) i_2.$$

But $(v_1 - v_3)$ = E.M.F. between line I. and line III.

and $(v_2 - v_3)$ = „ „ II. „ III.

And the wattmeter whose main coil is in I. measures the mean value of the product $(v_1 - v_3) i_1$, and the wattmeter whose main coil is in II., the mean value of $(v_2 - v_3) i_2$.



M M, main coils of wattmeters; S S, shunt coils of wattmeters; R R, high non-inductive resistance.

FIG. 1.

Hence the algebraical sum of the readings of the two wattmeters gives the mean value of W—*i.e*, the mean power in the three-phase circuit.

In this case, since the load is equally distributed amongst the three phases, we may measure the power by a single wattmeter, arranged as in Fig. 2. Take a reading with

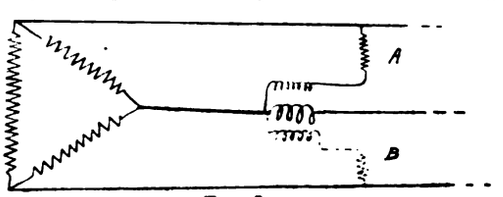


FIG. 2.

the shunt coil arranged at position A, then change over the shunt coil connections to position B, shown dotted in sketch, and take another reading. The sum of the two readings gives the power being supplied. Now run the motor light, and measure the power being supplied by one of the above methods, also have in one of the line wires a hot-wire ammeter giving the current, C, in that line, and also in the other two lines since the load is balanced. Then the current in each of the motor windings is $\frac{C}{\sqrt{3}}$. Then, knowing, or having measured, the resistance when warm of each winding of the motor, say it is r, we know the $C^2 R$ loss in each winding is $\left(\frac{C}{\sqrt{3}}\right)^2 r$, and therefore the total heating loss in the motor is

$$3 \times \left(\frac{C}{\sqrt{3}}\right)^2 r = C^2 r.$$

Subtract this loss from the total power being supplied, and we have the watts lost in friction, hysteresis, eddy currents, and if the motor is synchronous, exciting its own field magnets, magnetising current. As all these are approximately constant at all loads we need not separate them. Call these constant losses X. Then at any time if we are supplying power to a machine, if

P = power taken by machine in watts;
W = total power supplied to motor;
C = (R.M.S.) current in each line conductor; and
r = resistance of each winding of motor when hot;

we have $P = W - (X + C^2 r)$. —W. S. P.

Answer to No. 530 (*awarded* 7*s.* 6*d.*).—The power measurements that "Dynamometer" desires to make are for the purpose of ascertaining the power absorbed by various machines, using a three-phase motor as a transmission dynamometer. Two sets of measurements will be necessary: one to determine the power taken from the

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lines when the motor is supplying the requisite power to the machine under test, and one to determine the power absorbed by the motor when running at the same speed on no load. The latter measurement gives the sum total of the losses in the motor, it being unnecessary for "Dynamometer's" purpose to discriminate between the various losses through friction, eddy currents, etc. The portion of the power actually employed in driving the machine is then obtained by the subtraction of the no-load power from the power taken when the machine is doing its work. In measuring the power supplied to the three-phase motor, whether it be a synchronous or an induction motor, the ordinary method of determining the power delivered by a three-phase circuit can be adopted, but two cases may be considered.

Case 1.—Case of equal phase difference and equal lag. It is generally assumed that the three phases of the motor are symmetrical, and that this condition is true, and if such be the case, one wattmeter may be employed, with its thick wire, or series circuit, in series with one of the lines. The thin wire, or shunt circuit, is successively connected between this same line and each of the other two, the reading on the wattmeter being taken with each connection. The sum of the two readings thus obtained is

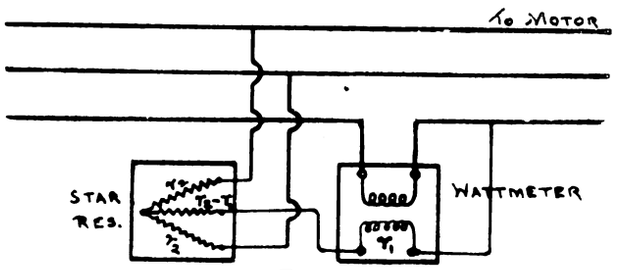

Fig. 1

the total power transmitted. The alteration in the connections may be avoided, and the power obtained in a single reading by the use of a three-phase star resistance (if "Dynamometer" has such at hand) in conjunction with the wattmeter. The wattmeter must then be connected up as in Fig. 1, and the reading—provided the instrument has been previously calibrated with the star resistance for for use on a three-phase circuit—will indicate the power delivered. The above method will be sufficiently accurate, unless the load on "Dynamometer's" line is a mixed lighting and power one. In this case the potential differences across the three lines will no doubt be unequal, and so the currents in the three phases of the motor will be unequal and have phase differences other than 120deg. This we may call

Case 2.—The general method for any phase difference and any current in which two wattmeters are employed.

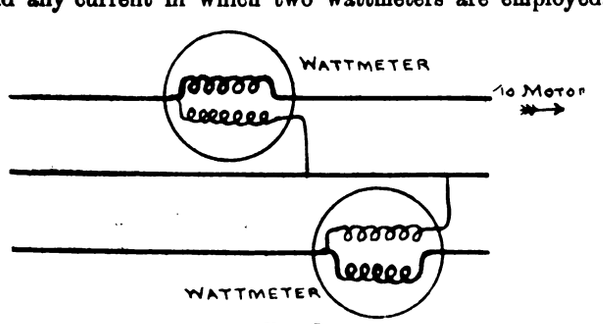

Fig. 2.

These are arranged, as shown in Fig. 2, with their series coils inserted in two of the three circuits, and the shunt coils respectively connected between the third line and the other two. The total power delivered to the motor is given by the sum of the two readings thus obtained.—Ll. R. L.

Answer to No. 530 (*awarded* 5*s.*).—Probably the simplest manner to find the power taken by the various machines would be as follows:

1. *Using Three-Phase Induction Motor.*—Run the motor free and measure the power supplied with a wattmeter (taking the product of voltmeter and ammeter readings as incorrect, on account of the difference in phase of current and voltage caused by the motor). Now connect motor to machine whose "intake" is required, and again measure the power supplied with the wattmeter. Subtract the power required to run the motor light from the latter reading, and this gives us the power supplied to machine. This method, however, is not *strictly* correct, on account of the increased copper losses in stator and rotor; but these losses, again, are nearly balanced by the decrease in hysteresis, friction, etc, losses due to slight diminution of speed, when the motor is loaded, thus rendering the method quite accurate enough for practical purposes. It must be noted that the wattmeter reading must be multiplied by 3 to get the full power given to the motor, as the wattmeter only reads the power in one phase, and the phases are equally loaded. Fig. 1 shows diagram of connections.

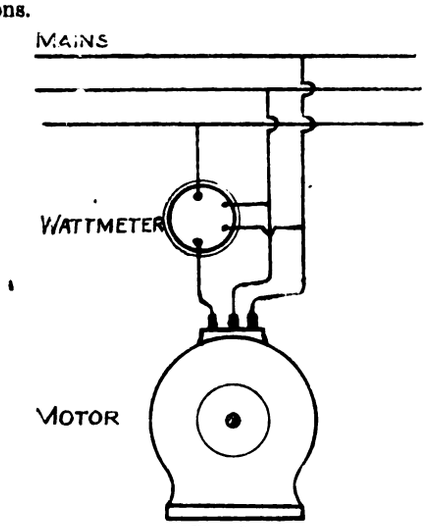

Fig. 1.

2. *Using Three-Phase Synchronous Motor.*—Run the motor light and increase or decrease the field excitation until the current taken by the motor armature is a minimum. Then take ammeter and voltmeter readings, the product of which gives power required to run the motor light. Now connect the motor to machine and again adjust excitation until armature current is a minimum. The product of ammeter and voltmeter reading again gives power supplied to motor. Subtract former product from latter and we obtain power given to machine.

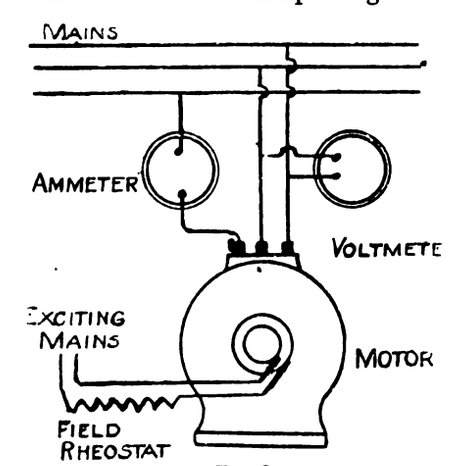

Fig. 2.

As in former case, the product of volts and amperes must be multiplied by 3 to get total power supplied to motor. In this case, instead of using volt and ammeters, a wattmeter could be substituted and used as in case 1. Fig. 2 gives diagram of connections.

In both cases, the motor will doubtless be connected to machine by belting and allowance must be made for the transmission loss due to the belting. It varies from about 1 to 3 per cent., according to condition of belt and pulley surfaces. With a fairly new and good belt, however, it could be neglected without causing serious error.—Erg.

[The internal connections of the wattmeter are not explained, and without these the correctness of the multiplier 3 cannot be assured.—Ed. *E.E.*]

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CONTENTS.

Notes	721	Appointments Vacant	741
A Contribution to the Theory of Commutation	726	Electric Railway Signals	741
The Application of Electric Power in the Iron and Steel Industries	728	Trade Notices and Novelties	742
Institution of Electrical Engineers	729	Manchester	743
Wireless Telegraphy	730	New Committees	743
Tunbridge Wells Telephones	731	Fareham Accounts	744
Street Lamp Testing	732	Legal Intelligence	745
Some Notes on Air-Pump Design	733	Companies' Meetings and Reports	745
Questions and Answers	734	New Companies Registered	746
At the Society of Arts	738	Contracts for Electrical Supplies	746
Correspondence	739	Traction Notes	748
Electric Lighting Returns—Company *v.* Municipal	740	Lighting Notes	751
Forthcoming Events	741	Provisional Patents, 1902	754
		Complete Specifications	755
		Companies' Stock and Share List	755
		Traffic Returns	756

TO CORRESPONDENTS.

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AT THE SOCIETY OF ARTS.

At the opening meeting of the session on Wednesday last Sir W. H. Preece (chairman of the council) gave his inaugural address. This address teems with controversial points and interesting topics. The former we must pass over briefly, but on one or two of the latter, where agreement is pretty general, we may dwell longer. The text of the address may be found in the following paragraph: "to determine the causes which result in successful or disastrous financial undertakings, and to show that the commercial conduct of industrial processes arising from the practical applications of discoveries follow distinct laws which may be said to constitute a 'science of business.'"

By means of curves the author claims to obtain information of a very practical character relating to business pursuits, signals as rapid and certain as those of a barometer showing changes of weather, but requiring observant and practical translation, giving indication of laws, and enabling a forecast, and even a prophecy. The industries selected to exemplify the argument were water, gas, railways, telegraphs, submarine cables, and telephones. Our objections to any rigid conclusions as applying to business generally being drawn from an examination of these sources, are founded upon the fact that all these industries are of the nature of monopolies, and ordinary business relations are wanting. We venture to think that figures taken from the books belonging to a great ironworks, a cotton or a woollen factory, will differ materially from those taken from any of the industries referred to in the paper. Mind, we are not combating Sir W. Preece's conclusions in regard to the industries selected, but merely suggesting that those conclusions are limited in application. The business of a gas company is over a well-defined area, its market is local, while that of a cotton mill is world wide. Although the conclusions may be limited in application, the information collected and other conclusions given are generally acceptable. We hail with great delight, for example, the remarks upon telephony. The author's experience in this particular is unique, and whatever he says ought to obtain the most careful examination. He says: "The telephone business of this country defies diagrammatic analysis. It has had a curse upon it from its first introduction. It is now in a state of chaotic confusion. It has been the shuttlecock of politicians and the football of local authorities. The attempt to force it on the municipalities is likely to prove a failure. Tunbridge Wells has lamentably broken down. It is an Imperial business, a part and parcel of the business of the Post Office, and the only possible solution of the present deadlock is for the Government to cut the Gordian knot and take over the business in 1911."

Another interesting topic mentioned was in reference to the Atlantic combine—thus: "It is startling to find that each holder of £1,000 in the White Star Line will receive £14,265 for his share from the new Atlantic Shipping Combine. Upon what capital is profit to be distributed which will enable the late holder of £1,000 to be as happy as the new holder of £14,265! Whence are the new profits to come!"

Suppose the shareholders so admirably treated reinvest only one-half of the money they receive in supporting the work of a British company, build new and improved ships, and compete with the combine. What would be the chances of success of the combine? It may be worth a considerable amount to create a monopoly, but we have never yet seen how this particular combine is going to retain a monopoly, or what is to prevent individual shareholders in risking a part or all the money received in competition. The genial author of the address seems to think

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that co-operation can do much good. Quite so; but the limits of beneficial co-operative effort (as ordinarily interpreted) are restricted; if by co-operation we mean combined effort, it includes even the work of the gigantic trusts which is deplored. When we say that technical commercial education and free trade policy formed other questions discussed in this address, it will be seen how wide a field was traversed, yet throughout the arguments, if not convincing, were eminently calculated to rouse deep thought. Many people think our educational enthusiasts have not as yet struck the right line, and have not evolved any system of education that altogether commends itself to the heads of great business houses. A commercial man is born, not made, but as one of the most eminent educationalists that ever lived said, "The born genius commercially can be made better by training, and the ordinary man by proper training can be made less a fool, and become of some use in the commercial engine of the country."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ON THE BRAKING OF TRAMWAY CARS.

SIR,—The letter from "Safety" in your issue of Nov. 14 provides some very interesting reading. It would appear, however, that more care might advantageously be expended in sifting and drying the sand used to prevent skidding. This, together with the delivery of the sand, is a point which is sometimes underestimated.—Yours, etc.,

M. M.

MUNICIPAL MATTERS.

SIR,—It is refreshing and enlightening to read your honest comments on the Tunbridge Wells telephone episode, as compared with the remarks of some of your contemporaries, all biassed in favour of trust monopoly. It is significant that they carefully omit full particulars of the underhand way in which the agreement with the National Telephone Company was brought about. The colossal impudence of the servant of the Corporation who was responsible, and the methods adopted to get the agreement rushed through, throw a lurid light on the methods of vested interests and their supporters. It is a betrayal of public interests much to be deplored, and the public should get thoroughly to the root of the matter.

The undertaking was on the road to success: only now had it got a fair field and no favour by means of the clause in the National Telephone Company's license forbidding it to undercut the municipal charges; but one of those "ratepayers' leagues" (*sic*) formed in the "interests of the community" (!!!), had been playing the National Telephone Company's game for all it was worth. If the Council had decided to sell in the full stress of unfair competition, it could have been called a logical action, but this competition is now removed. The whole business is ugly.

The *Electrical Review*, in an article this week, purports to reply to your criticisms of a fortnight ago, when you righteously took it to task for garbling your comparisons between municipal and company costs of electricity production. It talks about discussing "principles" in its usual superior fashion, but carefully leaves them alone—for what can a champion of vested interests know about principles? It drags ("bleeding from the context") a paragraph from the *Municipal Journal* into the discussion, and proceeds to talk about what, I suppose, it calls the principles involved. This is the *Review's* way of replying to *your* article. Comment is needless.

In my opinion the *Times* and those Press opponents of so-called municipal trading—though "trading" is a wrong term—who all printed the same article (misstatement of facts) supplied free to them under different names, have been shown up by Will Crooks, John Burns, and Lord Provost Chisholm. It is quite certain that the disgraceful methods of trust supporters at *Birmingham* and Tunbridge, and the statements of the irresponsible, interest-serving portion of the Press, are quite too low down for even the "wicked municipalities" to descend to.

I hope the *Electrical Engineer* will always stand for justice and truth as heretofore. There will then be "a lamp unto our feet and a light unto our path"—a good, steady electric light amid so many flickering, unsteady, and sickly glimmers.—Yours, etc., PRO BONO PUBLICO.

MOTOR.

SIR,—In reply to "Motor," in your issue of the 14th inst., I beg to state that his dynamo is able to charge the accumulators for driving motor, but this will have to be done in two lots, as an E.M.F. of 110 volts is insufficient for charging the number of cells required.

Allowing five cells in reserve for drop in voltage, he will require 55 + 5, or 60 cells altogether (each cell giving an average E.M.F. of two volts), and each containing one square foot of positive plate surface giving a discharge of eight ampere-hours; hence, total current = 55 × 8 = 440 amperes, the voltage being 55 × 2 = 110. His motor requires about 48 amperes, and would therefore run for $\frac{440}{48} = 9\frac{1}{6}$ hours with one charge.

Nothing has been allowed for loss in motor or accumulators, as this depends upon the efficiency of the motor and the type of accumulators used.—Yours, etc.,

M. GREGORY.

SIR,—To charge accumulators the dynamo must either be shunt or compound wound, preferably shunt. If compound wound, the series winding (particularly if the machine is over-compounded) should be cut out while charging. When nearly full each cell will take about 2·6 volts, therefore 40 cells may be taken as the number. On discharge the voltage may be taken as 40 × 2 = 80. The current required by the 7-h.p. motor will then be

$$\frac{7 \times 7 \times 6}{80} = 65{\cdot}2 \text{ amperes.}$$

The size of each cell must then be sufficient to carry 65 (say) amperes. More time will be taken in charging the battery than the battery will run the motor. Suppose we allow a return of 60 per cent., and that the average potential while charging is 100 volts; then

$$\frac{100}{60} \times \frac{65}{50} \times \frac{80}{100} = 1{\cdot}73;$$

that is, for every hour the motor is run by the battery the battery must be charged for about $1\frac{3}{4}$ hours.

A regulating resistance must be provided, as 110 volts will be too much at commencement of charging.—Yours, etc., M. M.

WASTED WATER POWER.

SIR,—Your account of the Cauvery power transmission set me wondering whether we are as ready to take advantage of the water power we possess or might develop as we should be. Surely the 150in. to 200in. of rainfall at places like Seathwaite, with a fall of, perhaps, 1,000ft. to sea-level, ought to give plenty of opportunities of locating power stations between the mountain summit and the sea, while many of our Welsh or Lake Country glens would pay better for storage of water than for sheep pasture if they were only dammed across. But without making these sources of power, are there not some water supplies that are already made, or being made, which might be utilised for this purpose? Take the water supply of a large town like Liverpool or Manchester or Birmingham. This in each of the above cases (and there are other similar ones) is collected at a height of at least 1,000ft. above the sea, while the towns themselves are not far from sea-level. Why should not the water supply of these towns be passed over turbines suitably placed, and made to give a return of power for the cost of its conveyance by pipes from the higher to the lower level? I cannot see that this need interfere at all with the purity of the water. Take the case of Liverpool. There have to be two or three pressure relief stations between Llanwyddyn and Liverpool. Why

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should not the relief of pressure be effected by making it do some useful work on a turbine? If a 35in. pipe with a fall of 250ft. at Cauvery produces about 2,000 h.p., surely one of these relief stations with the 40in. pipe which carries Liverpool's water ought to be good for 1,000 h.p. at least.

Again, in a smaller way, but on the whole, perhaps, mounting up to a greater total of power, is it not pitiful to see the water at our canal locks flowing uselessly down from one pound to another along the waste conduit. Take what I can see outside my gate. We have four locks in about a mile, each with a 10ft. drop. The waste water will about fill a 2ft. pipe, and it flows uselessly, as far as power is concerned, down the waste conduits almost all day long. Here is a constant stream of water at a head which varies but an inch or two, and which might surely be made capable of developing some 20 h.p. or 30 h.p. at each lock! It is true that each barge would cause an interruption of the flow for a few minutes, but barges are not *very* numerous, and for electrical purposes secondary batteries are not unknown means of equalising currents; and then think how many locks there are on all the canals in England!

No doubt there are many other sources of water power which could be found if only we could turn our eyes from the coalpit and the chimney stack, but I think I have mentioned two.—Yours, etc., R. J. ROBERTS.

Port Quay Vicarage.

ELECTRIC LIGHTING RETURNS — COMPANY v. MUNICIPAL.

For many years past we have systematically collected reports of speeches, articles, and criticisms concerning municipal affairs. In August last the *Times* commenced a series of articles on "Municipal Socialism." Other papers followed this lead—and newspaper articles and platform speeches abounded. Many of these articles and speeches discussed electrical matters—contrasting municipal *v.* company working—each controversialist selecting those incidents and figures which he deemed best fitted to prove his case. In our issue of Oct. 17 we had an article and a leader upon the subject. In its issue of Oct. 24 our contemporary, the *Electrical Review*, made bold to criticise our articles. We replied on Oct. 31, and our opponent comes once more to the charge in an article, entitled "The Ethics of Controversy," in its issue of Nov. 14 last. It is a fatal mistake to under-estimate the value of an adversary, otherwise we should merely state, what is to those who care to examine the matter an incontrovertible fact, that in no case does our critic criticise what we have put forward. He sets up a number of straw men and buffets away to his own satisfaction, making a great litter, but hurting nobody. His first article was weak, his second is weaker, and we trust that he will refrain from giving us a further chance of qualification. Instead of two electrical papers pulling together for a common object, the common good, here we are apart—and why? The reason is simple. We have principles, our critics have none; in other words, we have long since formulated the principles which guide us, but though the *Review* mentions principles, it has never expounded them. Before taking its statements for examination, let us say at once that it refrains absolutely from touching any of our pertinent statements. Thus we claim it has no answer, and that what we have said is true and unanswerable. The *Review* knows our aim is to get the truth, and there is no question of personality. Now to the consideration of the few statements which concern us:

1. "The only means of arriving at sound conclusions is to dispassionately deal with matters of controversy by a careful consideration of the *principles* involved, without reference to personal interests."—*Review*, Nov. 14, 1902.
2. "The whole matter must be dealt with on the broad principles of socialism *versus* private enterprise."—*Review*, Oct. 24, 1902.

We have asked, and we ask again, that these principles should be defined. Our contemporary must have some knowledge of these principles. What are they? As yet we have never heard two people agree upon these definitions, and it would be of immense advantage in controversy to know our critic's definition. If the critic cannot define the principles upon which he founds his criticism, what value can be placed upon his remarks?

3. "Eliminating the personal abuse which disfigures these articles [the critic is referring here not only to us, but also to the *Municipal Journal*], the controversy turns upon the broad principles [again, what are they?] of socialism *versus* private enterprise, with which we have endeavoured to deal purely on its merits [where and when?] without calling the arguments of those who differ from us 'idiotic nonsense,' or assuming that because we differ from certain local authorities in the way they keep their electric lighting accounts that we therefore accuse them of being 'liars.'—*Review*, Nov. 14, 1902.

Take the "idiotic nonsense" phrase first. Our articles of Oct. 17 did not deal with accounts generally, they dealt with specific items. The *Review* of Oct. 24 harps on accounts, accounts, accounts. What had we to do with the comparison of accounts? To say that specific items cannot be compared is not only "idiotic nonsense," it is wilfully false. Our critic did not say this, and, therefore, the phrase could not apply to him, yet as he fits on the cap, it would seem that his original intention was to argue that because accounts are not similarly kept, not only are the accounts as a whole not comparable, but specific items about which there is no dispute are not comparable. If that is his contention the phrase fits; if that is not his contention, why call it abusing the plaintiff's attorney.

4. "It is also important to remember that in *numerous* [the italic is ours] cases the auditors of municipal accounts have found *serious fault* [the italics are ours] with the system upon which they are kept. . . .—*Review*, Oct. 24, 1902.

"... the electricity accounts of local authorities are not subject to audit by the Board of Trade."—*Review*, Oct. 24, 1902.

If these extracts do not hint that municipal accounts are incorrect, and known to the authorities to be incorrect, we do not understand what inference is to be drawn, and if a writer accuses authorities of putting forth incorrect accounts, and that accusation is not dubbing them liars, what is the accusation intended to imply?

5. "Perhaps it [ourselves] will accept the report of the Croydon Corporation auditor as a guide (*re* depreciation and repayment of loan)."—*Review*, Nov. 14, 1902.

"... *the depreciation is very much greater than the amount of sinking fund*" (italicised in our contemporary, Nov. 14, 1902).

We challenged our critic to say what repayment was if not depreciation, and the above is his reply. Mark, well, he gives no opinion of his own, but merely refers us to the Croydon auditor's report. Did it not strike our critic that his quotation from the auditor gives his whole case away? The auditor's contention is not that repayment is not depreciation, but that it is insufficient depreciation—a totally different point, one worthy of discussion, no doubt, but not affecting our contention that repayment is depreciation. So far as we are concerned, we have dealt with our critic's reply to us. What is there in it? He does not controvert either our facts or our figures; he does not refer to them, but to asides which have no bearing on the point at issue.

We agree with our contemporary: "All controversies that can never end had perhaps better never begin." This particular one ought to have an end. As a matter of fact, none of the socialistic doctrines put forward are widely accepted, nor are the rabidly anti-socialistic doctrines. In both municipal and Imperial government there must be interference with the individual. No anti-socialist puts forward the doctrine that municipal authorities shall not deal with sanitary matters. In the matter of refuse destruction, is there a dozen individuals to argue

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that the authorities ought not to dispose of its clinker to the best advantage? Yet this is trading. Electrical people have *not* combated municipal activity on principle, but only from the purely selfish point of view. They and their interests suffered, and they kicked—small blame to them for so doing, especially as it is only those interested who try energetically to get rid of abuses. What is really required, then, is not the definition of socialistic principles as put forward by anti-municipalists, but the definition of the "sphere of municipal activity." Concentrate the energy of controversy upon that—agree upon a definition wide or narrow, and some good will result. Fling aside the petty squabbles about how this or that account should be kept, or the meaning of these or those figures, which can have no end, and try honestly and courageously to face and solve the greater problem.

FORTHCOMING EVENTS.

FRIDAY, NOV. 21.

North-East Coast Institution—Second general meeting at Newcastle, postponed from the 14th inst.

Institution of Junior Engineers.—At 8 p.m., opening meeting. Presidential address on "The Preparation of Engineering Projects," by Colonel Ed. Raban, C.B.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. The adjourned discussion will be resumed and concluded upon Captain C. C. Longridge's paper on "Oil Motorcars of 1902." If time permits, the following paper will be read: "Recent Practice in the Design, Construction, and Operation of Raw Cane Sugar Factories in the Hawaiian Islands," by Mr. J. N. S. Williams.

MONDAY, NOV. 24.

Society of Arts.—At 8 p.m., Cantor Lecture: "The Future of Coal Gas and Allied Illuminants," by Prof. Vivian B. Lewes. (Lecture I.).

TUESDAY, NOV. 25.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Electric Tramways," by Messrs. Charles Hopkinson, Bertram Hopkinson, and Ernest Talbot. The succeeding paper will be "High-Speed Electrical Generating Plant," by Mr. T. H. Minshall.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "High-Temperature Electro-Chemistry.—Notes on Modern Experimental and Technical Furnaces," by Messrs. R. S. Hutton and J. E. Petavel.

WEDNESDAY, NOV. 26.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Le Tunnel du Simplon, et la nouvelle ligne de Chemin de Fer directe, Anglo Italienne pour l'Orient," by Dr. Gustave Goegg, of Geneva."

Institution of Civil Engineers.—At 2 p.m., students' visit to inspect the conversion operations in progress on the South London tramways.

THURSDAY, NOV. 27.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper: "Elections," by Sir Oliver Lodge.—Students' Section, at 2.15 p.m. Visit to the works of Messrs. Siemens Bros. and Co., Woolwich.

SATURDAY, NOV. 29.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Potentiometer." by Mr. J. W. Peck, M.A.

APPOINTMENTS VACANT.

Station Superintendent, Ilford Urban District Council, £150 per annum, Dec. 1. See advertisement.

Assistant Mains Superintendent, Aberdeen Corporation Electricity Department, £2 per week, Dec. 1. See advertisement.

Designer, good experience in the calculation and construction for up-to-date transformer work. See advertisement.

Foreman Winder, to take charge of winding shop of large electrical engineering company. See advertisement.

Engineer in estimating department of large electrical manufacturing company. Knowledge of German desired. See advertisement.

Electrician and Linesman for colliery in Durham. See advertisement.

Mains Superintendent, Wimbledon Urban District Council, £120 per annum. Particulars may be obtained from Mr. H. Lee, chief electrical engineer, the Generating Station, Durnsford-road, Wimbledon, Nov. 28.

ELECTRIC RAILWAY SIGNALS.

The London and North-Western Railway have had a very perfect system of working the points from a distance by means of electric power under test at Crewe during the last three years. This is the invention of Mr. F. D. Webb (chief mechanical engineer of the line just named), Mr. A. M. Thompson (signalling superintendent), and Mr. J. A. Timmis, the patent being in the hands of the Railway Signal Company, Limited. On Wednesday, before a large company of experts, the effectiveness of the "Crewe system" appliances was demonstrated. It was found that without any apparent exertion one man is able to do the work of two, and a great saving in labour is thus effected. Except where a driver persists in running against the signals, all risk of wrong signalling is eliminated. A small lever pulled causes the points to move into position. Should anything happen to prevent them so doing the signal "danger" cannot be altered to "set clear." Until the signalman hears an answering "click," freeing his appliance, his utmost strength would not move the second handle that, communicating with the signal-post, allows the electric current to pass through, raising or lowering the indicator. The machinery is double-locked, thus forming a double safeguard against accidents.

The following description of the visit appeared in the *Times*: "On arriving at Crewe the party was divided into two parts, the larger proceeding to the chief signal cabin, which contains 152 levers. There are four other cabins, of 95, 75, 60, and 57 levers. These cabins serve the numerous sidings connected with Crewe Station, and also one of the main lines radiating from that centre. To complete the installation here five other cabins are needed, and one of these is to contain no fewer than 350 levers. The whole will then, it is said, constitute the largest power installation of this nature in the world. The hand levers by which the points and signals are controlled are placed in the cabin, and by pulling them over a circuit is completed which will convey power to the motor by which the semaphore arm is moved, or the end of the rails, which constitute the points, are pulled over. The motor may be an electric motor of the usual type on an electromagnet. In either case the machine is placed close to the work. If its points have to be moved, the motor is placed in an iron box sunk in the ground close to the line. The electromagnet operates directly, the current energising the magnet and pulling the points to the required position. This is the simplest and should be the least costly method, and during the trials it worked satisfactorily. The rotating motor also performed excellently. It is worked by a current of 20 amperes at 100 volts, and runs at a speed of about 800 revolutions per minute. The armature is on a shaft, which runs in ball bearings, and which drives a worm and worm wheel. The latter is loose on a cross shaft, but the rotary motion is communicated to the cross shaft by means of right and left handed clutches. In this way the points can be moved to the closed or open position by means of suitable attachments. When the point is moved over and secured, a striking gear disengages the clutch, and the motor runs free.

"For operating signals the electromagnet is used. As more power is needed to move the signal arm than is required to hold it in position, an ingenious device has been introduced by which a stronger current is applied for the short time the movement goes on, after which the demand on the current is reduced. It is necessary for purposes of safety that the signal should automatically go to the danger position should any mishap occur to the electric apparatus. The devices which are necessary to satisfy safety in working form a most important part of the system, but it would not be possible to make such details plain without elaborate descriptions aided by diagrams. Generally, it may be stated that in working a point the lever in the cabin is pulled over a part of its full travel and this makes connection, so that a current passes to the electric motor, which then pulls the point over. The lever is held in the partially-over position until it is released by electrical means due to the point's being safely home. The operator is then able to pull his lever to the right position, and there is certain evidence that the apparatus has worked and the signal can be placed at safety. The system affords saving in labour, two men only being employed in the 152-lever cabin, and there is less obstruction on the ground, as the wires can be placed beneath the surface in place of heavy rods being above ground. The working is more rapidly done by the manual system, and power can be conveyed practically any distance.

A contract has been let to the "Hall" Signal Company, of Broadway, New York, for the fixing of their system of automatic signals on a section of the North-Eastern Railway main line between York and Thirsk. There will be 84 signal arms. All the posts will have two arms, applicable to the next stop signal. Each of the sections will be 1,200 yards in length. A novel feature of the installation will be the means used for operating the signals. Until quite recently, under the "Hall" system, the semaphore signal was worked by an electric motor, but now carbonic acid has been adopted as the motive power, and it is this form of signal which will be used on the North-Eastern Railway. The gas is contained in a cylinder at a pressure of 600lb. per square inch (reduced to a 50lb. working pressure), whilst the valves for admitting the air to the operating cylinder are controlled electrically. This class of signal has apparently now got beyond the experimental stage; in fact, we are informed that there are at present several thousands in operation in America, where, we are told, it is found that a fully-charged cylinder contains sufficient power for operating a signal more than 10,000 times, whilst the cost of maintenance is considerably reduced.

For the electric automatic signalling it is claimed that it presents the "block" system in perfection by supplanting human intelligence by exact mechanism, whilst in addition to reducing the wages bill—by the abolition of intermediate boxes—it increases the carrying capacity of a railway by enabling the sections to be shortened without the expense of erecting and "manning" signal boxes.

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TRADE NOTICES AND NOVELTIES.

Sheet-Steel Gear Cases, etc.

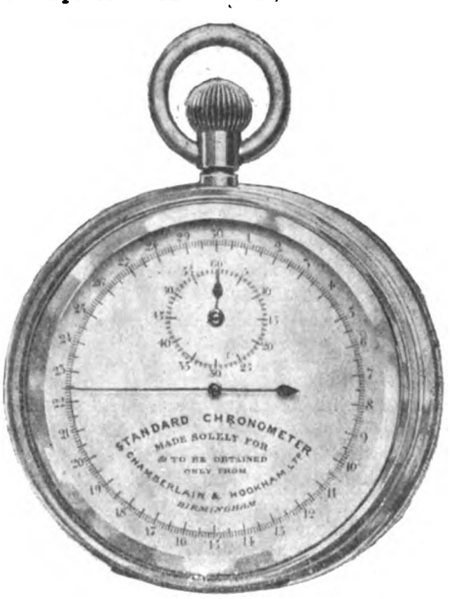
From Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, London, E.C., we have received a copy of their new catalogue of gear wheels, pinions for electric tramcars and sheet-steel gear cases, etc. As regards the gear wheels and pinions, their durability, superior quality, and low price are the points to which special attention is called, the process of manufacture whereby these several advantages are ensured being briefly referred to. A page is devoted to the merits of the firm's recently introduced sheet-steel gear cases. This form of case, we are told, is made of sheet steel approximately $\frac{1}{8}$in. thick. The top and bottom halves are made in one piece, pressed to shape, without seams or joints. The two halves are bolted together in the usual way, and the joint between the halves can be made either butt, as with cast gear cases, or lapped. The latter method is recommended, as it is then possible to run the gear entirely in an oil bath without any danger of the oil leaking or getting on the motor. The case is only one-quarter to one-third the weight of the corresponding cast gear case; it is thus easier to handle, and gives a substantial saving in the power bill, as the weight of each car is reduced by 2 cwt. The sheet-steel case can be made for any size or type of motor, has been thoroughly tried and found successful, we are told, and, in addition to the other advantages enumerated, has a long life at a low price. No attendant disadvantages occur to us, and we should, therefore, say that the popularity of the sheet-steel case is ensured.

Falk Cast-Welded Rail Joints.

Messrs. Robert W. Blackwell and Co., Limited, have also sent us an illustrated leaflet describing the Falk process of cast-welding rail joints, which has already been fully detailed in these columns. Some interesting testimonials to the value of the process, as shown by the performance of 7,000 joints welded by the above firm at Coventry and Norwich, are included. Writing on behalf of the New General Traction Company, Limited, Mr. I. E. Winslow says that out of approximately 7,000 joints cast-welded less than one-tenth of 1 per cent. have failed. Further he remarks: "We have noticed practically no trace of any movement on the part of the rail. In one case, at a curve of sharp radius, there appears in extremes of temperature to be a movement somewhere in the neighbourhood of $\frac{1}{2}$in.; at another joint, where the line passes over a short bridge with a sharp gradient on each side, there appears to have been a vertical movement of about $\frac{1}{16}$in.; but these are the only two instances which have been noticed. The rail laid was a very light one (only 65lb. to the yard), the reduction in weight being accomplished chiefly by a reduction in the web and base, but no trouble seems to have been experienced from this. The line is as solid and smooth riding as any track with a rail of 100lb. to the yard which has come under our notice. The rail was laid with steel cross sleepers every 10ft., and to these sleepers the rail was securely fastened, the sleepers being bedded in the concrete. We consider this sufficient anchorage at frequent intervals as absolutely essential to the success of the welded track. There are, of course, a number of points which on any fresh work we may undertake we shall do somewhat differently—that is, we should not again weld any points or crossings, not that these have given any specific trouble, but we do not think that the extra expense is justified. We also should not weld any curves of under 50ft. radius, as these curves wear much more rapidly than the straight track and require to be replaced oftener, and to do so with a welded joint is a matter of difficulty and expense. In fact, this difficulty of renewing occasional rails renders it necessary that rails of high carbon and considerable hardness be used, and that great care be taken to see that the hardness is as even as possible, which, in effect, means reducing the amount of variation of carbon and silicon in the rail somewhat below the usual variations allowed. Taken as a whole, we consider the welding process a distinct success, and trust to be able to utilise it in future construction work." Another of the testimonials is signed by the manager of the Coventry Electric Tramways Company, Mr. T. R Whitehead, who in the course of his remarks on the behaviour of 1,700 joints cast-welded in 1898 says: "We have not had a single casting break, and in only three instances have the rails shown signs of being free in the castings. This is noticeable by joints having opened about $\frac{1}{4}$in. The cause of this may have been that the metal was too cold when poured into the moulds to fuse the surface of the rail, thus not making a good weld. The cast-welding of the joints practically makes one continuous rail over the entire length of track welded, and the absence of 'hogged' joints makes a very smooth and easy-running road, and obviates the trouble and expense which occurs through the ordinary fish-plated rail 'sagging' at the joints, in addition to materially reducing the wear and tear on the rolling-stock. We may say that we have had some doubts as to the effect the heat of the molten metal would have on the temper of the rail, as it was considered this might have a tendency to soften the ends of the rail and cause excessive wear, but from our experience during the last three years such has not been the case, the wear at the joints not being greater than the rest of the head of the rail. No bonds are used across the joints, but between each pair of rails one 4/0 cross bond is fixed 200ft. apart. We find that the conductivity of the track with the welded joints is quite equal to other portions of our track that is fish-plated, with two 4/0 bonds to each joint." Equally favourable to the Falk process of cast-welding rail joints is a testimonial signed by Mr. Alan N. Banister, engineer and manager of the Norwich Electric Tramways Company. We understand that Messrs. Robert W. Blackwell and Co. are prepared to undertake to cast-weld the joints of any tramway, guaranteeing that the cost of making the joints will be less than that of fishplates and bonding.

Testing Chronograph.

We illustrate herewith a chronograph which has been introduced by Messrs. Chamberlain and Hookham, Limited, Solar Works, New Bartholomew-street, Birmingham, to facilitate the testing of electricity meters for accuracy, on the assumption that the simplest test is obtained by multiplying the number of amperes passing through the meter by the number of seconds (or fraction of a second) occupied by one revolution of the armature. Suppose, for instance, that the constant number of the meter is 5·14. Now, if 10 amperes passing through this meter cause one complete revolution of the armature in ·514 second, the meter will be recognised as correctly standardised, because 10 amperes × ·514 = 5·14, which is the constant



Front View of Testing Chronograph.

number; but if the constant obtained were greater, the meter would be proved to be slow, and if less, to be fast. By experience, however, Messrs. Chamberlain and Hookham have found that this test, simple and accurate as it is, is frequently falsified by the unreliability of the seconds hand of the watch used for timing. They have, therefore, made the special chronograph illustrated, which has a stop action, is easily read, and claimed to maintain its reliability for many years. One revolution of the large hand records 30 seconds, each second being divided into tenths; the small dial records each complete revolution of the seconds hand up to 120, or 60 minutes in all. The method of working is as follows: the first pressure on the button starts the seconds hand from zero; the second pressure on the button stops it; the next pressure on the button starts it again from where it had been stopped, when it runs on to zero, stopping there automatically. This cycle of movements can then be recommenced.

Ship's Side-Light Indicator and Controller.

We have received from the General Electric Company, Limited, Queen Victoria street, London, E.C., a copy of their illustrated leaflet No. L 1.019, which describes a patent ship's side-light indicator and controller, claimed to be a reliable automatic device, which not only shows the condition of the lights to which it may be attached, but substitutes a reserve light in the event of a lamp failing. This device, we are told, when applied to ships' running lights, is installed in a water-tight case in the pilot house or on the bridge (the latter principally on yachts). Each lamp station is fitted with two lamps of 32 c.p., or more, and three wires are run from each lamp station to the indicator. Under the indicator is placed a switch and cut-out for each station. When the switches are turned on one lamp at the station lights up, and the respective shutter on the indicator shows the word "Burning." This leaves the other

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lamp at the station in reserve. If for any reason the first lamp gives out, or shows a reduced candle-power, the indicating shutter for this station will show the word "Out." The reserve lamp is then automatically brought into circuit, and is indicated by the ringing of the alarm bell for this station, and the tell-tale lamp over the indicator lights up. The alarm bell is stopped by switching off the tell-tale lamp, or by replacing the faulty lamp at the station. In case of the current being completely shut off, the large alarm bell in the indicator is brought into circuit and continues ringing until current is on, and the word "Out" appears on each shutter. A number of ship fittings are illustrated in the same leaflet.

Ampere-Hour Meter.

From the British Thomson-Houston Company, Limited, Rugby, we have received a copy of their illustrated pamphlet No. 134, which supersedes No. 116 issued in January last. This pamphlet describes the firm's type O.K. ampere-hour meter constructed for use on two and three wire continuous-current circuits only, and for capacities of 15 amperes and under. We are told that the meter has been duly approved by the Board of Trade, and that its temperature coefficient is such that its accuracy is practically unaffected by the ordinary variations of temperature.

MANCHESTER.

We are indebted to the *Manchester Guardian* for the following interesting account of the municipal electricity undertaking: The application for the original electric lighting order granted to the city by the Board of Trade dates back to 1890 and the second to 1896, the first sanction of the Board of Trade being dated June 17, 1892 This scheme was for a loan of £80,000, repayable over 25 years. Following upon this application, however, are 10 others, promoted in quick succession and in conjunction with the various authorities in Greater Manchester, including Levenshulme, Moss Side, Withington, Droylsden, Heaton Norris, Audenshaw, and Denton. They are as follow: October, 1893, £70.000; May, 1895, £100,000; August, 1896, £100,000; August, 1897, £125.458; March, 1898, £15,053; September, 1899, £181.610; November, 1899, £22,000; August, 1900, £189,890; June, 1901, £810,110; and March, 1902, £477,000; making a total amount of loans sanctioned of £2,171,121. In addition to these a further amount of £75.000 was asked for in the last Manchester Corporation Bill. Contemporary with these loans, electric lighting orders were granted to outside districts, with power to transfer them to the Manchester Corporation. These were: Levenshulme, 21 years from August, 1897; Moss Side, from August, 1897, for 15 years; Withington, April, 1898, for 13 years; Droylsden March, 1899, for 21 years; Heaton Norris, September, 1899, for 21 years; Audenshaw, September, 1899, for 21 years; and Denton, March, 1901, also for 21 years. After the dates named, the various authorities may, on giving notice, take over such of the undertaking as lies within their districts, but in the meantime the responsibility for supplying current for electric lighting over these districts, roughly estimated at 22 square miles, devolves upon the electricity department of Manchester. For some years, indeed, the Manchester undertaking made the largest municipal electric supply outside of London; and though for the present its lamp connections are exceeded by those of Glasgow and Edinburgh, and its output of current and extent of capital outlay by that of Liverpool, it is more than likely that in a couple of years, when the vast enterprise has been completed, the city will again take the foremost place. In Manchester the development of the business has been retarded by many causes, not the least of which has been the difficulty of maintaining a generating capacity at all proportionate to the demand for current. For a considerable period—in fact, until the starting of the Bloom-street works—current had to be denied to hundreds if not thousands of would-be customers. So late as 1901 the Electricity Committee had to refuse 60,000 8-c.p. lamp connections because the plant was not available to produce the requisite current. They therefore had to look ahead in the matter of successive contracts and order such machinery as would enable them to deal with the supplies required to the end of 1904. In fact, the last of the machines placed on order is not expected to be running until March of that year.

To meet the great demand over such a large area, extraordinary efforts have been made by the department, for it is to be remembered that side by side with the current for lighting purposes the needs of the tramways department have had to be provided for. The capital expenditure on land, works, railways, battery stations, sub-stations, cables, meters, instruments, stores, and the consulting engineer's remuneration had up to March 31, 1902, amounted to £1,164,307, of which £301,014 was laid out in the year 1901-2. Some idea of the relative cost of the individual parts of the work will be gathered from the following figures:

Capital Account up to March 31, 1902.	£	s.	d.
Dickinson-street	238.698	18	1
Bloom-street	145,115	9	0
Stuart-street	50,965	10	6
Stuart-street railway	9,731	11	1
Hunt's Bank battery station	6,634	1	9
Sub-stations in Manchester	16,138	2	10
Ditto Chorlton	171	16	6
Ditto Didsbury	2,698	4	0
Ditto Whalley Range	568	15	0
Sub-stations in Withington	£461	1	8
Ditto Moss Side	3,573	15	6
Ditto Levenshulme	3,674	0	8
Ditto Heaton Norris	1,289	10	1
Ditto Denton	1,361	0	8
Cables	596,055	15	7
Meters	42,446	10	4
Instruments	4,822	9	9
Polygon stores	29 362	0	6
Cottage property (for further sub-stations)	3,401	14	2
Office furniture	2,136	16	0
Consulting engineer's remuneration	5,000	0	0
Total	£1,164,307	3	8

Analysed in another way, the figures show that in capital expenditure the generating stations have cost £449,511; the distributing stations, £39,972; cable stores, £29,362; mains, £596,055; meters, £42,446; instruments, £4,822; and office furniture, £2,136.

Compared with other large municipal undertakings, the following figures are interesting as showing Manchester's present position:

Town.	No. of lamps.	Units sold.	Load in kw.	Capital expenditure.
Liverpool	361,980	20,018,142	9,431	£1,187.622
Glasgow	491,306	9,282.043	7,950	962.727
Edinburgh	465.125	7,760,307	6,007	765,612
Manchester	414,115	10,502,299	9,140	1,164,307

The large number of units sold by Liverpool as compared with the number of lamp connections is accounted for by the tramway demand, the whole scheme of which has been completed. The figures of Edinburgh are particularly interesting. It will be seen from the accompanying table that two factors have combined to bring about the profit of £10,295 on an undertaking which supplies an area only one-sixth of that catered for by the Manchester Corporation. These are, first, the gradual increase in the number of customers owing to their familiarity with the advantages of electric lighting; and, significantly enough, the drop in the price of current from 3·01d. to 2·96d. to private consumers, with a corresponding increase to public consumers, leaving the combined price as before.

Results of the Edinburgh Undertaking.

Year.	Average price charged — Private. d.	Public. d.	Combined. d.	Gross profit. £	£
1895-6	5·38	1·80	4·07	9,267	2,447*
1896-7	4·45	1·72	3·46	16,815	7,424*
1897-8	3·50	1·47	2·91	20,647	7,024*
1898-9	2·99	1·33	2·57	23,730	5,886*
1899-0	2·90	1·26	2 54	30,972	3,674*
1900-1	3·01	1·13	2·67	35,788	2,690†
1901-2	2·96	1·25	2·67	52,054	10,295*
				£189,273	£34,060*

* Surplus. † Deficit

The latest figures for the Manchester district show that in 1901-2 the number of consumers was 4.030, the number of lamps in use 414,115, and the number of motors 774. The supply to a section of the tramways was started in June, 1901, and on the present records this class of business is only accountable for 19 per cent. of the output, as against 81 per cent. for general supply. But on the load factor its good influence is already traceable. By slight economies in all but one of the items the expenditure has been reduced by ·12d. per unit sold, and this in spite of the higher prices of coal. The last year's working has, too, been beneficial in Manchester by raising the charges per unit by ¼d. This produced an additional revenue of £11,500, and it assured a balance of £7,635 on the right side, or more than double that of the next previous year. During the eight years of the existence of the Manchester undertaking it has contributed £52,964 in relief of the city rates, has redeemed £92,857 of its original loan capital, and has built up a reserve fund of £16,341.

The city's electrical undertaking is the second highest of municipal undertakings in capital expenditure, in the load in kilowatts, and in the number of units sold. The city will probably head the figures when the tramway system has been completed. It is estimated that the tramways alone will then require a force of 19,000,000 units per annum. The capital expenditure must necessarily increase in proportion owing to the large area of supply and the system that has had to be adopted to overcome the difficulties connected with long-distance supplies. This has necessitated the erection of no fewer than 19 sub-stations. It may be stated that within six months from the present time, according to the original estimate, the Tramways Committee will have 638 cars running, and by the end of next year, allowing for the routes yet to be opened and cross routes, 119 more, or 757 in all. The Electricity Committee are now well abreast of these and other needs.

NEW COMMITTEES.

The following new committees have been appointed:

Ashton. — *Electricity* — The Mayor; Aldermen Grime, Shaw, and Siddall; Councillors Andrew, Barlow (chairman), Barrett, Boardman, Bradley, Catlow, Hall, Kelsall, Newton (deputy-chairman), Oldham, Phillips, and Yoxall. *Tramways*—The Mayor; Aldermen Grime, Hilton, and Siddall; Councillors Andrew (chairman), Barlow, Boardman, Bradley, Hall, Hallam, Newton, Oldham (deputy-chairman), Wilson (Gloucester-place), and Yoxall.

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BACUP.—*Lighting*—Alderman Astley, chairman; Alderman Law, vice-chairman.

BARNSLEY.—*Electricity and Lighting*—Councillor Brady, chairman; Aldermen Wilkinson and Wray; Councillors Atkinson, Charlesworth, Cotterill, Kenworthy, Rideal, Walker, and Wells.

BARROW.—*Electricity*—Aldermen Bradshaw, Lee, Little, and Towuson; Councillors Ashburner, Cox, Hardy, Hewetson, Mawson, Palmer, Postlethwaite, Smith, Tootill, Taylor, and Townsend.

BATTERSEA.—*Lighting*—Messrs. Borgars, Clist, Edwards, Mason, Oswald, Rines, J. Rogers, Tough, Hall, Hale, Fawcett, and Dr. Richards.

BIRMINGHAM.—*Tramways*—Alderman Beale, chairman.

BOLTON.—*Electricity*—The Mayor; Alderman T. E. Smith; and Councillors W. Cooper, Fielding, Golding, Panton (chairman), Preston, Rothwell, Marshall, J. P. Taylor, Duxbury, and Berry (vice-chairman). *Tramways*—The Mayor, Aldermen Harwood (vice-chairman), Nicholson, and T. E. Smith (chairman), and Councillors Battle, P. Higson, Panton, Preston, Wild (Deane) Witter, Fletcher, Horner, Maginnis, and Waddington.

BRADFORD.—*Tramways*—Chairman, Mr. James Hill; vice-chairman, Alderman Enoch Priestley.

COVENTRY.—*Electric Light*—The Mayor; Aldermen Booth and Hill; Councillors Bethell, Errington, Gardner, Goate, Hewitt, Liggins, McGowran, Rainbow, Slaughter, Statham, Webster, and West.

EASTBOURNE.—*Electric Light*—Chairman, Councillor Maude; deputy-chairman, Councillor Simmons.

GLOUCESTER.—*Electricity Supply*—The Mayor (ex-officio); the Sheriff; the Ex-Mayor; Aldermen Blinkhorn, Fielding, Hardman, and Sessions; and Councillors Karn, Clutterbuck, J. Clarke, Goddard, Holbrook, Poole, Brown, Fream, and Johnston-Vaughan. Proposed chairman, Alderman Fielding. *Tramways*—The Mayor (ex-officio); the Sheriff; the Ex-Mayor; the Deputy-Mayor; Aldermen Fielding and Hardman; and Councillors Karn, Peters, J Clarke, C. G. Clark, Reardon, Holbrook, Poole, Evans, Birchall, Fream, and Matthews. Proposed chairman, the Ex-Mayor, Councillor Bland.

GOVAN.—*Electricity*—Convener, Mr. Wightman; sub-convener, Mr. J. T. Buchanan.

GUILDFORD.—*Lighting*—The Mayor; Alderman Briggs; Councillors J. Baker, Hart, Brown, and Hughes.

HALIFAX.—*Tramways and Electricity*—Mr. T. Hey, chairman; Alderman Baldwin, vice-chairman; Aldermen Tyson, Walsh, Booth, and Crossland; and Messrs J. Whitaker, A. Crabtree, Fawcett, R. Maude, Oates, Stansfield, G. C. Alderman, J. W. Clark, and H. C. Starr.

HARROGATE—*Lighting*—Mr. W. Davidson, chairman.

HEREFORD.—*Electric Lighting*—Aldermen Beddoe, Clarke, and Llanwarne; Councillors Gethen, Hewitt, Humfrys, Landford, and Prosser.

HULL.—*Electric Lighting*—Chairman Mr. J. T. Skinner; deputy-chairman, Mr. W. G. Millington, J.P. *Telephones*—Chairman, Mr. J. Brown; deputy-chairman, Alderman F. Larard.

KING'S LYNN.—*Electricity*—The Mayor; Aldermen T. Pattrick and Savage; Councillors Dexter, Gemmell, Jermyn, Nicholls, J. T. Savage, F. W. Savage, W. Savage, and Thomas.

LANCASTER.—*Electricity*—The Mayor; Alderman Smith; Councillors Heald, Huntington, Oglethorpe, Threlfall, Dixon, Cardwell, Seward, Wright, Bell, and Bland. *Tramways*—The Mayor; the ex-Mayor; Aldermen Smith, Bell, Huntingdon, and Preston; Councillors Wilson, Allen, Heald, Threlfall, Towers, Langstreth, Thompson, Seward, and Wilkinson.

LEICESTER.—*Gas and Electric Lighting*—Councillor Edwards, chairman; Councillor Jennings, vice-chairman. *Tramways* Councillor Flint, chairman; Alderman Smith, vice-chairman.

LIVERPOOL.—*Tramways*—Alderman C. Petrie, chairman; Alderman F. Smith, deputy-chairman. *Electric Lighting*—Mr. S. W. Higginbottom, M.P., chairman; Mr. Dart, deputy-chairman.

LOWESTOFT.—*Electric Lighting*—Aldermen Johnson and Adams; Councillors Brooke, A. B. Capps, R. B. Capps, Fry, Mayhew, Orde, Shadforth, Smith. *Tramways*—Aldermen Beckett, Eastaugh, Mobbs, Notley, Stebbings, Adams; Councillors Brooke, A. B. Capps, R. B. Capps, Fry, Jackman, Jefferies, Jones, Mayhew, Orde, Rice, Smith, Spashett, Titcomb.

MACCLESFIELD.—*Lighting*—The Mayor; Councillors Davenport, Heath, Hordern, Whitmore, Marshall, Mellor, Harrison, Isherwood, and Wilson.

NORWICH.—*Tramways*—Aldermen Bagshaw, G. M. Chamberlain, Cunnell, Green, Hackblock, White, M.P., and Wild; Councillors Havers, Moore, and Tillett.

OBAN.—*Lighting*—Provost Cooper; Councillors Robertson, Campbell, M'Isaac, and Vass. Councillor Robertson, convener; Provost Cooper to be convener *ad interim*.

PORTSMOUTH.—*Electric Lighting*—Aldermen Corke, Ellis, and Power; Councillors Foster, Pink, Bolitho, Corner, Sprigings, Baldwin, Wolfe, Stobie, Gill, Vernon-Inkpen, H. R. Pink, Merritt, Main, and Freeman. *Tramways*—Aldermen Corke, Scott Foster, and Power; Councillors Kimber, Stevenson, Amatt, Emmett, Gillett, Dittman, Young, Curtiss, Carpenter, H. R. Pink, Merritt, Fulljames, Dummer, and Foster. *Telephone*—Aldermen Jenkins, Scott Foster, and Allen; Councillors Dittman, H. R. Pink, Edmonds, Bolitho, Corner, Gillett, Coffin, Aylwin, Curtiss, Carpenter, Ash, Malvany, Porter, and Dummer.

ROTHERHAM.—*Electric Light and Tramways*—Aldermen Winter and Gummer; Messrs. Cox, Fieldsend, Reeves, Taylor, Bryant, Copley, Hirst, and Beckett.

SALFORD.—*Electricity*—The Mayor; the ex-Mayor; Aldermen Shaw and Walmsley; Councillors Barrett, Barker, Carter, Hale, Hill, Hodgson, G. H. Jones, Leach, McDougall, Sackville, Wheatcroft, and Wilkinson. *Tramways*—The Mayor; the ex-Mayor; Aldermen Jenkins, Linsley, and Ollier; Councillors Barnes, Barrett, Hodgson, Hopwood, Hudson, Hulton, G. H. Jones, Kay, Muir, Robinson, and Worsley.

SOUTHAMPTON.—*Electricity*—The Mayor; Aldermen Bone, Button, Emanuel, and Dunsford; Messrs. Bayford, Bicker-Caarten, Blakeway, Emanuel Lewis, Tebbutt, Willey, and Wright. *Tramways*—The Mayor; Sheriff; Aldermen Andrews, Bone, Dunsford, Filling, and Button; Senior Bailiff Hutchens; Messrs. Bastick, Bicker-Caarten, Hancock, Line, and Willey.

SOUTHEND.—*Light Railways and Electric Lighting*—Aldermen Brightwell, Ingram, and Tolhurst; Councillors Barker, Norman, Roberts, Robertson, Hubbard, and Berry.

STOCKPORT.—*Tramways*—Alderman G. Atherton, J.P., chairman.

TAUNTON.—*Electric Lighting*—Aldermen Potter (chairman), Goodland, Lock, and Perkins; Councillors Lewis, Norman, Sibley, Van Trump, and Webb. *Tramways*—Alderman Potter, chairman; Councillors Lewis, Norman, Sibley, Westlake, Price, Spiller, and Vile

WAKEFIELD—*Electric Lighting*—Councillor Childe, chairman; Councillor Cookson, deputy-chairman; the Mayor; Aldermen Atkinson, Bolton, and Kilner; Councillors Cooling, Cradock, Firth, Hargrave, Judge, Lowrie, Nurse, Rhodes, Saville, and Young.

WIGAN.—*Electric Light and Tramways*—Chairman, the Mayor; vice-chairman, Mr. Thos Fyans: the ex-Mayor; Messrs. Thomas Ashton, Joseph Ballard, Joseph Thomas Gee, James Hilton, Robert Layland, William Layland, William Lowe, James Paxton, Robert Richards, Samuel Taylor, Samuel Wood, Thomas Clarke, sen.

WORKINGTON.—*Electric Lighting*—Messrs. M'Aleer, Walls, Milburn, Dodgson, Holmes, Duffield, M'Mullen, Harding, Kennaugh, Walker, and Yeowart.

WORTHING.—*Electricity*—Alderman Piper; Councillors Major Frazer, Geo. Gravett, Nockells, Ovenden, Raffety, Tate, and Walter.

YORK.—*Electric Lighting*—The Lord Mayor; Aldermen Purnell, A. Jones; Councillors Scott, Lund, Lambert, Wright, Fenwick, Mansfield, Moody, Todd, Sampson, Meyer, Richardson, Anderson.

FAREHAM ELECTRICITY ACCOUNTS.

From the accounts of the Fareham electricity department for the year ended March 31, 1902, it appears that the total expenditure on capital account amounts to £11,560. Abstracts of the revenue account, general balance-sheet, etc., are appended.

Dr. REVENUE ACCOUNT.	£	s.	d.
Coal or other fuel	247	9	2
Oil, waste, water, and engine-room stores	61	8	6
Wages at generating station	214	12	11
Repairs and maintenance of buildings and plant	106	8	3
Repairs and renewals of mains	17	17	11
Attending and repairs to public lamps	20	5	9
Renewals of lamps	37	2	11
Rents, rates, and taxes	44	17	1
Salaries—engineers' department	146	13	4
Salaries or commissions of collectors	23	6	1
Stationery and printing	4	1	8
Special charges—insurances, etc.	39	3	9
Total expenditure	963	7	4
Balance carried to net revenue account	136	13	3
	£1,100	0	7

Cr.	£	s.	d.
Sale of current per meter, at 7d. per B.T.U.	1,054	18	1
Rental of meters and other apparatus	31	15	8
Returned income tax	12	10	4
Charging accumulators	0	16	6
	£1,100	0	7

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	11,544	7	3
Amount charged to general district rate	628	9	4
Amount due to treasurer	16	3	11
	£12,189	0	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	11,560	11	2
Stores on hand	17	10	0
Balance at debit of net revenue account	610	19	4
	£12,189	0	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		88,690
Quantity sold: Public lamps	34,726	72,950
Quantity sold: Private consumers by meter	38,224	
Quantity used on works		3,632
Total quantity accounted for		76,582
Quantity not accounted for		12,108
Total maximum supply demanded (kilowatts)		65

Number of public lamps: 27 arc, 104 incandescent.

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LEGAL INTELLIGENCE.

THE FERRANTI ELECTRICITY METER.
Alleged Infringement.

This week the Court of Appeal, composed of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, heard the case of De Ferranti *v.* the British Thomson-Houston Company, Limited, in which the plaintiff, Mr. S. Z. de Ferranti, of the firm of Ferranti and Co., Limited, appealed from a judgment of Mr. Justice Swinfen Eady in the Chancery Division giving judgment for the defendants, the British Thomson-Houston Company.

The action was brought by the plaintiff for an injunction to restrain the alleged infringement of letters patent No. 701 of 1887, and for damages. The term of the patent expired shortly after the issue of the writ, and the action was treated as one for damages only. The defence was a denial of the infringement, and a plea that the patent was invalid. The patent in question related to improvements in electrical meters. Previous to the year 1887 the plaintiff had invented an electrical meter in which the current to be measured was made to pass through a bath of mercury in a magnetic field so disposed that the mercury was put into a continuous rotary movement by the passing of the current, the movement of the mercury being recorded by means of a float or disc with recording mechanism. That improvement was designed for use with a continuous current and with a solid magnet of cast iron, the residual magnetism of cast iron serving to assist in causing rotation of the mercury, and was sufficient to enable the meter to start with only a small number of lamps in use. In order to adopt the meter for use with an alternating current it was necessary to employ pole-pieces which did not retain residual magnetism, and plaintiff substituted laminated iron for solid cast-iron magnets. Then, in order to effect the object previously attained by the residual magnetism and so enable the meter to start and register correctly with a low load, the plaintiff in 1887 achieved this result by employing an additional coil of an insulated conductor, which would act as an electromagnet, and thus compensate for the loss of the residual magnetism arising from the abandonment of solid cast-iron magnets. This invention formed the subject of the letters patent of 1887. The infringement alleged was in the defendants having in an energy or wattmeter added a coil on their shunt circuit for the purpose of increasing the magnetic field. Mr. Justice Swinfen Eady held that the application of an additional shunt coil to a Thomson-Houston meter did not constitute an infringement of the plaintiff's patent, and dismissed the action, with costs. Hence the present appeal of the plaintiff.

Mr. Cripps, K.C., in support of the appeal, said the question to be decided was a comparatively short one—namely, whether or no the addition of a coil to the defendants' meter constituted an infringement of the plaintiff's patent. The learned counsel said that the action was a very important one, because if the plaintiff succeeded, he could prove that his invention had been adopted in probably every successful electricity meter in use. At a matter of fact, plaintiff's was the pioneer invention in making these meters commercially practicable

Mr. Moulton, K.C., for the defence, argued that there had been no infringement of the plaintiff's patent, and asked the Court to uphold the decision of the learned judge below.

The arguments of counsel did not conclude until Wednesday afternoon, when the Court reserved judgment.

CLAIM FOR ELECTRICAL WORK.

In the Westminster County Court on Wednesday his Honour Judge Woodfall disposed of the case of Alcock *v.* Deliannis, in which the plaintiff, an electrical engineer, sued the defendant to recover a balance of account in respect of work done to his order.

The defendant's case was that he simply gave the order for the fixing-up of seven electric lamps at an agreed charge, and he refused to pay any extras.

His Honour said he thought the plaintiff was entitled to his money, and gave judgment for the amount claimed, with costs.

ALLEGED TAMPERING WITH AN ELECTRICITY METER.

Before the Barnsley magistrates on Monday, Mr. J. W. Binner was charged with having tampered with the index of an electricity meter, the property of the Barnsley Corporation, so as to cause the meter to register unjustly.

Mr. Horsfield, for the prosecution, said the meter was supplied to defendant for the purpose of measuring the current supplied to a motor, and the case against him was that this meter had been forcibly altered, the intention, as alleged, being to defraud the Corporation.

A **Clerk** in the employ of the Corporation said the meter was properly sealed on Aug. 4 last, and on Sept. 30 it registered 468 units; and another witness said that on Nov. 3 he examined the meter and found the seal broken. The meter registered 456 units, having actually gone back.

Mr. S. E. Bastow, electrical engineer to the Corporation, said he had recently tested the meter which defendant had used. The bare running of the motor was sufficient to cause the meter to go forward. It was an absolute impossibility for the meter to go bac ward, but it was possible, after breaking the seal, for a person to get his finger to the hands and force them back. Defendant's consumption averaged about 100 units quarterly, but on the last quarter's reading the Corporation owed Binner a matter of about 4½d.

The **Defendant** denied that he had ever tampered with the meter.

The **Bench** held that the case was one of very extreme suspicion, which the Corporation were amply justified in bringing before the Court. At the same time there was an element of doubt, and this being a criminal case in which defendant was charged with fraud, they would dismiss it.

SMOKE NUISANCE.

The Electricity Committee of the Stockport Corporation were summoned before the local bench on Friday last for smoke nuisance said to have been committed on Sept. 16.

Inspector Billingham said that on April 30, between the hours of 2.15 and 4.15 p m., he took a smoke observation of the electricity works chimney in Millgate. This showed 31 minutes black smoke, 65 moderate, and 24 none. A second observation taken on Sept. 16 showed 8 minutes black smoke, 103 moderate, and 9 none.

Mr. Dobson, who appeared for the committee, said there had been a great improvement since the alleged offence. As a matter of fact ever since April they had been at work trying to abate the nuisance. On April 28 £1,200 was spent in condensers, but these were not yet completed. They were fixing in two additional boilers, and also making enquiries about mechanical stokers, and using a great deal more coke.

An order was made to abate the nuisance within six months.

COMPANIES' MEETINGS AND REPORTS.

WEST INDIA AND PANAMA TELEGRAPH.

The ordinary meeting of the directors of this Company was held on Wednesday at Winchester House, E.C.

Mr. W. B. Kingsford presided, and, in moving the adoption of the report, said the receipts for the half-year showed a small decrease of £175, being £28,970, as against £29,145 for the corresponding period. On the other hand, the expenses exhibited a slight increase—£22,399, as compared with £21,277. There was an available total of £13,166, out of which the directors recommended the payment of 6s. per share on account of arrears of dividend on the preference shares. This absorbed £10,369, leaving £2,797 to be carried forward. Having regard to disasters abroad and litigation at home, he thought the accounts might fairly be considered not unsatisfactory.

In reply to a shareholder, the **Chairman** stated that the Board would take into consideration the suggestion of a conference between the various West India cable companies with a view to determining the advisability of a closer union between them.

The report was adopted.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The half-yearly general meeting of this Company was held at River Plate House, Finsbury-circus, on Wednesday, Sir J. Wolfe Barry presiding.

The **Chairman**, in moving the adoption of the report (which appeared in our last issue), stated that the gross revenue showed a decrease on that of the corresponding period of 1901 of £52,000. He regretted to have to announce this decrease, but it was owing to causes entirely beyond the control of the directors or the Company, and it was attributable very much to the great depreciation of trade in our Australian Colonies. The serious loss on exchange consequent on the great depreciation in silver was also largely responsible for the decreased revenue. He hoped that the Company would get rid of the loss on exchange, or at least greatly mitigate it in future. The other important matter that had pressed upon them was the considerable reductions which they had made in their tariffs. He had no doubt, however, that some of these reductions would in course of time result in an increase in the volume of traffic. The Company lost by the reduction in their tariffs £26,000 last year. The Australian tariff had been reduced during the last three years from 4s. 9d. to to 3s. a word, but, notwithstanding this, the actual traffic transmitted now was practically the same as when the higher tariff was in force—a fact which refuted the confident statement made by their critics that reductions in tariff invariably recouped themselves very quickly. The working and other expenses in the half-year had been £121,000, showing an increase of £5,456 over those of the corresponding period of 1901. This advance was almost entirely accounted for by the opening of the new stations in connection with their direct Cape-Australian cable and by the general growth of expenditure. The net profit for the half-year was £148,500, out of which the usual interim dividends had been paid, and £73,500 was carried forward. Since the close of the half-year the Netherlands Government had arranged with the Company to supply and lay on their account a submarine cable between the islands of Borneo and Celebes, about 700 miles. Referring to the Pacific cable, he said it was expected to be opened within about a fortnight or three weeks. The tariff between this country and Australia by the new route would be the same as by the Company's—3s. a word. Of course, when the new cable was opened competition with the Company's system for the traffic between Australia and Europe would at once begin. They were not very glad to have this competition, and, honestly, he did not think that Australia would gain anything by it, but the directors did not look at the competition with any serious amount of alarm, because they felt pretty certain that the Company could offer to the public far greater facilities, and undoubtedly much greater certainty in the transmission of the messages, with their vast network of cables and their various routes, compared with the Pacific Cable Board's one single line, which had been laid with what was called "a swing" from point to point of a length at present almost without a parallel. They, however, could not help noticing that, almost for

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the first time, the British and the Colonial Governments had taken what was, from some points of view, a regrettable step in entering into competition with private enterprise, and in the present case the competition was with a company to which, he thought, everyone must admit the credit was due of connecting Great Britain with all her colonies and dependencies in every centre of trade. They asked now from all these Governments "fair play and no favour," and they asked this not least of all from his Majesty's Government. The meeting in London of the International Telegraph Conference, which had been postponed, had now been definitely fixed to take place on May 26 next, when all matters connected with the well-being and intercommunication of cables would be dealt with exhaustively, with the advantage of the advice of people from every part of the globe. He had nothing to add to what he had said at other public meetings with reference to the question of wireless telegraphy; all that he had previously said held good. They looked with interest upon what was being done, and they thought that the system would to a certain extent be useful to them, but they did not look on wireless telegraphy seriously as a competitor.

The **Marquis of Tweeddale** seconded the motion, which was unanimously adopted.

BRITISH ALUMINIUM.

A general meeting of the debenture holders in this Company was held on the 13th inst. for the purpose of considering, and, if thought fit, passing a resolution assenting to certain proposed modifications of the rights of the stockholders against the Company and its property, and certain modifications of the trust deed dated Nov. 30, 1899, proposed by the Company, and sanctioned by the trustees, for submission to the stockholders, and of empowering the trustees to concur with the Company in executing a supplemental trust deed in the terms of the draft submitted to the meeting.

Mr. J. D. Bonner, who presided, said the proposal before the meeting was the only one which could give any prospect of enabling the Company to attain a sound position within a reasonable time. The directors regretted having to solicit temporary accommodation for the Company from the debenture holders. The development of the aluminium industry in this country had proceeded very much more slowly than was anticipated would be the case when the British Aluminium Company was established. Since changes had been effected in the constitution of the Board and the management of the Company there had been a very marked improvement in the sales of aluminium, which would this year be nearly 40 per cent. greater than those of last year, and the directors had every reason to hope that the improvement would not be merely permanent, but progressive. Their relations, however, with other aluminium producers might not enable them to retain the full advantage of that great improvement in business. Another cause which had contributed to the Company's present position was the large amount of capital they had locked up in the water-power scheme, in connection with which nearly £30,000 had been expended by the Company during the last two years. To relieve the Company the directors, after consulting the trustees, decided to ask the debenture holders to agree to the postponement of all interest, including that now due on the debenture stock, until Nov. 1, 1903, and to authorise the trustees, in their discretion, to consent to postpone the payment of interest for a further additional period of one year, for which deferred interest warrants would be issued; to empower the Company to raise £10,000 upon the security of all or any of the assets of the Company, and in priority to the existing debenture stock, to the reduction of which £50 out of the sale of each ton of aluminium now deposited in the warehouse would be applied; and that after the period of postponement of interest had expired, and the postponed interest had been paid, 25 per cent. of the net profits of the Company in each year and available for dividend on the share capital should be applied towards the redemption or purchase of debenture stock, and stock so redeemed be cancelled without power of re-issue. In conclusion, the Chairman moved a resolution for the purpose of carrying out the modifications referred to.

Mr. Crewdson seconded the motion, which, after discussion, was carried with two dissentients.

DAIMLER MOTOR.

The report of the directors for the year ended Sept. 30, 1902, states that the accounts show a loss of £19,751. This loss is attributable to four causes: (1) rearrangement and reorganisation of the shops and stores with a view to more economical production; (2) loss on the sale and in the value of cars of the old type and of stock for such cars, which had been accumulated in former years; (3) cost of designing and manufacturing new types of cars; (4) increased cost of management and establishment. Sales show about the same result as in the previous year. More orders for cars were received than in any previous year, and at the close of the year there were in hand orders from customers for 84 cars, the net value of which was £62,000, or three times as much as on Sept. 30, 1901. This is, in a great measure, due to the high merits of the new types of cars which are now being manufactured, and is a proof of the wisdom of the policy adopted by the Board.

ELECTROLYTIC ALKALI.

The adjourned annual meeting of this Company was held on the 13th inst. at Middlewich to take a poll for the election of directors. Mr. J. H. Calvert was nominated against Mr. A. C. Fletcher, the retiring director. A poll resulted in 186,170 votes being recorded for Mr. Calvert against 66,460 for Mr. Fletcher, and Mr. Calvert was declared elected.

NEW COMPANIES REGISTERED.

Kitto Automobile Company, Limited. — Capital, £6,000. Objects: to acquire from W. H. Kitto the business of a motorcar and cycle builder, etc.

Elswick Motor and Accessories, Limited.—Capital, £500. Objects: to carry on the business of manufacturers of cycles, motors, carriages, and accessories, etc.

Power and Industrial Undertakings, Limited. — Capital, £10,000. Objects: to carry on the business of promoters, financiers, guarantors, agents, etc. No initial public issue. The first directors are not named.

Silent Motorcar Syndicate, Limited. — Capital, £3,000. Objects: to adopt an agreement with Gearings, Limited, F. W. Dunlap, M. Crawford, and H. Brooks, and to carry on the business of engineers, electricians, cycle, motor, mechanically-propelled vehicle and engine builders, etc.

The Irish Motor Company, Limited.—Capital, £2,000. Objects: the establishing, acquiring, and carrying on in the United Kingdom the business of manufacturers and dealers in all sorts of cycles and motors, and to acquire by purchase the business of John R. Evans, 12, South Avenue-street, Dublin.

Llangollen and District Electric Light and Power Company, Limited.—Capital, £6 000. Objects: to contract with the Urban District Council of Llangollen for the execution and maintenance of any works for the purpose of supplying electricity under the electric light provisional order obtained by the said Council.

Electromobile Company, Limited.—Capital, £50,000. Objects: to adopt an agreement with the Brush Electromobile Company, Limited, with the Gloucester Railway Carriage and Wagon Company, Limited, with Greenwood and Batley, T. G. Chambers, with T. H. Weguelin and E. Schenk, and to carry on business as motorcar manufacturers and machinists, etc.

Whitchurch and Pangbourne Electric Supply Company, Limited.—Capital, £10,000. Objects: to acquire from F. J. Ferguson and other necessary parties (if any) a lease of Whitchurch Mill, with water power and yard belonging thereto, and to carry on at Whitchurch, Oxon, and Pangbourne, Berks, the business of an electric supply company in all its branches.

Hindhead and District Electric Light Company, Limited.—Capital, £15,000. Objects: to acquire the business carried on by J. Grover at Hindhead, Surrey, and the undertaking authorised by the Hindhead and District Electric Lighting Order, 1902, and to carry on the business of suppliers of electric light, heat, sound, and power, electricians, electrical and general engineers, etc.

Electrical Treatment Association, Limited.—Capital, £2,000. Objects: to acquire the goodwill of a system for treating diseases by electricity, to treat persons medically by electrical method, to adopt an agreement with W. N. Brough, E. E. Bartlett, and C. W. Cox, and to carry on the business of manufacturers of and dealers in electrical appliances for medical and other purposes, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Swansea.—The Corporation invite tenders for the supply of electric motors and starting switches for a period of 12 months. Tenders by Dec. 1. See advertisement.

Bristol.—The Electrical Committee invite tenders (from boiler makers only) for water-tube boilers and accessories. Tenders by Dec. 11. See advertisement.

Lowestoft.—The Corporation invite tenders for overhead line equipment, poles, etc., and underground feeder cables, etc. Tenders by Nov. 26. See advertisement.

Aberdeen.—The Tramway Committee invite tenders for one electrically-driven tower wagon for overhead equipment repairs. Tenders by Nov. 25. See advertisement.

Hull.—The Corporation invite tenders for the erection of a car-shed, 340ft. by 47ft., on the Hedon-road. Particulars may be obtained at the City Engineer's Office. Tenders by Nov. 28.

Heckmondwike.—The Urban District Council invite tenders for supply and erection of a water-tube boiler and accessories at their electricity works. Tenders by 24th inst. See advertisement.

Bulawayo (Rhodesia).—The Municipal Council invite tenders for the establishment and working of an electric tramway system for that municipality. Tenders by Feb. 26. 1903. See advertisement.

Sunderland.—The Corporation invite tenders for one steam-driven three-phase generator, motor-generators, and static transformers, and high and low tension switchboards. Tenders by Nov. 28. See advertisement.

Eastbourne.—The Corporation invite tenders for motor-omnibuses to accommodate not less than 16 passengers. Particulars can be obtained from Mr. H. W. Fovargue, town clerk, Town Hall, Eastbourne. Tenders by Nov. 29.

Erith.—The Electric Lighting and Tramways Committee invite tenders for the wiring and supply of fittings for a complete installation of electric light at the Council offices and Council chamber. Tenders by Nov. 26. See advertisement.

Warrington.—The Cheshire Lines Committee invite tenders for telegraph materials, etc., for the year 1903. Particulars can be obtained from Mr. S. Saxon Barton, storekeeper, Cheshire Lines, Warrington. Tenders by 10 a.m. on 28th inst.

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Bexley.—The Electric Lighting and Traction Committee invite tenders for car-shed buildings and steelwork. Specification, etc., may be seen at the Public Hall, Bexleyheath, and obtained at the offices of the Engineers, 82, Victoria-street, S W. Tenders by Dec. 8.

Caen (Calvados, France).—The Prefect at this place requires tenders for the concession and working of a light railway between Trouville and Honfleur, a distance of about 10 miles, for goods and passenger traffic. Electric traction preferred. Tenders by Jan. 1, 1903.

Sidmouth.—The Urban District Council invite tenders from electrical engineers and others for the lease for a period of 42 years of a provisional order for the supply of electricity for lighting, heating, and power throughout their district. Tenders by Dec. 20. See advertisement.

Pontypridd.—The Urban District Council invite tenders for tramways permanent way, traveller, and storage battery. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on 22nd inst.

Manchester.—The Trafford Park Estates Company, Limited, invite tenders for permanent way, roadmaking, draining, etc., overhead equipment, and steel poles, etc. Specification, etc., can be obtained from Messrs Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Dec. 13.

La Valette.—The Municipality invite tenders for the establishment and working for 99 years of a tramway between La Valette and Senglea Cospiena, Vettoriosa and Casal Zebbug. Deposit £300. Tenders by Nov. 25 to Wm. Casolani, receiver-general and director of contracts, La Valette. Plans and particulars will be ready by March 1, 1903.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for motor-generators, combined change-over and equalising switches, starting motors, and transformers, combined boosting sets, combined balancing sets, and air-compressors, batteries of accumulators, and hand travelling cranes. Tenders by Nov. 24. See advertisement.

Glasgow.—The Caledonian Railway Company invite tenders for telegraph appliances, telephones, etc., electric lighting material and fittings, indiarubber and asbestos goods, etc., for 12 months from Jan. 21, 1903. Specifications, etc., may be obtained from Mr. Jas. Lorimer, stores superintendent, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Tenders by Nov. 24.

Dumfries (Scotland).—The Town Council invite tenders from companies as follows—viz.: (1) for the burgh's electric light provisional order, and alternately (2) for light and traction combined; (3) for a supply of electricity to drive the cars, if the Council resolve to conduct the traction; (4) if the Council construct the works, tenders for a lease of each. Tenders by Dec. 1. See advertisement.

Clacton.—The Urban District Council invite tenders for the supply and erection of boiler-house plant, two Economic boilers with fittings and accessories, steam and exhaust piping, two high-speed engines, two 100-kw. dynamos, balancer and boosters, switchboard, street work, underground cables, switch pillars, etc., accumulators, travelling crane, and rails. Tenders by Dec. 22. See advertisement.

Dublin.—The Dublin United Tramways Company invite tenders for the supply of general stores, including car fittings, iron, steel, castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, timber, etc., during year ending Dec. 31, 1903. Forms of tender (price 2s. each), etc., can be obtained at the Secretary's Office, 9, Upper Sackville-street, Dublin. Tenders by Dec. 8.

Finchley, N.—The Urban District Council invite tenders for three water-tube boilers; two steam balancing sets, spare armature, and travelling crane; two storage batteries and accessories; and feeders, distributing mains, service cable, street-lighting leads, etc. Specifications, etc., may be obtained at the office of the electrical engineer to the Council, Mr. E. Calvert, Broadway, Finchley. Tenders by noon on 28th inst.

Mansfield.—The Corporation invite tenders for the complete wiring and equipment of their electricity works for power, light, and bells. Specification, etc., may be inspected and obtained at the office of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Corporation, 64, Victoria-street, London, S.W., or at the office of Mr. E. Holcombe Hewlett, clerk of the works, at the Electricity Works, Mansfield. Tenders by Dec. 1.

Manchester.—The Electricity Committee invite tenders for the whole of the work required in connection with the supply, testing, delivery, and erection of power and distributing circuits, complete, and a system of arc and incandescent lighting at Stuart-street generating station and 10 sub-stations. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by 10 a.m. on Nov. 25.

Blackburn.—The Town Council invite tenders for two Lancashire boilers, with mechanical stokers, etc., six superheaters, one battery of economisers, two feed pumps, etc., three ejector condensers, a complete system of pipework, tanks, valves, and accessories, and a coal and ash conveying elevating plant. Specifications, etc., may be obtained from the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Nov. 24.

Durban (Natal).—Tenders are invited for the following in connection with the new municipal telephone system: a complete exchange equipment for an ultimate capacity of 7,200 lines, the present contract to make immediate provision for 2,520 lines. The equipment comprises all distribution and switchroom boards, power plant, and wiring. The contract also includes the work of erection in Durban and maintenance for three months; and underground dry-core air-space cables, comprising approximately 15,000ft. 200 pair, 12,000ft. 150 pair, 25,000ft. 100 pair, 6,000ft. 75 pair, 7,000ft. 50 pair, 12,000ft. 25 pair. Tenders by Dec. 5. See advertisement.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tientsin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

RESULTS OF TENDERS.

Belfast.—The Town Council have accepted the tender of Chamberlain and Hookham for the supply of electricity meters.

Sheffield.—The British Schuckert Electric Company, Limited, Strand, W.C., has received an order for 50 electricity meters from the Corporation

Newcastle.—The Corporation have accepted the tender of V. Coates and Co., Belfast, for the supply and erection of one 3,000-h.p. high-pressure engine, at £13,200.

Dewsbury.—The Infirmary Board have accepted the tender of D. Firth and Sons, Manchester, for the supply of fittings in connection with the electric lighting of the infirmary.

Woolwich.—The Western Electric Company have accepted the tender of Messrs. Grover and Son for the first portion of new cable factory at North Woolwich, subject to reduction, at £18,402.

Bloemfontein.—Messrs. Crompton and Co., Limited, have secured the contract for two 200-kw. three-phase alternators coupled to Bellias engines, and 100 incandescent fittings and pillars for street lighting, from the Corporation through Messrs. Davies and Soper.

Mersey Railway.—Messrs. Rowland Carr and Co., of 6 and 8, Lime-street-square, E.C, have secured the contract from the British Westinghouse Company for the supply of the steel cable ducts required by them in connection with their Mersey Railway contract..

Wellingborough.—The Urban District Council have accepted the tender of Hughes and Lancaster, Albany-buildings, 47, Victoria-street, Westminster, S.W., for supply and installation of Shone's pneumatic ejectors with Hughes and Lancaster's electrically-driven air compressors, at £712.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board have accepted the following tenders for (Contract No. 6, Section A) Lancashire boilers, (B) economisers, (C) surface condenser, and pumps, etc., (D) steam, feed, blow-off, and drain pipes, etc., and (E) travelling crane: (Section A) Tinker, Shenton, and Co., Limited, Hyde; (C and D) Sir Hiram Maxim Electrical and Engineering Company, Limited, 65-67, Gracechurch-street, London, E.C.; (E) Higginbottom and Mannock, Limited, Crown Ironworks, Hyde-road, West Gorton, Manchester. Section B has not yet been decided.

Maidenhead.—For wiring the guildhall for electric light, for the Corporation:

	Surface work.	Concealed work.
G. J. Gray	£259 8 0	£279 14 0
Simmons Bros., Limited	220 0 0	236 0 0
Ber yn and Sillem	200 0 0	200 0 0
G. Wastow and Co.	174 0 0	228 0 0
Gülich and M'Intyre	217 0 0	220 0 0
National Electric Wiring Company	193 0 0	213 0 0
A. H. Wood	188 0 0	192 14 0
Bakewell and Co.	173 0 0	189 15 0
Sunderland Forge Company	174 0 0	184 0 0
Empire Electrical Company	163 0 0	183 0 0
Tamplin and Co.	157 8 0	182 8 0
Mossop and Co.	167 8 10	180 8 10
Fiford and Estall	149 10 0	179 8 0
R. J. Whitmarsh	150 0 0	178 0 0
Statter and Co.	150 0 0	175 0 0
F. Pollard	139 0 0	170 0 0
Electrical Installation Company	185 16 3	169 2 0
W. H. Lane and Co.	140 0 0	169 0 0
H. J. Godfrey	157 0 0	168 0 0
Baxton and Impey	144 0 0	156 0 0
Bayfield and Co.	152 15 0	155 17 6
Coleby and Co.	148 15 0	155 10 0
Dawson and Co., Limited	130 0 0	140 0 0
W. M. Penrose	125 0 0	155 0 0
Bourne End Electrical Installation Company	150 0 0	155 0 0
Kilburn Electrical Engineering Company	150 0 0	155 0 0
Cathcart and Son	145 0 0	155 0 0
C. C. McCarthy	128 0 0	136 0 0
Screel, Cooper, and Co.	122 13 0	132 10 0
Northern Electrical Engineering Company	125 10 0	136 0 0
Lea and Warren	118 0 0	130 0 0
Hill, Upton, and Co.	121 0 0	128 0 0
T. Clark and Co.	115 10 0	127 0 0
G. E Whiteman	108 7 4	118 18 7
Baughan and Co.	94 15 0	105 0 0
H. Quartermain	93 0 0	98 0 0
F. J. Bloomfield	74 0 0	85 10 0
W. H. Arundell	70 9 0	70 9 0

Note.—The lowest tender is recommended for acceptance.

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BUSINESS NOTES.

TRACTION.

Barnsley.—The first day's receipts from the tram service amounted to £120.

Dover.—It is proposed to double the tramway line in St. John's-road and also in High-street.

Huddersfield.—The Corporation are experimenting with an electric tramcar having a covered-in top.

Higham Ferrers.—The British Electric Traction Company are extending their tramways into this district.

Hebburn.—The Northern Counties Electricity Supply Company are prepared to consider a local tramway scheme.

Cork.—The tramway employés here went out on strike on Sunday in consequence of several union men having been dismissed.

Ilford.—Mr. Gilbert R. Spurr, assistant electrical engineer to the Urban District Council, has been appointed tramway manager.

Swinton.—A provisional order is to be applied for to enable the conversion of the Bolton-road and Station-road tramways to be carried out.

Brighton.—The Corporation have resolved, by 21 votes to 15, to promote a Bill in Parliament for powers to extend the electric tramway system.

Macclesfield.—A syndicate is intending to apply next session for parliamentary powers to construct an electric tramway system in this district.

Ashton.—The engineer has been instructed to prepare specification and quantities for the construction of the Manchester-road section of the tramways.

Southport.—The Corporation are advised that the running of trams by the company on Sundays is a breach of the agreement, and action will be taken accordingly.

Ormesby.—The Imperial Tramways Company intend to apply next session for powers to extend their electric car system to the Ormesby and South Bank districts.

St. Helens.—At the last meeting of the committee it was stated that at March 31 last the balance to the credit of the tramways revenue account was £3,273. 9s. 2d.

Mexborough.—A syndicate is arranging to take over the share capital and control of the company incorporated under the Mexborough and Swinton Tramways Act, 1902

Great Eastern Railway.—It is stated that in the next session of Parliament the Great Eastern Railway Company will seek powers to work their railways by electricity.

Hitchin and Leighton Light Railway.—The promoters of this scheme have come to terms with the Bedfordshire County Council with regard to level crossings, etc.

Perth.—A special meeting of the Town Council in committee on Saturday agreed to the provisional order it is proposed to apply for as to the working of the tramways.

Ince.—The District Council have agreed to an extension of the period in which the South Lancashire Tramways Company can construct the tramways in the township.

East Sussex.—The County Council have appointed a committee to consider the proposal of the British Electric Traction Company for a tramway between Hove and Worthing.

Rochester.—The City Council have given the necessary statutory notice of a proposed application to Parliament next year for powers to construct electric tramways in the city.

Poole.—The Poole and District Electric Traction Company give notice of an intended application to Parliament next year for powers to lay down new tramways in the district.

West Ham.—The Town Council have decided to proceed with their Bill in Parliament next session to widen High-street, Plaistow, and to extend the tramways in the borough.

Coseley.—It was stated at the last District Council meeting that the British Electric Traction Company intend to reconstruct the tramways at Princes End for electric traction.

Dewsbury, Batley, and Birstal Tramways.—Statutory notice is given of an intended application to Parliament next session for powers to lay down and work the above tramways.

Wellingborough.—A Bill will be promoted in the ensuing session of Parliament by the British Electric Traction Company to authorise the construction of tramways in this district.

Hove.—The Town Council at their last meeting adopted the recommendation of the committee to proceed with the tramways scheme, particulars of which were given in our last issue.

Norwich.—The Norwich Electric Tramways Company have, with the approval of the Council, appointed Mr. George Moore Chamberlin, of Norwich, to be one of the directors of the company.

Ilkeston.—It was stated at the last Town Council meeting that there was a prospect of the electric power company being able to supply current for the tramways by the end of the year.

Mid-Yorks.—A syndicate has given notice of an intended application next session for powers to construct a system of tramways in Mid-Yorks, around Keighley, Bradford, Bingley, Shipley, etc.

Exeter.—A memorial pointing out that South-street, Holloway-street, and district is totally unprovided for in the new tramway scheme has been referred to the Electric Traction Committee.

Colchester.—The Corporation have made application to the Board of Trade for their consent to the tramways authorised by the tramways order of last year being constructed on a gauge of 3ft. 6in. instead of 4ft. 8½in.

Weston-super-Mare.—In the new by-laws adopted by the Corporation it is provided that "the driver of every car shall so drive that it shall not follow a preceding car at a less distance than 20 yards."

Cardiff.—The Corporation have given notice of their intention to apply to the Board of Trade for a provisional order empowering them to construct and work additional tramways, both in the borough and in the outskirts.

German Motor Cabs.—The motor cabs which have been plying for hire in the streets of German towns for the last three years have been finally withdrawn, it having been shown that they entail a loss to their proprietors.

Southall.—The District Council are making representations to the London United Tramways Company to improve the tram service to Southall, which, it is stated, at present does not exceed a dozen cars to and from per day.

Beckenham.—The Urban District Council have declined to support the British Electric Traction Company in their intended application to Parliament next session for powers to construct a tramway from Penge to Beckenham.

Halifax.—The Corporation give notice in the *London Gazette* for the 11th inst. of an intended application to the Board of Trade for a provisional order to authorise the construction in the borough of four new lines of tramways.

Greenwich.—The Borough Council have refused to contribute towards the cost (£13,500) of the necessary street widenings involved in the London County Council's scheme for a tramway from Deptford to the Herbert Hospital.

Wakefield.—Application will be made in the ensuing session of Parliament for powers to construct electric tramways between Wakefield and Dewsbury (with a branch to Ossett). Messrs. Pritchard, Green, and Co. are the engineers.

Ripon.—After an interview between the Corporation Highways Committee and the representatives of the Power and Traction Company it has been decided to postpone the question of tramways for Ripon until the spring of next year.

Sunderland.—The tramway receipts for the past financial year have amounted to £37,285, as against £34,481 in 1901—an increase of £2,803—while the mileage has increased by 73,025 and the number of passengers carried by 509,175.

Chelsea.—The Borough Council have accepted the offer of the Underground Electric Railways Company to pay the Council £500 to be relieved from making the necessary additions and alterations to the house on the Council's new wharf.

Broughty Ferry.—It is understood that another company will in all probability take up the scheme for a tramway to Broughty Ferry, the negotiations between the present promoters and the Dundee Corporation having broken down.

Edinburgh.—The Town Council have refused to sanction the applications for authority to construct tramways from Musselburgh to Joppa and from Queensferry-street to Queensferry. This refusal is merely to preserve the status of the Council.

Aberdeen.—The Tramways Committee held a meeting on Tuesday for consideration of the draft of the proposed provisional order for extended powers to lay down additional tramway routes in the city. After discussion the draft was unanimously approved.

York.—At the City Council meeting on Monday it was officially recognised that the electrification of the tramways was a growing necessity. It will be recalled that the tramways company are proposing to apply for powers to convert their lines for electric traction.

London United Tramways.—The Company give notice of an intended application to Parliament in the 1903 session for powers to acquire property and carry out extensive street-widening works in connection with their tramway proposals in Middlesex and Surrey.

Alexandra Park.—The Light Railway Commissioners have granted an order to the Middlesex County Council to construct lines of light railways in this park—one from the Muswell-hill (Hornsey) gate, and another from the Wood Green gate to the entrances of the palace.

Metropolitan District Railway.—This Company have given notice of their intention to promote in the ensuing session a Bill to confer on them further powers in connection with the electrification of their system, including the construction of new lines, subways, sidings, etc.

Eccles.—The Manchester Southern Tramways Company have approached the Eccles Corporation with the view of obtaining consent to construct a line from Eccles Town Hall to Barton Bridge, to connect with the system which will run through Stretford and Sale to Wilmslow.

Stainland.—It is rumoured in this district that the Huddersfield Corporation officials have been viewing the roads from Outlane to Stainland with a view to bringing the trams to Stainland. This it is considered locally would be a great boon to the people who work in the Huddersfield district.

Staines.—The Highways Committee of the Surrey County Council have requested the Parliamentary Committee to oppose any Bill introduced into Parliament for the construction of the proposed Staines and Egham light railway, unless provision is made therein for a footway on the south side of Egham-causeway.

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Concert.—On Wednesday evening last week a very successful variety entertainment was given at the central hall by the members of the London United Tramways Club and Institute in aid of the funds of the Acton Cottage Hospital.

Lancaster.—The first car made a successful trial run over the complete length of tramway track now laid down on Saturday night, the 15th inst. The track and overhead line worked very smoothly, and we understand the trip gave every satisfaction to the borough electrical engineer, Mr. Wm. A. Tester.

West Sussex.—At to-day's meeting of the County Council a report will be submitted by the Tramways Committee recommending support of the application of the British Electric Traction Company's Bill for the construction of a tramway between Hove and Worthing, with a probable extension to Littlehampton.

Twickenham.—The London United Tramways Company have acquired all the properties in Twickenham required under the company's Act of 1900 for road and street widening purposes, and also the properties which were to be acquired in pursuance of the various agreements entered into between the Council and the company.

Swansea.—At a meeting of the Swansea Corporation Tramways Committee on Tuesday it was reported that 19 members had accepted the invitation to visit Paris to view a surface-contact system of electric traction in operation. The Tramways Committee decided to decline the offer of the Schuckert Company to visit Nuremburg.

Horsforth.—It was decided at the last monthly meeting of the District Council that application be made for a provisional order for the construction of tramways within the urban district of Horsforth. It was also decided to make application to the Board of Trade for a provisional order for public and private lighting purposes.

The Proposed Electric Post.—Signor Pisicelli reached London on Tuesday to arrange, if possible, with the authorities at the General Post Office for the construction of an experimental line in London for the dispatch of letters by means of his electric post invention. It is stated that the officials of St. Martin's-le-Grand are disposed to grant the required facilities.

Croydon.—As an evidence of the popularity of electric trams, it is stated that during the present year the Croydon Electric Traction Company have carried no fewer than 10 million passengers, equal to 71 times the entire population of the borough. An application to Parliament next session for powers to lay down additional lines in the borough has been decided upon.

Hastings.—At a meeting of the Town Council on Friday an intimation was received from Mr. W. M. Murphy, the tramway promoter, which shows that it is his intention to promote in the next session of Parliament a Bill to enable him to construct tramways on the front line of Hastings and St. Leonards, and also through London-road, St. Leonards, to Silverhill.

Preston.—The Tramways Committee have had under consideration numerous applications for the position of resident electrical engineer, and at the next meeting of the Council the appointment will be made. As soon as the position has been filled a commencement will be made towards carrying out the scheme for electric tramways in Preston. The estimate for the scheme is £200,000.

Dudley.—With reference to the approaching reconstruction of the tramway from Birmingham to Dudley by the Midland Tramways Company the Town Council have made it conditional that the company shall widen the road where necessary, that the tracks have concreted beds, that Leicestershire setts be used, and that the trolley poles be at the side instead of in the centre of the road.

Proposed Autocar Track.—A dispatch from New York says that the Amateur Automobile Association has taken up General Miles's plan for a Transcontinental highway across the United States *via* the Lake Cities toward Chicago, and thence over the old overland route to the Pacific coast. The Amateur Automobile Association will introduce a Bill to Congress to promote the enterprise.

Torquay.—With a view of ascertaining the opinion of burgesses in reference to the proposed electric tramways, the Town Council have undertaken a postcard *plebiscité*. In a poll of 4,938 a majority of 472 has declared for tramways. There is, however, a majority of 3,647 against the Corporation undertaking the work, and a majority in favour of negotiations being opened with a company.

Stockport.—An agreement has been entered into between the Corporations of Stockport and Hyde and the Bredbury and Romiley Urban District Council and the Oldham, Ashton, and Hyde Electric Tramways, Limited, as to mutual running powers over tramways in Hyde and Bredbury, whereby the Corporation of Stockport are granted running powers over tramways situate without the borough.

Convention.—At Loughborough Town Hall on Tuesday the first annual convention of the British Electric Associated Companies was held, and was attended by a large number of members. During the afternoon the assembly visited the Falcon Works of the Electrical Engineering Company. Mr. E. Garcke, managing director of the British Electric Traction Company, presided at the convention.

Collision.—On Saturday morning a tramcar collision occurred at the top of Market-street, Newcastle. By some means not explained the points refused to work properly at the junction of Market-street and Grainger-street, the consequence being that the Osborne-road car and the Scotswood-road car collided. The footboard of the first-named tram was smashed, and the vehicle had to be sent to the sheds.

Electric Railways in Hants.—Engineers and surveyors are now engaged in making the necessary surveys for a light railway from Totton to Stone Point, on the banks of the Solent. It is understood the railway, which will be worked by electricity, will be projected by the London and South-Western Railway Company, and will branch off from the London to Bournemouth line at Totton, 4½ miles from Southampton.

Heckmondwike.—The District Council and the British Electric Traction Company having failed to come to terms on all points relative to the proposed agreement for the supply of electrical energy by the Council for tramway purposes, the Council have empowered the Law and Parliamentary Committee to proceed to arbitration before the Board of Trade.

Automobile Record.—On Dourdon-road on Monday, M. Augieres, says Dalziel's Paris correspondent, with a French motor-car covered a kilometre in 29 seconds. This beats by one-fifth of a second the record established by M. Fournier on Nov. 6. An English automobile was on the ground, but on account of some slight damage sustained during the conveyance of the car from England, its driver made no attempt to lower the record.

Kilmarnock.—At the last meeting of the Town Council a lengthened discussion took place regarding electric lighting and traction. The Council having already acquired powers for lighting, the Electric Committee recommended that an application should now be made for powers under the Tramways Act so that the two schemes might be put into operation concurrently. An amendment was, however, carried that the matter be delayed for further consideration.

Burton.—The specifications for the sixth tramway contract, together with drawings of a car, were approved at the last Town Council meeting, subject to the car being Dick, Kerr, and Co.'s Nottingham car design, with a suggestion to the engineers that its width should be 5ft. 6in. instead of 6ft. 6in. Tenders are to be invited for the supply of cars. Application is to be made in the next session for powers to lay down several new lines of tramways in the borough.

Dewsbury.—The differences between the British Electric Traction Company and the Corporation have been settled, an agreement, said to be satisfactory to each party, having been arrived at on Saturday. The company are to be supplied with energy for the running of cars on an agreement extending over 28 years, subject to revision at the end of 21 years, and they are to pay for extra land required near the Anchor Inn, Dewsbury, and to make a perfectly safe curve in the descent from Webster Hill.

Rumoured American Purchase.—The *Westminster Gazette* states that a leading English railway company, having ramifications in the North of England and the Midlands, with headquarters in London, has been approached by the representatives of an American syndicate who are desirous of purchasing the property. It is added that these gentlemen have made an offer for the system, and that negotiations are in progress. It is further stated that if the deal is effected the railway will be electrified throughout.

Glasgow.—Last week the Corporation tramways ran 262,277 car miles, carried 3,457,177 passengers, and drew in fares £12,673. 9s. 7d., as against 242,113 car miles, 2,845,276 passengers, and £10,446. 7s. 5d. for the corresponding week of last year. Since June 1 the revenue has amounted to £294,762. 13s. 1d., as compared with £306,207. 19s. 9d. for the corresponding period of last year, the decrease of £11,445. 6s. 8d. being more than accounted for by the abnormal traffic of the preceding summer during the international exhibition.

Isle of Man.—Mr. Ernest Shenck, of London, has completed the purchase of the tramway to Ramsey and Snaefell by paying into Parr's Bank in Douglas £201,800, the balance of the purchase price of £252,000. Of this amount £65,000 go to the liquidator of Dumbell's Bank in respect of debentures held by the bank, and will enable the payment shortly to the bank depositors of 2s. in the pound, making up to the present a dividend of 7s. 6d. Another £100,000 will be paid to the tramway debenture-holders within 14 days.

Motor Omnibuses.—It is stated that a large order for motor omnibuses for the London Motor Omnibus Syndicate is now in course of fulfilment at Stirling's Motor Works, Granton, near Edinburgh. They are being built in accordance with the requirements of the Chief Commissioner of Police, and will be geared so that the drivers cannot exceed a speed of 14 miles an hour. One of the routes on which they will be employed is indicated by the words "Oxford-circus to Cricklewood," which appear on the first that has been completed.

Walsall.—The Bloxwich tramway extensions are completed, and the inspection by the Board of Trade officers is only awaited to commence the new services. The specification of the electrical engineer for the proposed electric cars has been approved, and tenders are to be invited for the 28 cars required. The Tramways Committee have inspected the model of the Wilson and Bennett patent automatic life-guard, and the town clerk has been instructed to obtain an estimate for the supply of such guards to the 28 cars proposed to be ordered.

Yarmouth.—On Thursday last week a meeting of the Town Council in committee was held to receive counsel's opinion as to the validity of the town clerk's decision in regard to the vote upon the proposed scheme of tramway extension, mentioned in our last issue. The point was submitted to counsel as to whether the fact of the minority abstaining from voting affected the result; and the opinion was to the effect that two-thirds of the Council must be present and vote. The result is that the town clerk's ruling is upheld, and the scheme drops.

Wolverhampton.—The British Electric Traction Company's tram service in Willenhall on the section of route between the Old Bank and the Board schools on the Walsall-road was withdrawn at the end of last week. It is stated that the number of passengers the trams had carried between the points named did not warrant the company running on that portion of the route at present. It is thought that the service will not be recommenced until a through passage can be made by the trams to Darlaston, although probably on Saturdays only the cars may run.

Batley.—A special meeting of the Town Council was convened for yesterday afternoon for the purpose of ratifying an agreement with the British Electric Traction Company for a lease of the tramways within the borough. All the details were finally approved by the

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sub-committee last Friday, and on Wednesday morning a letter was received from the traction company making an entirely new proposal. Some strong remarks were made at yesterday's meeting, which was a private one, and unless the proposal is withdrawn there is a probability that the negotiations may be broken off.

Additional Traffic Returns.—Anglo-Argentine, £167 increase; Barcelona Ensanche y Gracia, £18 increase; Barcelona, £157 increase; Brisbane, £90 increase (month of October, £10,359, increase, £979); Buenos Ayres and Belgrano Electric, £180 decrease (month of October, £13,053, increase £183); Calcutta, £546 increase; Cape Town (month of October), receipts £16,507, expenditure £8,727; Isle of Thanet Electric, £32 increase; Mexico Electric (month of October), receipts, £21,600, expenditure £12,580; Perth Electric, £165 increase; Port Elizabeth (month of October), receipts £3,832, expenditure £2,095.

Newport.—The Parliamentary Committee of the Newport County Council at their meeting on Tuesday had before them several questions connected with the electrification of the tram service and the relaying of the line wherever it is a single one. The Great Western Railway Company demur to the line which already goes over the Eastern and Western Valleys bridge in High-street being relaid unless the bridge is reconstructed, alleging that the bridge is not strong enough to bear additional traffic. Should the bridge be reconstructed, the Great Western Railway Company will ask for a contribution towards the cost. The action of the railway authorities may possibly lead to serious delay.

Nottingham.—Major Pringle, R.E., of the Board of Trade, was expected in Nottingham on Wednesday to inspect the recently completed tramways route from Canal-street along Wilford-road to the foot of Wilford Bridge. It is intended to run the St. Ann's Well-road cars through on the new section, giving a five minutes' service. By this means the congestion in the Market-place will be further reduced, leaving only one terminus there, that for the Basford cars. The electric tramways afford such excellent facilities for rapid transit that, it is stated, some of the large shopkeepers in the centre of the town are now advertising that they will pay the fares of customers from the outlying districts.

Hammersmith.—Negotiations have for some time been going on between the Borough Council and the London County Council with reference to the construction of tramways in the borough—from Hammersmith-broadway, *via* Bridge-road, to and across Hammersmith Bridge, from Hammersmith-broadway to Harlesden, and from Shepherd's Bush-road to near the Marble Arch. The bone of contention has been the question of the cost of the street widenings involved in the scheme, but as a result of a conference between the parties on the 6th inst., the Borough Council have agreed to contribute one-third the cost of the street widenings. The tramways are to be constructed on the overhead trolley system.

Dundee.—The convener of the Tramways Committee has put forward a scheme of tramway extension, which includes a service to the Tay Bridge and the West Stations. The idea is to lay a line from Whitehall-street to the east end of the esplanade, over which the cars on the Constitution-road route would run. On Monday the Special Tramway Committee of the Town Council met to consider the question of the appointment of an engineer, and to complete their revision of the statutory parliamentary notice in connection with the provisional order at present being applied for. It was remitted to the town clerk to ascertain whether the appointment of an engineer should be made by the Special Committee or by the Town Council.

Berlin.—A Berlin message states that it is now definitely arranged that that city shall have its underground electric railway, at a cost of 56,000,000 marks, the money to be raised by a special loan. The line, which will belong to the municipality, will be about seven miles long, with 15 stations, including the termini. It will run from the north to the south of the city under the most busy thoroughfares. The trains, which will consist of seven carriages, will run every three minutes, and be driven, of course, by electricity. The tunnels throughout will be lined with concrete. It is supposed that the work will begin next summer, and that the entire line will be open in six years, the first half being ready for use in three years.

Railways v. Tramways.—Since the introduction of the tramway service between Leeds and Bradford the local receipts of the Great Northern Railway Company have been much reduced. Now it would seem that the company have decided to enter into a spirited competition. Starting on Nov. 24, the journey by rail between Stanningley and Bradford is to be run in eight minutes. It takes the tramcars three times as long to cover the distance. The journey between Stanningley and Leeds on the train is to be accomplished in nine minutes. The trams now occupy four times as long. There will thus be a distinct saving in time, and the railway fares are to be reduced to a point nearly equalling the fares on the tramways.

Leeds-to-Guiseley.—The "street notices" of the intended application to the Board of Trade for a provisional order to construct a tramway from Leeds to Guiseley were on Saturday posted all along the proposed route from the city boundary at Kirkstall, through Horsforth, Rawdon, and Yeadon, to the White Cross Hotel at Guiseley. Another scheme which is of interest to Guiseley and Yeadon is the mid-Yorkshire tramways, which, according to the notices posted along the route, is to come up Hollings-hill and through Menston to Burley and Ilkley. This line will, therefore, pass close to the terminus of the Leeds and Guiseley tramways, and a convenient junction for the two schemes will be afforded at the White Cross Hotel.

Portsmouth.—The chairman of the Tramway Committee presented his annual statement at the last meeting of the Town Council. During the last six months, under the new management, the expenses had been reduced very considerably. The takings were £47,651. 14s. 11d. for the six months, as against £50,843 for the last year. The car mile takings were in a similar way, 13·17d. as against 12·35d. for the last year. Of course, this six months included the summer. The deficit of £6,000 had been wiped out, and there was now a balance in hand which, for the remainder of the year, would meet all expenses. The running cost for the electric cars was 5·26d. per car mile. The committee had prophesied 5·25d., which showed how accurate the committee's prognostications had been. Now the cost had been reduced to 5d., and a car mile profit of 3·63d. was shown. During the year ending March 31, 1902, 9,168,137 passengers were carried, as against 8,764,000 for the past six months.

The Chatham Accident.—The county coroner resumed the enquiry at Chatham on Tuesday into the electric tramcar accident at Westcourt-street-hill on Oct. 30, whereby four dockyard workmen were killed. Alfred Drakeford, traffic superintendent in the employ of the company, stated that strict regulations were laid down that no car was to descend Westcourt-hill without a pilot. One driver had been discharged for disobeying this regulation. He had never had any fault to find with the driving of Pearce, the driver of the car. Witness drove the car the day before the accident, and found that the brakes were all in good order. In answer to the foreman of the jury, witness said he could not understand how it was that the driver of the car said he did not know that he could reverse the current, because the driver had to reverse the current every day. Witness believed the car could have been stopped soon after it started by the power brake, if properly applied. He attributed the accident to exceptionally bad state of the rails. He believed that the accident would have been averted if the rails had been properly sanded from the top to the bottom. The enquiry was adjourned until the 25th inst.

Liverpool.—The general manager of the tramways (Mr. C. R. Bellamy) reports that the receipts for the four weeks ended Nov. 1 amounted to £39,601. 8s. 5d., an increase of £2,631. 3s. 4d. compared with the same period of last year. The passengers carried during the four weeks numbered 8,556,392, an increase of 565 004 over those carried during the corresponding four weeks of 1901. In connection with an important new departure, which is in contemplation, the chairman of the Tramways Committee and other members of the Liverpool City Council, besides the town clerk and the general manager of the tramways, waited on Monday afternoon upon the Traffic Committee of the Mersey Docks and Harbour Board. The object was to submit a scheme for the transit of merchandise over the Liverpool tramways, and for connecting the dock quays with the Lancashire towns in which tramways exist, or are in course of construction, thus connecting nearly all South Lancashire towns with the port of Liverpool. The municipal deputation were met most cordially, and it was arranged that the Tramways Committee would supply further details in regard to their proposal, the Dock Board providing any information essential to outline a complete scheme, so that it may receive further consideration from both the Board and the Corporation.

Salford.—A special meeting of the Town Council was held on Friday to consider a report of the Tramways Committee recommending the Council to promote a Bill in the ensuing session of Parliament to seek compulsory powers to purchase land for widening certain streets, and to authorise the Corporation to construct a tramway on the widened new road. The Tramways Committee also recommended the Council to apply for powers in the Bill (*a*) to enable any local authority (with the consent of the Board of Trade) whose tramways are worked or can be worked in connection with the Salford tramways to grant a lease to the Corporation for a period not exceeding 42 years; (*b*) to enable any such local authority with the consent of the Board of Trade to lay double or interlacing tramways in lieu of single tramways; (*c*) to enable the Corporation to construct (in default of the Manchester Corporation constructing the same within six months after the passing of the Act), the tramway in Middleton-road, in the city of Manchester, from Bury Old-road to the boundary in Middleton-road between Manchester and Prestwich; (*d*) to obtain upon terms to be agreed between the owners and lessees, or, failing agreement, as may be settled by arbitration, running powers over the Stretford tramways in Trafford road, from the centre of Trafford Bridge to Chester-road, and also to equip the same for electrical traction. The report was adopted.

Baker-street and Waterloo Railway.—The company have given notice of their intention to promote a Bill next session for powers in connection with their railway. Among the objects of the Bill are the following: To enable the company to transfer to and vest in the Brompton and Piccadilly Railway Company and the Great Northern and Strand Railway Company the undertaking of the Baker-street and Waterloo Railway, subject to terms as may be arranged; to empower the company, on the one hand, and the transferee company, the Charing Cross, Euston, and Hampstead Company, the Metropolitan District Railway Company, the London United Tramways, Limited, and the Underground Electric Railways Company of London, to enter into and carry into effect agreements with respect to the interchange, transmission, and delivery of traffic passing over the respective railways and works of the contracting companies; to empower the company on the one hand, and the contracting companies, or any or either of them, to enter into agreements for the supply of the electric power or current for the working of the railways and works of the company and the railways and works of the contracting companies; and to empower the company to lease their undertaking to the Underground Company, and to empower the last-mentioned company to take on, lease, and work the same upon a rent or upon a guarantee of dividend, or for such other consideration as may be agreed.

London County Council.—At the meeting of the Council on Tuesday the Highways Committee reported with reference to the proposals for new tramways which it is intended to place before Parliament next session. In consequence of the failure of the Council to obtain the consent of the local authorities, either to the tramways themselves or to the street widenings required to be carried out, the following proposed lines will have to be dropped for the present—*i.e.*

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(1) from Edgware-road, *via* Sutherland-avenue, to Harrow-road (tramway terminus); (2) from Shepherd's Bush-road, *via* Westwick-gardens, Netherwood-road, Richmond-road, Holland Park-avenue, High-street, Notting Hill, and Bayswater-road, to a point near the Marble Arch; (3) from New Cross-road (London County Council tramways), *via* Lewisham High-road and Loampit hill and vale, to the South-Eastern Metropolitan tramways; from (4) Tooting broadway (London County Council tramways terminus), *via* Mitcham-road, to Tooting Junction railway station. The committee also asked the Council to authorise a further expenditure of £1,300 in respect of the construction of the foundations for the electricity generating station at Greenwich. The Improvements Committee recommended for approval an estimate of £129,226, submitted by the Finance Committee in respect of the widening of Fulham Palace-road, High-street, Fulham, and Church-street, in connection with the tramways scheme.

Belfast.—The town clerk has received a communication from the tramways company informing him that the directors cannot accept the conditions imposed by the Corporation as the price of their consent to the electrification of the through tramway route from Campbell College, Sydenham, to Ligoniel, and that they, therefore, purpose going to Parliament for a Bill to dispense with the consent of the Council so far as that route is concerned. The directors have made another offer to the Corporation with reference to the conversion of the lines in the city for electric traction—viz., to sell the undertaking of the company to the Corporation for £445,000 (the company retaining its sinking fund investment). The company to forthwith convert its whole system to electric traction on the following conditions: to charge a universal 1d. fare—*i.e.*, 1d. in any car as far as it goes; to pay to the Corporation 5 per cent. of the gross receipts with a guaranteed minimum of £7,000 in any year; the Corporation to postpone the date of purchase for 40 years from the completion of the conversion to electric traction; at the expiration of that period the company to be bound to sell its undertaking, and also the Sydenham and Ligoniel lines, to the Corporation on Tramway Act terms; the Corporation to have the option to purchase the company's undertaking, and also the Sydenham and Ligoniel lines, at the expiration of 25 years and at the expiration of every subsequent five years, on six months' notice, on the terms of paying the fair market value thereof; if the Corporation can undertake to supply the requisite electric power for working the tramways, the company to take it from the Corporation on terms to be mutually agreed. It having been stated in the Council-chamber and in the Belfast Press that the British Electric Traction Company is behind the Belfast Street Tramways Company, the directors in their letter to the Corporation state most emphatically that such an assertion is absolutely untrue, the Belfast Street Tramways Company having no connection direct or indirect with the British Electric Traction Company.

Birmingham.—Notices have been given for the promotion of Bills in Parliament next session which will seriously affect the tramway question in Birmingham. These notices are the outcome of the secret conclaves which have recently been held by representatives of the governing bodies of the suburban districts around Birmingham, in conjunction with the British Electric Traction Company and the local companies in which that company has acquired a controlling interest. A separate notice has been given by the Aston Urban District Council for a General Powers Bill, which, however, contains clauses to confer upon themselves or their lessees compulsory running powers over the tramways in the city authorised by the Birmingham and Aston Tramways Orders, 1882 and 1884—that is to say, the Aston line to the Old-square. The Bill is also to give power to convert the routes into electrical traction routes, and to enter into agreement with the authorities of the city respecting the payments for wayleave, and also respecting the supply of electrical energy. Failing agreement, an arbitration clause will be inserted. The second notice, entitled Birmingham and District Tramways, is to confer upon the City of Birmingham Tramways Company, the Midland Tramways Company, and the British Electric Traction Company, together with the District Councils of Aston, Erdington, Handsworth, King's Norton, Northfield, and Yardley, and the Corporations of Smethwick and Sutton Coldfield, and the lessees of these bodies, compulsory running powers over the tramways in the city of Birmingham. Mutual running powers for the various district councils over the lines of their neighbours is also provided for. The clauses relating to the adaptation of the lines for electric or other traction also seek to give power to the promoters "freed from the restrictions imposed by the existing Acts of Parliament," and "without the consent of the local authority, and without the consent of the owners and lessees of the lines." It is also sought to remove the restrictions as to speed on certain lines. These rights are to be exercised subject to such terms, conditions, and payments as may be agreed upon or be prescribed by the Bill. The Bill also seeks powers to construct new lines, or portions of line, the chief of them being routes through Aston, Gravelly Hill, Erdington, and Sutton Coldfield in the one direction, and on the other side of the city along the Warwick-road in the direction of Olton, and along the Stratford-road line to Shirley and other contiguous places.

Railway Bills for Next Session.—The transformation which is sure to come in time in the means of locomotion is indicated by the Railway Bills of which notice has been given for the ensuing session of Parliament. The companies giving such notice are the South-Eastern, London, Chatham, and Dover, the Great Eastern, and the London, Brighton, and South Coast. These railways do not contemplate an immediate change from steam to electricity, but ask "covering" powers to enable them to convert the whole of their system, or any part of it, as occasion may require. With regard to "tube" railways, powers are sought to construct the City and North-East Suburban Electric Railway, which, beginning at the Monument, will run to the Bank, thence to Shoreditch High-street, then to Tottenham, at the corner of Seven Sisters-road, and on to Southgate, in Middlesex. Between the Monument and the Bank a line will branch from this "tube," and will, under Cannon-street, effect a junction with the Deep-Level Electric Railway authorised by the Metropolitan District Railway Act of 1897. Another tube will "feed" the parish of Leyton, joining up with the Great Eastern Railway. Parliamentary sanction is also sought for the construction of an electric "tube" railway between Clapham and the Marble Arch. The Great Northern, Piccadilly, and Brompton Railway promoters intend to apply for powers to enable them to carry out their scheme, and to confirm and carry into effect the following agreements—viz.: (1) an agreement dated April 17, 1902, between the Metropolitan District Railway Company of the one part and the company of the other part relating to the construction of a portion of the railway authorised by the Metropolitan District Railway Act, 1897; (2) an agreement made April 28, 1902, between the Metropolitan District Railway Company of the first part, the Metropolitan District Electric Traction Company, Limited, of the second part, and the company of the third part, relating to the supply of electrical power to the company from the generating station now being erected by the Metropolitan District Railway Company at Lots-road, Chelsea. Among other companies which have given notice of intention to apply next session for powers to construct "tube" railways in London are the City and Crystal Palace Railway Company and the Paddington, Victoria, and Kennington Railway. The London and Brighton Electric Express Railway Company will seek powers to lay down an electric railway between London and Brighton.

LIGHTING AND GENERAL.

Malton.—The Guardians are about to instal a telephone in the workhouse.

Colombo.—Electric lighting will shortly be introduced on the Ceylon railways.

Leicester.—The Corporation have decided to establish a municipal telephone exchange.

Dublin.—A telephone call office will be installed in a building at the North Wall extension.

Oban.—An extension of the electric light system is to be made at an estimated cost of £132.

Colchester.—The Town Council are considering the extension of the electric light to Lexden.

Barnsley.—The electric light service mains are to be extended through the park at a cost of £70.

Ilford.—Mr. J. E. Allen, mains superintendent at Wimbledon, has been appointed outside superintendent.

Govan.—The Electricity Committee have under consideration the question of extension of plant and station.

Nottingham.—The School Board have agreed upon the introduction of electric light at High Pavement School.

Brierfield.—The electric arc lamps are to be discontinued and incandescent electric lamps fixed to the arc standards.

London Gazette.—An adjudication order has been made out in the estate of A. P. Hunt, 49A, Lord-street, Southport.

Jarrow.—An application of the Electric Power Distribution Company for permission to lay a cable down has been granted.

Hebburn.—It is expected that the Northern Counties Company's supply of electricity will be ready at the end of December.

Leven.—The Town Council have assented to Messrs. Crompton's intended application for an electric supply provisional order.

Dudley.—It is proposed to light the Netherton free library and public hall and the Woodside free library buildings by electricity.

New Barnet.—An enquiry will be held next month into the electric lighting scheme. There appears to be some local opposition.

Stratford.—We understand that a proposal to instal the electric light in the town will be brought before the Town Council very shortly.

West Hartlepool.—An enquiry has been held into the application of the Corporation for power to borrow £7,107 for electric lighting purposes.

"The Smart Set."—In the December number this pleasant periodical keeps up its policy of being entertaining and clean at the same time.

Penrith.—The proposed electric lighting scheme is considered to be a practicable one, and a canvass will now be made by the Urban District Council.

Rathmines.—The Urban District Council have obtained permission to erect three arc lamps on a portion of road under the control of the Dublin County Council.

Midsomer Norton.—The Urban District Council have asked the National Telephone Company when they intended to lay their trunk main at Midsomer Norton

Northfleet.—The District Council are still corresponding with the Kent Power Company and the Gravesend Corporation as to the electric light supply for Northfleet.

Weston-super-Mare.—A small committee has been appointed with regard to the application of the National Telephone Company to lay telephone wires underground.

Whitefield.—The District Council are conferring with Salford with regard to obtaining an order extending Whitefield powers of transfer under the electric lighting order of 1900.

Aberdeen.—It is expected that the new installation in Union-street will be completed in the course of a fortnight. The new standards will be of a light and ornamental character.

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Weymouth.—Mr. W. O. E. Meade-King will hold an enquiry to-day into the application of the Town Council for leave to borrow a loan of £41,800 for purposes of electric lighting.

Bideford.—The Town Council have referred the question of electric lighting to a committee of the whole Council, so that they may take the necessary steps for their protection.

Board of Trade Appointment.—Mr. C. H. Wordingham, M.I.C.E. has been appointed by the Board of Trade to act as electric inspector under the Salford electric lighting order.

Bishop Auckland.—It is stated that a certain well-known licensed victualler in Bishop Auckland is considering the question of lighting up his premises with a private electric installation.

Ryde.—The Town Council have declined to recommend the adoption of the third site chosen by the Isle of Wight Electric Light and Power Company for a station owing to faulty foundation.

Rickmansworth.—The Postmaster-General has been granted wayleaves in connection with the Post Office telegraphs and telephones, subject to the lines not being laid underground.

Nelson.—The concentric cables in Netherfield-road, Railway-street, and Leeds-road have been found unsatisfactory at the increased voltage, and are to be replaced with new 0·25 cables on the solid system.

Plymouth.—An electrical installation, consisting of two dynamos, etc, 600 lamps, bells, telephones, and chaff-cutter, has just been completed at the Royal Hotel by Messrs. Lord and Shand, of Plymouth.

Dunblane.—At the last Town Council meeting a communication from the Board of Trade was read containing formal notice of the revocation of the Electric Lighting Order, 1900, as from Oct. 24 last.

Paris-Rome Telephone.—The new service will be opened to the public at the commencement of December. The line is already 1,900 km. long, and it is proposed to extend it still farther to Naples.

Agency.—Messrs. William C. Yuille and Co., West-street, Tradeston, Glasgow, have been appointed agents for Scotland for A. P. Lundberg, Pioneer Electrical Works, 477 to 487, Liverpool-road, London.

Paignton.—The Urban District Council have received an offer *re* the electric lighting scheme, but are awaiting a reply from the Kingsland Tram Company, with whom a provisional agreement was made last year.

Upholland.—The question of applying for powers to supply the district with electricity, either by themselves or from the South Lancashire Electric Power Company, will come before the next District Council meeting.

Mutford.—The Council have empowered the Executive Committee to settle any matters of detail which may arise with regard to the application for a provisional order authorising the Council to supply electricity in their district.

Frome.—The plans and specifications of the proposed electrical works submitted by Mr. F. H. Medhurst are to be amended, the Council having decided to reduce the number of arc lamps to 11, the district to be covered remaining the same.

Cable Steamers.—The two cable-laying steamers now completing in the Tyne are about to lay for the Eastern Extension Telegraph Company, on behalf of the Netherlands Government, a telegraph cable between the islands of Borneo and Celebes.

Canal Towage.—A company has been formed to obtain parliamentary powers to construct a canal from London to Southampton. The towage is to be by electric power, and the canal is to be available for pleasure craft as well as business barges.

Falmouth.—The Corporation have decided to apply to the Board of Trade for a provisional order giving them powers of instituting electric light and a dust destructor. A preliminary agreement has been entered into with Messrs. Crompton and Co.

Long Eaton.—During a discussion at the last Council meeting with regard to the agreement with the gas company for lighting the streets, it was explained that the Council were safeguarded as to lighting some of the lamps with the electric light.

King's Lynn.—The electric light is to be extended to West Lynn. The question of supplying electric light at the docks is still under discussion. A room is to be arranged as a store and showroom so that the fitting-up work of the department may be extended.

Morley.—The borough electrical engineer (Mr. H. Drewett) in his last report states that the output from the electricity works during the four weeks ending Oct. 4 was 9,060 units, against 7,575 for the corresponding period of last year, being an increase of 1,485 units.

Lowestoft.—The electrical engineer in his last report states that during the past month nine consumers have been connected to the mains, representing 413 8-c.p. lamps, giving a total of 297 consumers, representing a load of 15,895 8-c.p. lamps connected to the mains. There are about 17 applications now in hand.

Islington.—The Council are in favour of the renewal of the London County Council's application for parliamentary powers to enable metropolitan borough councils to wire and fit consumers' premises for electric lighting and to obtain loans for the cost of the work, subject to their not being restricted to borrowing from the sanctioning authority.

India Rubber, Gutta Percha, and Telegraph Works Co.—This Company propose to promote a Bill next session, the objects of which are shortly stated as follows: extension of powers of Company; repeal or amendment of the Company's Act of 1884; alteration of memorandum of association; extending operations beyond the United Kingdom; holding of shares, stock, or securities of other companies; and stock and securities of public bodies.

Award.—The E. A. G. vorm. Lahmeyer und Co., Frankfurt-on-Main, who had electrical machinery aggregating about 15,000 h.p. running at the Düsseldorf Exhibition, have received the highest awards for their various machines—viz., the large gold State medal and the gold exhibition medal. The Lahmeyer Electrical Company, Limited, of 109 and 111, New Oxford-street, W.C., has the sole selling agency for the whole of the British Empire.

St. Helens.—With respect to our abstracts of the St. Helens electricity accounts published in our last issue, Mr. J. S. Highfield, the electrical engineer, points out that the fuel item includes a payment of £367. 14s. 9d. to the health department for steam supplied from the destructor works. The figures relating to the different classes of load are as follows: units sold—traction, 827,837; motors, 143,311; public and private lighting, 266,817—total, 1,237,965. The maximum loads on feeders were: lighting, 334 kw.; traction, 519 kw.—combined, 792 kw.

Stock Exchange.—The Stock Exchange Committee has appointed Dec. 3 as special settling day for the British Insulated and Helsby Cables, Limited, further issue of £250,000 4½ per cent. first mortgage debenture stock. The committee has also ordered the said mentioned securities to be quoted in the official list. The committee has further been asked to allow Bournemouth and Poole Electricity Supply Company, Limited, 7,500 6 per cent. cumulative second preference shares of £10 each (fully paid), Nos. 15,001 to 22,500, to be quoted in the official list.

Accidents.—The recent fatal accident at the Leeds electrical works had nothing to do with electricity. The workmen in question slipped from a travelling crane and fell into a fan which was then in motion—a distance of over 40ft. At the inquest it was stated that instructions had been given that the fan should be stopped whilst the oiling was being done. On Tuesday morning one of the serving water-mains at the bottom of King Cross-street burst, and the water then ran into the draw boxes connected with the electric lighting cables and fused them. Smoke was seen issuing from the ground. The Corporation electric lighting men were at once summoned, and they set to work to do the repairs as soon as possible. The traffic was interfered with, and on Tuesday evening for some time the light was also affected.

Ealing.—The Electric Lighting Committee in their last report state that in presenting plans of the proposed extension of mains in Loveday, Lavington, and Bellevue roads and Lancaster-gardens, the electrical engineer reported that 206 houses were to be wired throughout for electric light. It was resolved to extend the supply mains at a cost of £1,101, subject to a site being obtained for the necessary transformer station and the usual agreements being entered into by the builders. In view of the rapid local development it was resolved to extend the high-tension main to the proposed sub-station on the Leeland Estate, and a branch taken from this feeder to a proposed sub-station at St. John's Estate. The electrical engineer estimates that light will be required for 500 houses on these estates. It was also agreed to lay the necessary distributing cable to supply the first 12 houses in Seaford-road at a cost of £50.

Post Office Telephones.—The Postmaster-General (Mr. Austen Chamberlain) in the House of Commons on Wednesday said: "Seven Post Office telephone exchanges have already been opened in London since March 1. These serve districts which include more than half the previous users of telephones. Four other exchanges to serve large areas are well advanced. Owing to the rapidly-increasing demand for a telephone service, it is not practicable to name a date when the system can be regarded as complete. The authorised expenditure on works now in progress is, in round figures, £1,262,000. These works provide not only for the service of existing subscribers, but, to a much greater extent, for future requirements. The number of subscribers' telephones now working is 5,160, and this number is being increased by from 150 to 200 a week. The receipts in respect of the local exchange service in London up to 15th inst. were £34,473, and £1,086 was received for trunk calls made by Post Office subscribers."

London County Council.—At Tuesday's meeting of the Council tenders were received for the supply and erection of a 50-ton overhead travelling crane, etc., at the Greenwich tramways electricity generating station. These were referred to the Highways Committee for consideration and report. It was agreed to lend the Stepney Borough Council £17,950 for electric lighting and meters. The following notices under Electric Lighting Acts and Orders were agreed to: Blackheath and Greenwich District Electric Light Company, of intention to lay low-tension mains across Church-lane and along a portion of Troughton-road, and high and low tension mains along Woolwich-road and Anchor-and-Hope-lane; Brompton and Kensington Electricity Supply Company, to lay high and low tension mains along Ashburn-mews; County of London and Brush Provincial Electric Lighting Company, to lay power and low-tension mains along a portion of George's-row and Dean-street, also to lay low-tension mains along Vestry road and mews and along Tunley-road, and, further, to construct a transformer box in Putney Heath; the Lewisham and District Electric Supply Company, to construct two transformer boxes and to lay mains in connection therewith in Lewisham High-street; Metropolitan Electric Supply Company, to lay extra high-tension mains from the company's Willesden generating station, along Acton-lane, Harley-road, Station-road, Tubbs-road, Harrow-road, Amberley-road, Formosa-street, Blomfield-road, Edgware-road Richmond-street, Carlisle-street, Church-street, Exeter-street, Devonshire-street, Lisson-grove, Marylebone-road, Wyndham-street and place, Montagu-place, Dorset-street, Baker-street, George street, Manchester-street, and South-street, to the company's station there (when the company served a similar notice in August last the Board of Trade decided, at the instance of the St. Marylebone Borough Council, to make a variation in the route proposed for that borough, and as the notice served upon the Council referred to the laying of mains along a route which had been so altered, the Council disapproved the proposed works; the notice now submitted embodies the variation of route made by the Board of Trade); and from the St. Pancras Borough Council, to lay mains along Cleveland-mews.

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Swansea.—A record maximum load was supplied at the electric lighting station on the 15th inst., the amount being 478 kw., as against 464 kw. The new generators, which are urgently required, and which are capable of supplying 600 kw., were to be ready this week.

Portsmouth.—The installation of the electric light at the Royal Garrison Church will shortly be commenced. The cost will be a little over £150, and we understand that current will be supplied without charge from the plant recently established at the Point Barracks.

Sutton.—It is reported that the promoters of the Cheshire and North Staffordshire Power Syndicate have abandoned their original intention of erecting their Cheshire station at Sutton, and decided to construct it at Bollington. The erection of the station will be commenced in August next.

Llandudno.—The Council intend to apply for sanction to borrow various sums, amounting in the aggregate to £7,186, which had been expended over and above the loans sanctioned for various purposes, together with sanction to reborrow £1,025, being part of £4,844 sanctioned for purposes of electric lighting.

Newark.—The Town Council have confirmed an agreement with the Notts and Derby Electric Power Company for the supply of the borough with electric light and power. Current will be supplied at 4d per unit for the first 200 hours of maximum power and 2½d. afterwards, and for power 2½d. and 1½d. The first outlay is estimated at £27,000.

Taunton.—An agreement has been entered into between the Council and the National Free Wiring Company. An electrical inspector is to be appointed for the purposes of the Taunton Electric Lighting Order, 1893, including the certifying of meters. The installations during the past month were equivalent to 768 8-c.p. lamps.

Ashton.—In consequence of the proposed extensions of the Oldham, Ashton, and Hyde Electric Tramway, Limited, it is expected that the company will require about 850,000 units per annum. The Corporation are prepared to supply the increased quantity of current thus required provided the minimum referred to in their agreement be increased from 350,000 to 450,000 units.

Hammersmith.—According to the last report 12 additional consumers have been connected, representing a maximum of 407 8-c.p. lamps and one consumer has been disconnected. The total number of consumers now taking current from the mains is 1,127. Permission has been given to the Postmaster-General to take up portions of various footways and carriageways for the purpose of laying telephone wire pipes.

"Town Topics."—We have received from New York a copy of a shilling edition of this weekly, which has been published on the occasion of the opening of the new New York Exchange. It is practically an illustrated monograph upon the principal exchanges in various parts of the globe, interlarded with articles upon the history of American railways and the present commercial conditions in the United States of America.

Eccles.—The electric light undertaking's deficit of £1,606 in March, 1901, has been reduced to £867 in March of the present year, and we learn that the prospects for the current financial year are brighter still. The extensions recommended by the committee, and which are now before the Local Government Board, will, it is expected, be approved shortly, but the sanction of the Board of Trade is first required on technical grounds.

Indian Appointments.—Mr. John Fairley, B.Sc., recently assistant to Prof. Jamieson in connection with his engineering science correspondence classes, has been appointed a telegraph superintendent by the Indian Government out of over 80 competitors. Mr. Sam. Trail Jamieson has just been appointed chief electrician for repairs to the West Indian cables, and has left with the c.s. "Newington" for Trinidad, Demerara.

Catalogue.—In a well-bound catalogue of Mr. J. S. Cock, Christiania, who is an agent and importer of machinery, armatures, and mechanical appliances of all sorts, we notice illustrations of a London and North-Western Railway locomotive and steamer, of a 150-h.p. Crossley gas motor coupled to a Siemens dynamo, and various types of ammeters and voltmeters. It may interest manufacturing firms to know that Mr. Cock keeps a stock of the goods he imports.

Rossendale.—The Lancashire Electric Power Company are about to start with the laying of their first line of route of mains as follows: (out) *via* Swinton, Radcliffe, Ramsbottom, etc., through Rawtenstall, and along the Rossendale Valley to Bacup, with a branch to Haslingden. There will probably be two return routes—the first from Bacup *via* Whitworth, Milnrow, Crompton, Royton, Chadderton, Failsworth, Gorton, etc.; and the other *via* Turton, Westhoughton, Worsley, etc.

Diaries.—No. 2 of the publications of the Brazilian Navy League (Annuareo Maritimo) is a most creditable production. It is full of useful information, and illustrated with well-executed plates of flags, code signals, etc., the plate illustrating the funnels and flags of all steamship companies trading in Brazilian waters being of special interest. The secretary of the league, Captain J. A. Santos Porto, is the editor, and the Typographic Company of Brazil, Rio de Janeiro, are the publishers. We understand the diary is distributed gratis to the members of the league.

Paisley.—Permission has been given to lay an electric cable from the boundary of the burgh of Paisley to Corsebar, a distance of 300 lineal yards, subject to the following conditions—viz.: that the Electricity Committee shall be in no way liable for injury to or accidents arising from the cable; that the cable shall be a low-tension one, protected by tiling; that the current shall be restricted to 250 volts; and that the consumer agrees to the usual conditions as to lighting, watching, liability for accidents, etc., and deposits a sum of £2 for due restoration of the road.

Worsborough.—The Urban District Council have asked the Barnsley Corporation upon what terms they would be prepared to light with electricity for a period of five years the roads in the township of Worsborough traversed by the tramways, the lamps to be 50 c.p., fixed to the present tramway standards at a distance of about 80 yards. The letter asked that the estimate should be based on capital expenditure, cost of light, and maintenance. The matter is before a committee.

Stoke Newington.—The Electric Lighting and Sites Committee propose to appoint an electrician at a salary not exceeding 30s per week. The Council will promote a Bill to authorise them to take electrical energy in bulk, and, in conjunction with the Councils of Hackney and Islington respectively, to mutually supply one another with electrical energy in bulk, and to enter into agreements for this purpose, and conferring upon the Council powers of acquiring, compulsorily or otherwise, the lands in Albion-road referred to in the Council's recent application for a provisional order for that purpose.

Bridgwater.—The Town Council have passed a resolution consenting to a provisional order being granted by the Board of Trade to the Bridgwater and District Electric Supply and Traction Company, Limited, authorising such company to construct electrical works and to supply electrical energy for public and private purposes within the borough subject to the following conditions being embodied in the order: "The Corporation to have the right at any time from the commencement of the order to require the company to sell the undertaking to the Corporation in such manner as may be agreed upon between the Corporation and the company."

Worthing.—There is an increasing demand for electric light, and it is probable that the sum set apart from the rates to meet the interest may not be required. Up to the end of September the entire receipts of the electricity department were £2,394. 10s. 6d., besides which there were sums outstanding to the amount of £763 19s. 5d. The payments came to £4,122. 14s. 11d., with liabilities of £370 odd. This gave a deficit for the year's working of £1,271. 18s. 11d. The public lighting last year cost £2,822. 14s. 6d., or £793. 16s. 10d. more than in 1901. That brought up the cost of the electric light to the town to £2,065 15s. 9d. The value of stores would reduce this to about, in round figures, £1,500.

Rochester.—The Kent Electric Power Syndicate have taken up the award of the arbitrator in the matter of the purchase of the undertaking of the Chatham and Rochester Electric Lighting Company. The purchase price is fixed at £62,791, which includes the goodwill and provisional order, the works, machinery and plant, and the mains and cables. The undertaking was originally offered to the Chatham and Rochester Town Councils, whose offers for the portions in their respective jurisdictions amounted together to only £25,000. The Gillingham electricity works, a subsidiary undertaking connected with the Chatham and Rochester Company, has been sold to the Gillingham Urban District Council for £27,659—making a total value for the combined undertakings of over £90,000.

Grimsby.—The Higher-Grade School Committee have been empowered to obtain estimates for an installation of electric light and power. Mr. Vignoles (borough electrical engineer) in his last report states that there has been good progress made during the past month. He had visited the Newton Electrical Company's works at Taunton, and saw complete tests on the motor boosters. The machines ran very satisfactorily, and as soon as some alterations were made in the winding of the motor they would be forwarded to Grimsby. The cooling tower at the works was now completed, and the setting of the boiler was practically finished. A new engine and dynamo was being forwarded from Birmingham, and its erection would be proceeded with as soon as possible. Sir Hiram Maxim's were proceeding as rapidly as possible with the pipework.

London Gazette.—Notices appear in the *London Gazette* of the following intended applications to the Board of Trade:—Electric lighting: Scunthorpe (U.D.C.), Brentwood (U.D.C.), Waltham-on-Thames (U.D.C.), Tadcaster and District (Co.), Sidmouth (U.D.C.), Hendon (U.D.C.), Gainsborough (U.D.C.). Electric supply: Willesden (U.D.C.), Blackheath and Greenwich Electric Lighting (Co.), London supply of electricity, adjustment of areas between companies. Tramways: Barrow-in-Furness (B.E.T. Co.), Huddersfield (Corporation), Burton-on-Trent (Corporation), Cardiff (Corporation), Bury (Corporation), Ilford (U.D.C.). In Parliament: Sheffield electrical energy, tramway, etc. (Corporation), Stockport tramways, etc. (Corporation), Wood Green electric supply (U.D.C.), Birmingham tramways (Corporation), Rochester tramways (Corporation).

Hampstead.—The borough accountant's last return shows that the amount of the consumers' accounts for the half-year to Michaelmas was £15,200. 13s. 9d., as compared with £13,249. 2s. in the corresponding half of last year. No reduction is to be made at present in the price charged for electricity supplied to the various departments of the Council, it being stated that cost price only is being charged. The town clerk has been instructed to inform the contractors for the condensing plant that by the non-completion of the contract the Council had sustained considerable loss, and to urge upon them the necessity for completing the work as quickly as possible. The Council are in favour of the London County Council's proposal to again apply to Parliament in the session of 1903 for powers to enable councils of metropolitan boroughs to wire and fit consumers' premises for electric lighting.

Newton Abbot.—The offer of the Urban Electric Supply Company, Limited, to light the town by electricity for £900 a year has been accepted and a contract prepared for a term of 10 years, determinable at the option of the Council at the end of five or seven years, the agreement to contain the following stipulations: The £900 is to include the whole cost of installing, providing, lighting, and main-

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taining lamps and plant of every description, the company being allowed to use and convert the present lamp-posts for the purpose. The half-night and all-night lamps are to be as nearly as possible alternate, but the Council is to have the power of determining where the lamps shall be placed. Should additional lamps be required, they are to be provided at the price stated in the estimate. All existing lamp-posts will remain the property of the Council. Every lamp is continuously to give the amount of light specified, and a penalty is provided for any breach in this respect. New lamp-posts are to be provided and fixed by the Council, except the arc lamp-posts, which are to be provided by the company.

Southend-on-Sea.—The Council have appointed Mr. William Edwin James Heenan, M.I.E.E., at present temporary electrical engineer, borough electrical engineer, at a salary of £350. Mr. Heenan is to have complete charge of the electricity generating station, plant, and electrical equipment in connection with the light railways and electric lighting undertakings, and generally to perform such other duties as are usually appurtenant to the office of borough electrical engineer, and as may from time to time be required by the Corporation. According to local opinion, Mr. Heenan well deserves the belated promotion. Soon after his appointment last December he prepared specifications for electric lighting plant, etc. The cable contractors (Messrs. Callender and Co.) commenced to lay the mains in the middle of February, and finished on June 25, when a temporary supply for lighting purposes was commenced, the light being available from 3 p.m to midnight. Part of the battery was completed at the beginning of October, and a continuous supply started at that time. There are now connected 150 consumers, with the equivalent of 9,649 8-c.p. lamps, and applications for over 1,500 equivalents are in hand. Mr. Heenan has also during that period reconstructed part of the overhead equipment of the Council's light railways system.

Fife.—It is understood that a Bill is to be promoted in next session of Parliament to constitute a company with powers to supply electrical energy in the county of Fife. The proposals in the Bill involve the establishment of five electrical generating stations at suitable equal intervals over the county, with distributing electric mains in the principal roads and to all the chief towns, collieries, and manufactories. At present in the area there is only one town or district where there is power to supply current—namely, Kirkcaldy. Here the supply is in the hands of the Corporation, who are building a generating station. The price at which this Corporation will most likely be prepared to supply current will be from, say, 4d. to 6d. per unit. They, however, will be catering for an "electric lighting load," and not for the "power load" which the company desire to obtain. By the scheme in the Bill it is only intended to charge customers from 1d. to 1½d. per Board of Trade unit for current for power, or equal to, say, £12 per horse-power per annum for 300 days working of 10 hours each. Further, the promoters seek power to supply in bulk to any corporation or tramway company or other "authorised" body who should desire to take current from them. The solicitors for the scheme are Messrs. Davidson and Syme, W.S., Edinburgh, and the engineers are Sir Frederick Bramwell and Mr. H. Graham Harris, of Westminster.

Islington.—The Borough Council have authorised the laying of low-pressure distributing mains in order to give a supply of electricity to premises in Hornsey-road (£188) and Wharfedale-road (£85). They have also adopted a report of the Lighting Committee stating that in the case of certain flats in Turle-road, Tollington-park, for which a supply of electricity had been requisitioned for about 100 lamps, the owner was asked to give a formal guarantee that such a supply of electrical energy would be taken for two years from the date of laying the necessary low-tension distributing mains as would, at the rates of charge for the time being, produce a revenue equal to at least 20 per cent. per annum upon the estimated cost of laying such mains but the owner declined to give such guarantee. The tenants were now making application for supply, and the owner urged that he should not be required to give any guarantee, inasmuch as the expense of wiring falls upon him, and unless tenants can obtain supply no owner will go to such expense. The committee were of opinion that it would be to the advantage of the Council's electricity supply undertaking if reasonable facilities were given to the public to avail themselves of the supply, and that in the case of flats which are wired by owners, extension of mains should be made without insisting upon the guarantee, subject to each case being individually considered by the committee, and they recommended accordingly. The engineer's estimate for laying the necessary low-pressure distributing mains was £180.

Bath.—The accountant's report for the half-year ending Sept. 29, 1902, shows a satisfactory increase in revenue in the electric lighting department. While, owing to the reduced price paid for street arc lamps, £2,161 has been received from that source against £2,370 in the corresponding half of last year, the private consumers paid £2,781 against £1,830. Altogether the revenue is given as £5,258 against £4,380. Unfortunately, the expenditure has been £3,756 against £3,004, the increase being due apparently to repairs and renewals, and to expenditure on the mains and sub-stations, which cannot be charged to capital. The balance towards interest and sinking charges is thus £1,501 against £1,376, which leaves a deficiency of £1,173 against £1,079 after paying all charges (£2,673 against £2,467). The electrical engineer (Mr. Francis Teague) has submitted the following report: "The Ferranti high-tension switchgear has now been in satisfactory use since Oct. 5, and Messrs. Ferranti are anxious to receive payment for same. You will no doubt remember that it was supplied about 11 months ago on the understanding that it might be returned at any time during six months from the date of its completion, and if you determined to purchase it at the end of the six months the price agreed on was £1,312, this being the price obtained by Messrs. Ferranti for exactly similar gear supplied to other authorities in public competition. You have already heard that this is a standard article that has been in use for many years in other central stations owned both by municipalities and supply companies, and it is quite unnecessary for me to add any further information as to its popularity. I append hereto a detailed specification and drawing of the switchgear, and beg leave to recommend you to accept it as being the most satisfactory switchgear that can be purchased for high-tension alternating-current work, but before authorising payment I would suggest that a guarantee be obtained from Messrs. Ferranti to maintain the gear free of cost to the Corporation for 12 months dating from Oct. 5 last."

Clyde Valley Electrical Power Company.—Important progress has, according to the *Glasgow Herald*, now been made in carrying out the objects for which this Company was promoted. By the Act which was obtained last year the Company was authorised to construct three central power stations—one at Motherwell, in the heart of the Lanarkshire coalfield; a second at Yoker, on the north bank of the River Clyde; and a third near the Halfway House, between Paisley and Glasgow—for the production and supply of electrical energy, chiefly for traction and power purposes. The Company has a subscribed capital of £600,000 in ordinary shares, and has acquired 20 acres of land at Motherwell and nearly 10 acres at Yoker for the sites of the central stations. It has also contracted with the British Westinghouse Electric and Manufacturing Company, Limited, of London and Manchester, for the construction of the first instalment of the works, which, with the relative cables and sub-stations for distribution, will cost about £500,000. It is expected that these two stations will be completed and in operation within from 18 months to two years from the present date. The company's authorised area of supply—over 700 square miles—extends from the burgh of Lanark on the south to Port Glasgow on the west, and Balloch and Lennoxtown on the north (with the exception of Glasgow, Govan, Partick, Paisley, and Hamilton), includes more than 1,000 works of all kinds, and affords a wide field for the application of the principle of supplying electric energy from large central power stations From the central stations at Motherwell and Yoker cables will be laid along the public roads for the supply of electric energy to public works within a radius of 15 or 16 miles from each station, and also for the supply in bulk of electricity for public lighting purposes to burghs or other authorities holding lighting orders under the Board of Trade. The Company's Act authorises it to lay a cable under the River Clyde from Yoker to Renfrew, so as to supply energy to the important burghs and industrial centres in Renfrewshire within the Company's area. By this means power for industrial purposes will be "on tap" at every work and pit within this great area. The Company has already received promises of support from many of the steel manufacturers, coalmasters, shipbuilders, engineers, bridge builders, and other users of power within the area, and in course of time the use of steam as a motive power in works within the valley of the Clyde will be very largely superseded by the more economical application of electric driving. A supply of electricity is also largely in demand by coalmasters for traction purposes, both above and below ground, and for coal-cutting, pumping, and lighting purposes. The Company's stations will also afford a ready and economical supply of electricity for tramways within the valley of the Clyde, and for the network of railways in and around Glasgow, whose suburban traffic, if it is to be retained at all, must be operated electrically.

PROVISIONAL PATENTS, 1902.

Nov. 10.

24556. Non-inflammable waterproof-insulated conductors for the transmission of electrical energy. Walter Claude Johnson and Sydney Paterson, Electric Cable Works, Old Charlton, Kent.

24576. Improvements in and connected with telephone party-line system on telephone exchanges working on central battery system. Hermann Oppenheimer, 55, Redcross-street, Barbican, London, E.C. (Actiengesellschaft Mix und Genest, Germany.)

24579. Improvements in electric dynamos and motors. John E. Neale, 12, St. James's-square, London.

24598. Improvements in electrical furnaces. John Franklin Hammond, 111, Hatton-garden, London. (Complete specification.)

24634. Improvements in driving mechanism for use in connection with electric train-lighting systems and for other purposes. John Ebenezer Bousfield, of the firm of G. F. Redfern and Co., 4, South-street, Finsbury, London. (Heinrich Gerdes, Germany.)

24637. Improvements in telephone systems. Alfred Ekström, 4, South-street, Finsbury, London. (Complete specification.)

24643. Improvements relating to the detection of faults in the conductors of electric traction systems. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

24644. Improvements in or connected with the field magnets of dynamo-electric machines. John Wesley Burleigh, Norfolk House, Norfolk-street, Strand, London.

Nov. 11

24687. Electric tram dry seating. T. Richardson, 143, Main-street, Addingham, Yorks.

24705. Improvements in contact clamps for electric conductors. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24706. Improvements in fire-indicating wires. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

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24707. Improvements in electric arc lamp hangers. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24708. Improvements in lightning arresters. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24709. Improvements in electric cut-outs. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24710. Improvements in electrical measuring instruments. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24711. Improvements in magnet coil spools. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24712. Improvements in alternating-current electric motors, also applicable to meters of the induction type. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24713. Improvements in induction motors. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24714. Improvements in electric switch control mechanisms. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24715. Improvements in systems of electrical distribution. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

24742. Improvements in or connected with electric railways. Willis Nelson Stewart and Herman Ernest Dick, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24744. Improvements in and relating to lightning guards, especially applicable for submarine telegraphy. Oliver Joseph Lodge and Henry Alfred Charles Saunders, 323, High Holborn, London.

24755. Improvements in or connected with electric cables. Walter Claude Johnson and Joseph William Bass, Norfolk House, Norfolk-street, Strand, London.

24756. A new or improved covering or insulating material for electric cables. Walter Claude Johnson and Sydney Paterson, Norfolk House, Norfolk-street, Strand, London.

24770. Apparatus for electrical control of motors. George Henry Hill, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 25, 1902, being date of application in United States.) (Complete specification.)

24772. Improvements in electrical transformers. Arthur Francis Berry and the British Electric Transformer Manufacturing Company, Limited, 46, Lincoln's-inn-fields, London.

24777. Improved means for protecting the third rail in electric railways. Howard Brooks, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

Nov. 12.

24802. Improved system and appliances for operating signals by electric tramcars and the like vehicles. Samuel Hindley, 17, Haymarket, Sheffield.

24820. Improvements in disconnecting and junction boxes for underground electric cables and manhole covers and frames for same. Arthur Sowden, Penny-Bank-chambers, Halifax.

24857. An improved method of producing induction currents. Robert Grisson, 45, Southampton-buildings, Chancery-lane, London.

24859. Improvements in or relating to arc lamps. Tito Livio Carbone, 322, High Holborn, London.

24865. Improvements in or relating to insulating substances for cables, wires, and other electrical devices. William Windle Pilkington and William Reginald Ormandy, 6, Lord-street, Liverpool.

Nov. 13.

24890. An electric shade or globe holder. William Leach, 136, Oaklands-road, Hanwell, London.

24915. Improvements in ceiling roses, cut-outs, and the like. John William Sutcliffe, 72, Wilberforce-road, Finsbury Park, London.

24943. Improvements relating to switches for starting electric motors. John Somerville Highfield, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

Nov. 14.

24986. Improvements in or applicable to pendant incandescent electric lamps. William Royston Laidlaw and George Hamer Scholes, 70, Deansgate, Manchester.

24990. Improvements in electrical switches. Percy Richard Julius Willis, Fife House, Kingston-on-Thames (Nicholas Britz and Ernest C. Goodrich, United States.)

24998. Improvements in electric accumulators. Ernest Henry Hill, 43, Victoria-road, Broomhall Park, Sheffield.

25023. Improvements in controller for electric motors. Gustavus Adolphus Edward Kohler, 46, Lincoln's-inn-fields, London. (Complete specification.)

Nov. 15.

25069. An alternating-current frequency counter. William B. Redgrave and J. M. Rokes, 20, Westmount-road, Eltham.

25084. Improvements in and relating to primary and secondary electric batteries. Matthew Cranswick Greenhill and Stanley Edward Hammond, 27, Chancery-lane, London.

25085. A new and improved method for electrically lighting street poles and other like standards. Kyran Quaney William Cecil Kirwan, 5, Upper Sherrard-street, Dublin.

25149. Improvements in and relating to apparatus for distributing and measuring alternating currents. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

25151. Improvements in electrical synchronism and phase indicators. The British Thomson-Houston Company, Limited, and Reginald Charles Clinker, 83, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 4.

1901.

22546. Systems of electric motor control. British Thomson-Houston Company, Limited. (Garfield and D'Ornellas.)

22640. Automatic apparatus for controlling and operating the points of electric railways and tramways. Stewart and Turner.

22711. Apparatus for reversing the motion of a reciprocating body by electric current impulses transmitted through a single line Cerebotani and Bernstein.

22937. Electric relays. Siemens Bros. and Co., Limited, and Forrest.

23030. Apparatus for automatically switching electric current on or off, turning gas or water on or off, and the like. Stockall.

23046. Electromagnetic cut-outs. Joseph and Gardner.

23153. Electrical demand or rebate indicators. Wright and Reason Manufacturing Company, Limited.

23225. Enclosed or open electric arc lamps. Mensing.

23738. Magnetisable bodies for use in telegraphones. Pedersen.

23813. Dynamometers or dynamometric transmission gear for revolving shafts. Müller.

24825. Methods for producing electric waves. Fleming and Marconi's Wireless Telegraph Company, Limited.

25885. Switches for electric current circuits. Moy, Bastie, and Ernest F. Moy Limited.

26062. Insulators for overhead equipment for electrical traction and other purposes. Walsh and Leigh.

26476. Electric switch. Marshall.

1902.

18. Trolley pillar on electric tramcars and the like. Peters and Peters.

53. Electric relays or the like. Picard.

185. Electric resistances. Duddell and Mather.

418. Thermo-electric batteries. Hall.

493. Electrical demand or rebate indicators. Lux and Reason Manufacturing Company, Limited.

9296. Indicator for electric signalling on railways, tramways, and the like. Gulliver and Robinson.

11510. Electric incandescent lamps with rare earth filaments. Crook and Mines.

17220. Third-rail and sectional conductor systems of electric railways. Lake. (General Electric Company.)

19272. Incandescent electric lamps. Miller.

20616. Dynamo-electric machines. Lamme. (Date applied for under International Convention, Sept. 24, 1901.)

21733. Electric fans. Fell. (Coleman.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¼-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated Wire, Ord., 1-70,000	5 ..	7½-8
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6½
—— 4 per cent. Mortgage Debenture Stock	100 ..	101-103
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	14½-15½
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	2½-3
—— 5 per cent. Debentures	100 ..	101-106 p.c
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1¾-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102

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Name.	Amount paid.	Last price.
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16½-17½
—— 4½ per cent. Preference	5	5½-5¾
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	4¼-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100	127-132
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3½-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	105-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9½-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12½-13
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12½-13
—— 5 per cent. Perpetual Debenture Stock	100	123-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2¼-2⅜ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4⅜-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98
Imperial Tramways, Ordinary	all	22-22¼
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4¾
—— 4 per cent. Debenture Stock	100	95-99
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref. } Within 1-82,500	10	11¼-12
—— " " " " } Within 1-82,500	10	11¼-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	106-108
—— " " Prov. Crts.	100	105-107
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11½-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8¼-8½
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109 xd
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	16s.	13/16
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c.	80 p.c
Electric Railways.—		
Central London, Ordinary	100	106-109
—— 4 per cent. Pref.	100	106-109
—— " " deferred	100	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-119
City and South London, Consolidated Ordinary	100	76½-77½
—— 4 per cent. Debenture Stock	100	114-117
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	126-129
—— " " " '01	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	93-96

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅛-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	108-111
Bournemouth and Poole, Ordinary	10	12¼-13¼
—— 4½ per cent. Cum. Pref.	10	10-11
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	10¼-10¾
—— 7 per cent. Preference	5	10¼-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7-8 xd
—— Nos. 20,001-30,000	5	7-8 xd
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	16½
—— " " £10 Ord.	6	10⅝
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	107-110
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4⅜-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5½-6
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104-107
County of London and Brush Provincial, Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6-6¼
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	6-6¼
—— 4½ per cent. First Deb Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7½-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10½
London Electric, Ordinary	3	1¾-2¼
—— 6 per cent. Pref.	5	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	110-115
—— 3½ per cent. Mortgage Debenture, Red.	100	98-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6¾
Notting Hill Electric Lighting	10	14-15
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oriental, 1879	1	—
—— £5 Shares	5	—
—— £4½ Shares, New	4½	—
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¾-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8¼-8¾
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3¼-4¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3¼-4¼
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	5	6-6½
Telephones.—		
National Telephone, Preferred	100	92-94
—— Deferred Stock	100	59-61
—— 6 per cent. Cum. First Pref.	10	12¼-13¼
—— 6 per cent. Cum. Second Pref.	10	11½-12½
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100	95-98
—— 4 per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	⅞-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 1	815	515	+ 20)	+ 5,987	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	" 15	5,102	4,366	+ 736	+16,266	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	" 15	680	712	— 32	+ 3,741	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	" 13	305	248	+ 57	+ 219	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	" 15	209	153	+ 56	+ 200	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	" 16	1,619	1,262	+ 357	+ 3,986	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	Oct. 26	3,208	1,090	+2,118	+82,937	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57*
Bristol Tramways Company	Nov. 14	4,300	3,870	+ 430	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	" 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	" 15	7,358	6,809	+ 549	+10,759*h*	12	12	" 31	335,086	41,188,389	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	" 16	3,426	2,476	+ 950	+20,212	12½	9½	" 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	" 13	420	398	+ 22	+ 5,885	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	" 15	181	181	—	+ 71	4½	—	" 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	" 16	91	84	— 7	+ 68*h*	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	" 14	3,594	3,356	+ 238	} +2,254	46	46	" 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	" 14	707	675	+ 32											
Dundee City Tramways	" 5	768	625	+ 143	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	" 15	12,673	10,446	+2,227	−11,445	104	95	" 31	582,146	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	Oct. 22	1,139	1,028	+ 111	+ 2,225	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	Nov. 15	1,000	866	+ 134	—	48	48	Sept. 30	29,061*h*	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	" 15	1,712	1,601	+ 110	+ 2,633	19	9½	" 30	72,331*h*	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	" 8	9,902	8,733	+1,169	+34,344	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	" 16	1,552	1,391	+ 161	− 983	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	" 16	4,106	—	—	—	46¼	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	" 13	929	752	+ 176	—	11	—	" 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	" 16	1,062	1,067	— 5	+ 2,672	19	17	" 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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NOTES.

Institution of Electrical Engineers.—We are informed that Mr. Swinburne's inaugural address, postponed on account of his illness from the 13th inst., will be delivered at an extra meeting to be held at the Institution of Civil Engineers at 8 o'clock on Thursday, Dec. 4.

The Pacific Cable.—On Monday, Dec. 8, the Pacific cable will be opened for public traffic. As forecasted in our last issue, messages from any part of the United Kingdom to Australia, New Zealand, Norfolk Island, and Fiji will be charged at the rate of 3s. a word. For transmission by this route telegrams may be handed in at the offices of any of the Atlantic cable companies, or at any postal telegraph office in the kingdom

Prof. J. J. Thomson.—We are pleased to hear that the Yale Corporation, in the United States, have retained Prof. J. J. Thomson to give a course of lectures there, this being the first appointment to the Silliman lectureship on an endowment left to Yale by the late Benjamin Silliman. It should be stated that this engagement will in no way interfere with Prof. Thomson's home duties as professor of experimental physics at Cambridge University.

Cablegram Facilities.—By the introduction of what is called a "social code" the Associated Eastern Telegraph Companies are offering further facilities to the occasional sender of social or domestic cablegrams, as distinguished from commercial messages. Copies of this code will be placed in each of the offices of the company in towns at home and abroad, and the officials have received instructions to afford the senders and receivers assistance in coding and decoding their cablegrams.

The American Institute.—The first local section of the American Institute of Electrical Engineers has just been formed at Pittsburg. This is probably an indirect result of the president's outspoken address to the members at the inauguration of the new session a few weeks back, when the position of the American Institute was unfavourably compared with that of our own Institution. It is to be expected that the example of Pittsburg will be followed by other large towns in the States, so that before long there will be a number of local organisations started, as in this country.

American Institute Proceedings.—The August and September issue of the *Transactions* of the American Institute of Electrical Engineers has reached us. Opening with a paper by Mr. C. O. Mailloux, entitled "Notes on the Plotting of Speed-Time Curves," it gives a good account of the proceedings at the nineteenth annual convention at Great Barrington in June last, including the discussions on several of the papers read at that time and also several communications on matters raised in these papers. Mr. B. G. Lamme's instructive paper, entitled "Washington, Baltimore, and Annapolis Single-Phase Railway," is also reproduced in this issue.

Royal Meteorological Society.—The first meeting of this society for the present session was held on the 19th inst. at the Institution of Civil Engineers, Mr. W. H Dines, M.A., president in the chair. Mr. F. Campbell Bayard read a paper on "English Climatology, 1881-1900," which was a discussion of the climatological data from the 40 stations of the Royal Meteorological Society, which have been continuous for the whole of the 20 years. A paper by Mr. C. V. Bellamy, M.I.C.E., on "The Rainfall of Dominica" was also read. This was a continuation of a former paper on the subject, and dealt with all the available rainfall data for the island of Dominica.

Books Received.—We have to acknowledge the receipt of a copy of the subject-matter index of "Mining, Mechanical and Metallurgical Literature" for the year 1900, which is published by the North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne. From Messrs. H. Alabaster, Gatehouse, and Co. we have received "Telegraph Switching Systems" by Mr. T. F. Purves, technical officer in the engineer-in-chief's department of the General Post Office. We have further to acknowledge a copy of a new monthly illustrated magazine under the title of "The World's Work." This new publication, which deals both with the national and social questions of the day, is edited by Mr. Henry Norman, M.P., and published by Wm. Heinemann at Bedford-street, W.C. Volume 5, Part II., of *Science Abstracts* is also to hand this week.

Electric Tug Boats.—A German company is reported to be running a number of electric tug boats for touring purposes regularly between Zehrdeuick and Berlin. The dimensions of the boats are from 46ft. to 49ft. long and 10ft. wide, and they have a draught of 3·4ft. We understand that these boats are also used for towing barges up and down the canal, their displacement being considerably less than that of steam tugs of equivalent drawing power, and they are, therefore, peculiarly suited to towing purposes in shallow and winding canals. We regret that no information is given as to how the electrical energy is obtained — whether from accumulators on the boats or from an overhead line. Electric haulage on canals on the Continent and in America is usually accomplished by tractors running along the banks and receiving current from overhead trolley wires.

John Fritz Medal.—On the celebration of the eightieth birthday, last August, of Mr. John Fritz, who is popularly known in the States as the "Father of Mechanical Engineering," his professional associates and friends founded an award, which is to be called the John Fritz medal, to perpetuate his achievements in industrial progress. The conditions of this award have now been decided on. The medal is to be awarded annually for notable scientific or industrial achievement, and there is to be no restriction on account either of nationality or sex. The medal will be of gold, and the recipient will also receive an engraved certificate, which shall recite the origin of the medal and the special achievement for which the award is made. A Board of 16 members appointed from the membership of four national societies of America, including the American Institute of Electrical Engineers, will make the award each year.

Electricity in the Growth of Man.—Prof. Herman, of the University of Michigan, is reported from New York to have made the discovery that growth can be artificially given to the human body by properly directed electric currents. From the information before us the professor requires 15 years in which to transform a child into a full-grown person. Having exhausted his experiments on animals he has treated three young men—two of them healthy and the other a paralytic—who volunteered to act as subjects. It is said that they all added to their stature, and the paralytic felt an absence of his usual pain while he was under the influence of the electric currents. Prof. Herman himself believes that growth thus obtained is not conducive to health, but he asserts that electricity applied by his method will cure rheumatism, gout, and other diseases of that nature. We doubt the statement above. Prof. Herman uses a large solenoid, into which he places his victims, and claims that the magnetic stresses set up induces growth. There have been many unsuccessful attempts in the same direction by magnetic belt experts.

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St. Petersburg Tramways.—With respect to the advertisements issued on behalf of the Municipality of St. Petersburg—which were opened in the middle of August, and did not close until the beginning of the present month—for offers for taking over the complete tramway system of that city and converting it to electric traction, we learn that there was not a single offer received in reply. On the date at which tenders were to have been opened it was found that there was no proposal to lay before the Municipality, and it is presumed that the only alternative will be for the trams to be converted under municipal control. We hardly think that it is due to want of initiative among electrical firms and financiers that there were no offers for taking over and working the St. Petersburg trams, but rather to the uncertainty as to the real value of the concessions which would be granted. It will be remembered that in electric lighting affairs a comparatively large number of rival concessions have been granted, which only gave the owners the right to obtain what connections they could in spite of strenuous opposition. It is a great pity that there is not a larger representation of the commercial classes in the Government of Russia.

Attractive Force and Magnetic Induction.—In the *Physical Review* for October Mr. G. E Poucher has an article on the above subject, in which he describes some experiments in order to see how far the formula $A = \frac{S B^2}{4\pi}$, as given in Mr. Kapp's book on Dynamos, Alternators, and Transformers is correct. In this formula, A = the attractive force in dynes, B = the magnetic induction in C.G.S. lines per square centimetre, and S = the area of the end of the bar in square centimetres. The author in his experiments, however, uses a ball of iron opposite to the magnetic pole on which the experiments are being conducted, and his conclusions are that the attractive force, as expressed as a function of the induction in Kapp's formula, does not hold for objects at a distance from the magnet. This conclusion was exactly what one would expect, as the formula was meant to express the pull between the pole of an electric magnet and a keeper practically in contact with it. In that case all the lines of force pass from the magnet into the keeper, whereas in Mr. Poucher's experiment it is an open question how many of the lines of force emanating from the magnetic pole would pass through a sphere of iron suspended at some distance above it.

Electrolytic Phenomena.—The current number of the *Journal* of the Chemical Society has a short abstract of a paper by Messrs. W. Nernst and E. H. Riesenfeld on the electrolytic phenomena at the surface of separation of two solvents. It seems that when a current passes through a U-tube containing a solution at the bottom and another solvent on both sides, electrolytic phenomena take place on account of the migration of the dissolved substance. The deduction is made that the electrolyte diffuses into the two solvents according to the distribution ratio and the ratio of the square root of the diffusion coefficients. The quantity of electrolyte which remains at the surface of separation depends only on the current passed through and on the difference of the transport numbers of the electrolyte in the two solvents. This has been experimentally proved with potassium tri-iodide in water and water saturated with phenol. It has also been proved by experiments with potassium dichromate, ferric thiocyanate, and *o*-nitrophenol. With the latter, there is an increase of concentration at the anode and a decrease at the cathode, the change being easily recognised by the colour. With potassium tri-iodide, the increase of concentration takes place at the cathodes. The method can be used to determine the transport number in one solvent if that in the other is known.

Central-Station Heating.—In a paper presented to a recent meeting of the National Electric Light Association of America Mr. P. H. Korst enumerates some of the advantages of utilising the exhaust steam in a central station to heat water, and supplying this hot water to dwellings through a system of pipes. In the case instanced by the author it was found possible while using the exhaust steam for this purpose to do so without putting back pressure on the engines, and even to run the engines condensing. With exhaust-steam heat the author states a temperature of 212deg. or more is obtained whenever there is steam on, and for fully three-quarters of the heating season this is more than is needed. Again, both heat and water are lost when condensing water is turned into the sewers. With hot-water distribution the temperature of the water can be varied to suit the outside temperature, and the condensed exhaust steam in the heater can be returned to the boilers after trapping out the oil even if the engines are run non-condensing. Fuel economisers can be used to impart waste heat to the water, and live steam-heaters are generally used to add extra heat in very severe weather, and also at times when sufficient exhaust steam cannot be obtained. Among the advantages of a hot-water system, the author mentions that proper insulation of mains and service pipes is a simpler proposition with hot water than with steam on account of the lower temperature, which permits the use of efficient material, that would deteriorate under the higher temperature of steam heating.

Radiations from Radio-Active Substances.—A paper by Mr. E. Rutherford and Miss H. T. Brooks is abstracted in the current number of the *Journal* of the Chemical Society, in which a comparison is made of the radiations from radio-active substances. The authors state that the more penetrating β-radiation from uranium is deflected by a magnet, the deflection being of about the same order as for radium rays. The α-radiation is not affected by a magnetic field. The coefficient of absorption of β-rays by various metals has been determined, and it is found that the law of the absorption of cathode rays depending only on the density is not true for all substances. The most penetrating rays are the excited radiations due to thorium and radium, then follow in order the rays from thorium, radium, polonium, and uranium. In seeking for a connection between absorption and density, it has been found that when aluminium and air are compared, the absorption is proportional to the density. The result for the non-deviable rays is opposite to that for the deviable β-uranium rays. The emanating power of radium is increased more than 10,000 times by heating to dull redness. From the rate of leakage from excited radio-activity, it is deduced that the speed of formation of ions by this is greater than by the direct radiation. The penetrating power of radium-excited radiation is independent of the substance in which it is produced. The decay of excited radio-activity has been found to be a function of the time of exposure.

Dublin Local Section.—In the opening remarks of his inaugural address to the Dublin Local Section on the 21st inst., Mr. A. E. Porte, the chairman, referred to two matters of general interest to the electrical profession. In the first place, he stated that Mr. J. W. Towle, electrical superintendent to the Dublin United Tramways Company, has been appointed to the leading position in connection with the electrification of the London underground rail-

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ways, and he will be responsible for the erection of the giant power station at Chelsea, which will have a capacity of 50,000 h.p. The second announcement was to the effect that Mr. F. Gill was leaving Dublin to take up the position of chief engineer to the National Telephone Company, in London. Both these gentlemen have in the past been prominent members of the Dublin Local Section, and Mr. Towle had, in fact, been chosen chairman of the section for the present year. Mr. Gill has acted as hon. secretary to the section for a considerable time, and at the opening meeting last Friday the members of the section presented him with a handsome piece of silver plate in recognition of his valuable services in that capacity, and in token of the sincere regard of his professional brethren in Dublin. The chairman's address was confined to a review of the progress which has recently been made in electrical work of all kinds, and a consideration of the directions in which engineers might reasonably expect advances to be made in the near future. We hope to reproduce the address in full in an early issue.

Electric versus Gas Lighting.—The economy of electric lighting over gas lighting has once more been proved in the case of the new central Board school at Morecambe. When it became necessary to consider the question of the artificial lighting of this building, tenders were got in from the Corporation departments for both illuminants. The gas manager estimated that the cost of gas lighting would work out at 19s. per hour, while the electrical engineer calculated that an outlay of 7s. 6d. per hour would illuminate the whole building if the electric light were adopted. It is not surprising, therefore, that the School Board decided to instal the electric light, and Mr. Richard Pape, the borough electrical engineer of Morecambe, was appointed consulting engineer for the work, to whose plans and specifications an installation of about 300 lights has been successfully carried out. A test of the consumption has since been made, when it was found that the cost per hour was even less than was estimated by Mr. Pape, and that it did not amount to more than 6s. 3d. This result is naturally very gratifying to the Morecambe School Board, who, although in favour of the electric light, were at first afraid that the estimate of 7s. 6d. would either be much exceeded or the installation prove insufficient. Happily, these forebodings have not been realised, nor, in the light of previous experience, was it to be feared they would be. It may be mentioned that the installation includes four one-ampere Nernst lamps, and that steel conduit has been used throughout.

A 25,000-Volt Direct-Current Dynamo.—In order to test the insulation of the complete system for the transmission of energy by continuous current from St. Maurice to Lausanne, an interesting dynamo has been constructed, of which the following particulars are available. The transmission scheme in question is being carried out on the Thury system, and we believe that that firm is responsible for the design of the small dynamo used to test the insulation. In it the armature is fixed and the field magnet revolves, contrary to the usual practice. The field magnet has two poles, and the excitation for these is led to the windings by means of two independently insulated rings. The fixed armature is wound with 48 coils, each of 500 turns each, and has a total internal resistance of 700 ohms. It is in the commutator that the greatest novelty is found. In this machine, when working at 25,000 volts, there is often 750 volts between adjacent segments at the point of commutation. Mica insulation between the segments would be quite useless at this pressure, and the designer has accordingly used air insulation instead. The revolving brush is also ventilated by means of a current of air supplied from a small fan on the shaft. The blast is thus increased in pressure with an increase in speed of the machine, with the result that destructive sparking is entirely prevented. In order to facilitate commutation, a series of condensers is also shunted across the successive segments and the commutator at the commutating point. This machine was able to give an ampere at a pressure of 25,000 volts, and the insulation of the system was sufficiently high for it to prove that no fault existed.

Goods Traffic at Huddersfield.—The committee of the Huddersfield Corporation which has the management of the electric tramways, has recently entered into an agreement for seven years to carry to the works of a firm at Lindley all the coal they will require. The coal will be taken over a distance of 2½ miles, including a short length of tramway, which has to be constructed, into the works of the firm. This departure by the Huddersfield committee, acting on the advice of their tramway engineer, Mr. H. N. Thomas, is one which is likely to be followed by other corporations in the near future. We understand that a special motor-driven truck is to be constructed for the work in question, which will be able to carry about seven tons of coal. The truck will have hoppers, and will discharge at the sides, and, if possible, the design will be such that it will be self-trimming. It will be mounted on a four-wheel truck equipped with two motors, the wheel base being 6ft. A platform at either end will be provided for the driver, and a controller will allow of the car being driven from either end. In view of the heavy grades in the Huddersfield district, hand, slipper, and electric brakes are to be provided. We should not be surprised to hear that when this truck has been proved to be successful, the Corporation will undertake the delivery of coal with it to outlying residents on the moors around Huddersfield. The interesting feature of the present contract is the provision of the branch line into the manufacturer's works, which will enable the terms of the agreement to be carried out without interfering with the time schedules of the ordinary cars, as all the loading and unloading will be done off the main line of the Corporation tramways.

Personal.—It is officially announced that Mr. Francis Wm. Webb has resigned the position of chief mechanical engineer of the London and North-Western Railway, to which he was appointed in 1871 in succession to the late Mr. Ramsbottom. Mr. Webb's connection with the Crewe railway works dates from over half a century ago, and it is computed that in the last 20 years he has built over 4,000 locomotives. He entered the Crewe works as the pupil of the then locomotive superintendent, and was appointed chief draughtsman in 1859, eight years later. In 1861 he was promoted to works manager, and subsequently attained to the high office from which his retirement is now announced. As a builder of locomotives Mr. Webb stands out prominently in the railway world, where his name is more particularly associated with the construction of engines of the coupled compound class. He has designed and carried into effect numberless improvements in steam locomotives. It was Mr. Webb who introduced steel locomotive boilers at Crewe in 1872, and it is to his credit that not a single case of rupture occurred among 4,000 boilers of this type. He also invented electric tube cutters; he was largely responsible for the introduction of the method of making in cast steel articles which were too expensive to forge, and he designed the interlocking of signals in 1874. In the same department at Crewe, where this latter work is carried out, is manufactured the Webb-Thompson electric staff apparatus for single-line working. Also, in conjunc-

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tion with Mr. Thompson, Mr. Webb patented the complete electrical system of signals used in all the Crewe boxes. With this system all the signals and points at this important junction are worked electrically.

Earth Return Currents.—A committee appointed by the German Association of Gas and Water Engineers recently reported the result of their year's labour towards the protection of gas and water pipes from earth currents from electric tramways. The committee have been in conclave with a committee of electrical engineers without coming to any definite conclusion. From the report, which is before us, we gather that the real cause of the difficulty is that there are no reliable facts or data as to obstruction caused by such stray currents. In consequence of this the electrical engineers in Germany naturally opposed the requirements of the gas and water engineers as to extremely low limits for the variation of the voltage in the return circuit of the tramways. Reference is made in the report to damage done in Hamburg and other large towns in Germany, and in England, but the evidence from this country is not known to us. As was recently stated by the electrical expert of the Board of Trade, there is no evidence available to prove that the Board of Trade limit of seven volts in the return circuit is not sufficient to protect metal pipes in the ground. The great difficulty of the matter is the differentiation between the ordinary corrosion which takes place in iron pipes buried in the soil, and that corrosion which is due to electric currents entering and leaving the same. As was pointed out recently in this journal, gas engineers are too apt to conclude that the ordinary corrosion is caused by electrical means, and others again look upon an arcing between electric mains and gas-pipes as being due to stray currents from tramways. Everything is to be gained from an accurate record of the facts. All such accidents as occurred at Bradford, where electric lighting mains were the cause of trouble, which was immediately localised by the damage done, should be eliminated from consideration.

Water-Power Development in the States.—A water-power plant of the capacity of 32,000 kw. is under construction at Sault Ste. Marie, Michigan, and is attracting considerable attention in the States on account of its size. Indeed, it is exceeded in magnitude only by the Niagara Falls power plant. The most remarkable feature about this new installation is that it is made up of no less than 80 small generating units, of 400 kw. each, and the length of the station is something over a quarter of a mile. It seems that the difficulty of getting large turbine units to operate on as low a head as 20ft. was the principal cause of installing such small generating units, and in this particular the generating station at the "Soo"—as Sault Ste. Marie is commonly termed—is quite unique when compared with other large water-power plants in America. From an editorial comment in the *Electrical World* we gather that the small units employed at the "Soo" have led to considerable difficulty in the designing of a comprehensive scheme of switchboard control. If the ordinary practice were followed, supervision of the entire board by one man would have been impossible, besides involving an enormous amount of copper in the power-house for generator leads and 'bus bars. The problem has been solved by the use of edgewise instruments and very narrow switchboard panels with electrically-operated switches, so that no main circuits are taken to the switchboard. It may be noted that the use of these edgewise instruments has resulted in a very neat scheme for enabling the attendant to see at a glance the relative load and the relative field current on all the generators operated. Also it is proposed to use circuit-breaking switches operated by solenoids, the switches being held closed as long as current flows in the solenoids. The Sault Ste. Marie scheme does not contemplate the transmission of energy to long distances. Most of the current generated will be used in the neighbourhood of the station, principally for the operation of electric furnaces and in electro-chemical work.

Train-Lighting by Electricity.—There have been many attempts to devise an ideal system of train-lighting by electricity, but an altogether novel method for attaining this object is proposed by Mr. G. D. Wilson, of Chicago. As in other methods, the motion of the train is used to generate the electricity, but in a different way. Instead of using the power from the car axle, it is furnished by a rotary fan attached to the front end of the locomotive. As shown in the illustration accompanying a description of the apparatus in the *Railway and Engineering Review* of Chicago, the fan is located close to the boiler head, and presents a moving and cutting surface to the air. The fan, cutting through the air, revolves swiftly, and, it is said, does not add to the resistance of the car nor retard the speed of the train. The ordinary pressure of the train moves it sufficiently to generate the electrical energy required to light the carriages. The dynamo is located either on or under the pilot, and is direct-connected to the fan by a special device. A storage battery is placed on the tender or underneath each car, and is equipped automatically with cut-outs so as to properly govern the flow of current from dynamo to battery. We gather that the system has been subjected to tests on a train running 45 miles an hour, resulting in the development of 4·5 kw. at the dynamo constantly. This was found to be sufficient to charge the storage battery so as to illuminate a train of five coaches seven hours per night, and leave the battery with nearly its maximum charge. This application of an air-driven dynamo for train-lighting is interesting, but we hardly think it is so practical as other systems which have been developed for driving the dynamos from the axles of the cars. In the first place, the speed of the fan will vary not only with the speed of the train, but as the difference between the speed of the train and the wind velocity resolved in the opposite direction to that in which the train is moving. For instance, if the train has a 30-mile gale behind it, presumably there would be hardly any movement of the air-propeller driving the dynamo. The same gale in the opposite direction would cause unduly high speeds.

Electromotive Behaviour of Chloric Acids.—Mr. E. Müller has shown that when a solution of a chloride is electrolysed with gradually increasing applied E.M.F. (the anode being a point of smooth platinum and the cathode a hydrogen electrode), there are two changes of direction (at 1·3 and 1·9 volts) in the curve representing the current passing. The second change at (1·9 volts) is not observed when the anode is platinised, and it is not so well marked when the electrolyte is acid as when it is alkaline. In a more recent paper, shortly abstracted in the current number of the *Journal* of the Chemical Society, Mr. Müller describes some experiments in which measurements were made of the E.M.F. of cells consisting of a hydrogen electrode and of a smooth platinum electrode immersed in an acid or alkaline solution of hypochlorous acid, or of chloric acid. The results show that chloric acid gives a very much lower E.M.F. than hypochlorous acid of similar concentration. A solution of hypochlorous acid of about normal strength gives an E.M.F. about 0·1 volt higher than a saturated solution of chlorine. The author considers that these observations are best explained as follows. The change occurring at the anode is

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$Cl' + OH' = HClO + 2F$. In presence of a platinised electrode, the hypochlorous acid is very rapidly decomposed, so that its concentration can never rise much above the value corresponding with the equilibrium $Cl_2 + H_2O \rightleftarrows HClO + HCl$. The decomposition point observed at 1·3 volts corresponds with the establishment of this equilibrium. With a smooth platinum anode, the catalytic decomposition of hypochlorous acid is very much slower, and its concentration may therefore become considerably greater than that given by the equilibrium. The higher decomposition point would thus be due to the formation of a concentrated solution of hypochlorous acid at the anode. That a solution of hypochlorous acid does not give so high an E.M.F. may be due to the fact that the concentration in contact with the electrode is diminished by catalytic decomposition and electrolytic reduction to a lower value than it would have if the hypochlorous acid were being formed at the electrode.

The Valtellina Three-Phase Railway.—Although many interesting particulars of the construction of this railway came to light in the arbitration proceedings between the London underground railway companies last year, a complete description of the line was not then forthcoming. Now that the railway has been working electrically for some six or seven weeks, an article in the *Electrical World* describing some features of the three-phase line is most opportune. It is contributed by Mr. Cesare Pio, and we gather from his remarks that so far no hitch of any kind has occurred in the running of the passenger services or the freight trains. With regard to the anticipated danger to human life of working the line with a 3,000-volt pressure on the trolley wires, it is satisfactory to read that only one accident, resulting in the burning of the left arm of a motorman, happened in the whole year of experiments and tests. The electrical energy is generated by water power at 21,000 volts, and is reduced to 3,000 volts for the working line at transformer stations located along the side of the railway. The poles supporting the trolley wires are of wood, which in five years' time will require to be replaced by iron or steel poles. The suspension of the trolley wire is made without soldering, and it may be noted that there is not much complication of wires. Two peculiar features of the line are the double insulation and the elastic suspension of the trolley wires. The primary line is also carried on the trolley poles, and where this crosses the trolley wires a special arrangement has been devised to avoid accidents. It will be recalled that this device was explained at the arbitration above referred to, being such that in case of a communication between a primary and secondary circuit the fuses blow in the secondary sub-station. Lately, there has been added to the trolley arch a little dash-pot, so that in lifting up and lowering down with compressed air inconveniences due to the kinetic force are avoided. A cooling device has also been added to the water resistances of the controlling apparatus. The collecting device of the trolley used on the Valtellina line is worthy of special study. It consists of two cylindrical rollers terminating in two little conical surfaces, designed to work smoothly at the switching points. The rollers are of phosphor-bronze, and are fitted with ball bearings. It is important to note that these bearings do not carry current at all. The current is conveyed by means of small carbon contacts. The two rollers are insulated from each other with wood. Locomotives are used for freight traffic, and these have a tractive effort of 10,000lb. and run at the speed of 18 miles an hour. The multiple-unit system is employed in the passenger services, the motorcars running at two different speeds, 18 and 36 miles per hour. The cars are lighted by electricity, and heated and ventilated with current at 120 volts, derived from a small step-down transformer installed on the car. At present the Ganz Company is lighting all the stations along the line by utilising primary current from the Marbegro power station after lowering its voltage with convenient transformers.

The Nernst Lamp.—At a time when electrical engineers are able to experiment for themselves on the life and light-giving properties of the Nernst lamp, any technical information on the subject is of exceptional interest. Unfortunately, this technical information on the Continent and in England is in exceedingly few hands and, in consequence, is not allowed to appear in the technical Press. The *Electrical Review* of New York has been fortunate in obtaining an interesting history of the development of the Nernst lamp in the United States under the guidance of Mr. Westinghouse, who secured the patent rights for America. The lamp has been developed in that country by Mr. A. J. Wurts, who had to assist him Mr. H. N. Potter and Mr. M. W. Hanks. The article before us is not signed. The first interesting detail is that connected with the mounting of the glower on the platinum terminal. In order that this may be done securely, a small globule of platinum is fused into the end of the glower by means of an arc. When the globule has been placed on the end of the glower, it is inserted again into the arc, and the difference in the surface tension of the two materials results in the globule of platinum formed being slowly drawn into the larger ball of molten glower material. The glower is then removed from the arc and a platinum wire inserted into the globule whilst still in the molten state. On cooling, the oxide mixture shrinks round the platinum and gives an exceedingly good joint. The experiments as to the behaviour of the glower in a vacuum are given in detail, and amongst the facts noted is that with a direct current in a vacuum the surface of the glower becomes black, and oxygen is set free. It was also found that when in a vacuum a tree of metal was formed in the centre of the glower, which confirms the idea that the action of the current is as that of an electrolyte. The use of a pure iron wire resistance in series with the glower in order to prevent an excess of current through the same if the voltage should rise is described as being an invention of Mr. Potter, who found that if this wire were enclosed in a globe with inert gas it prevented the Edison effect taking place, and also prevented rusting of the iron. The type of heater used in the American type of lamps to bring the glower up to the temperature at which it conducts, consists of two tubes of porcelain wound with fine platinum wire and then covered with a non-conducting paste. With this, trouble was found at first through a leakage of the current through the heated porcelain tube, and a new mixture of porcelain had to be found which did not become a conductor under the temperature used. Another fault was the unequal expansion of platinum and porcelain, which caused abrasion between the two, which wore the platinum wire away. This trouble has been overcome by making the tubes of soft porcelain. The automatic arrangements for cutting out the heating coils when the current through the glower has been established are described, and the article concludes that while there are many small details in the construction of the Nernst lamp which still require attention, the lamp is being steadily improved and simplified. This conclusion will, we think, be endorsed by English engineers, but there are some of these who are inclined to visit on the Nernst lamp the faults arising from the imperfect voltage regulation of their own supply systems.

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CLECKHEATON ELECTRICITY WORKS.

On Friday last, Nov. 21, the electricity works at Cleckheaton were formally opened by the chairman of the Council, Mr. Francis Birkett. The three engines which at present form the generating plant in the station were started by three different gentlemen, who have all taken a prominent interest in the carrying out of the work. These three were Councillors Thornton, Wadsworth, and Roberts. In spite of the fact that the opening ceremony was hurriedly arranged, all the details being organised within a week, it was a most successful function, and over 50 gentlemen were entertained afterwards to dinner in commemoration of the event. Owing to the short notice, however, several of the contractors were unable to be present, and we ourselves found the notice too short to be able to accept the kind invitation to attend. Cleckheaton has a population of 12,500, and is about equally distant from Leeds and Bradford. The Cleckheaton area lies along the Spen Valley, through which the British Electric Traction Company are about to run a system of light railway. In the earlier days, when the undertaking was first considered, it was a question as to whether this company or the Bradford Corporation would obtain the powers to construct the railway, and there was in consequence considerable opposition to the application made by the Cleckheaton Council for their order. In spite of this, they succeeded in their efforts, and also obtained from the British Electric Traction Company an agreement by which the whole of the electrical energy required for the line within their area will be supplied from the present station. It is also now arranged that the other sections of the same railway in the Liversedge and Gomersal districts will be supplied from the works. This agreement between the Cleckheaton Urban District Council and the traction company provides for a minimum supply of electrical energy of 400,000 units per annum at 1½d. per unit. In other words, the company has to pay at least £2,500 per annum to the Council. The next 100,000 units are to be charged at 1·4d., and all energy above this at 1·3d. per unit. These prices are, in our opinion, quite fair to all concerned. They will enable the standing charges of the present station to be met, and, on the other hand, the Council are not making an undue profit out of the tramway company, as has been done in other places. In fact, the agreement allows Cleckheaton to have its municipal electric lighting undertaking practically without risk of it being a burden on the rates. The town itself is an enterprising one, as it has secured under its municipal control the gas and water supplies, public baths, and markets. For the present work they have consulted the firm of Messrs. Baker and

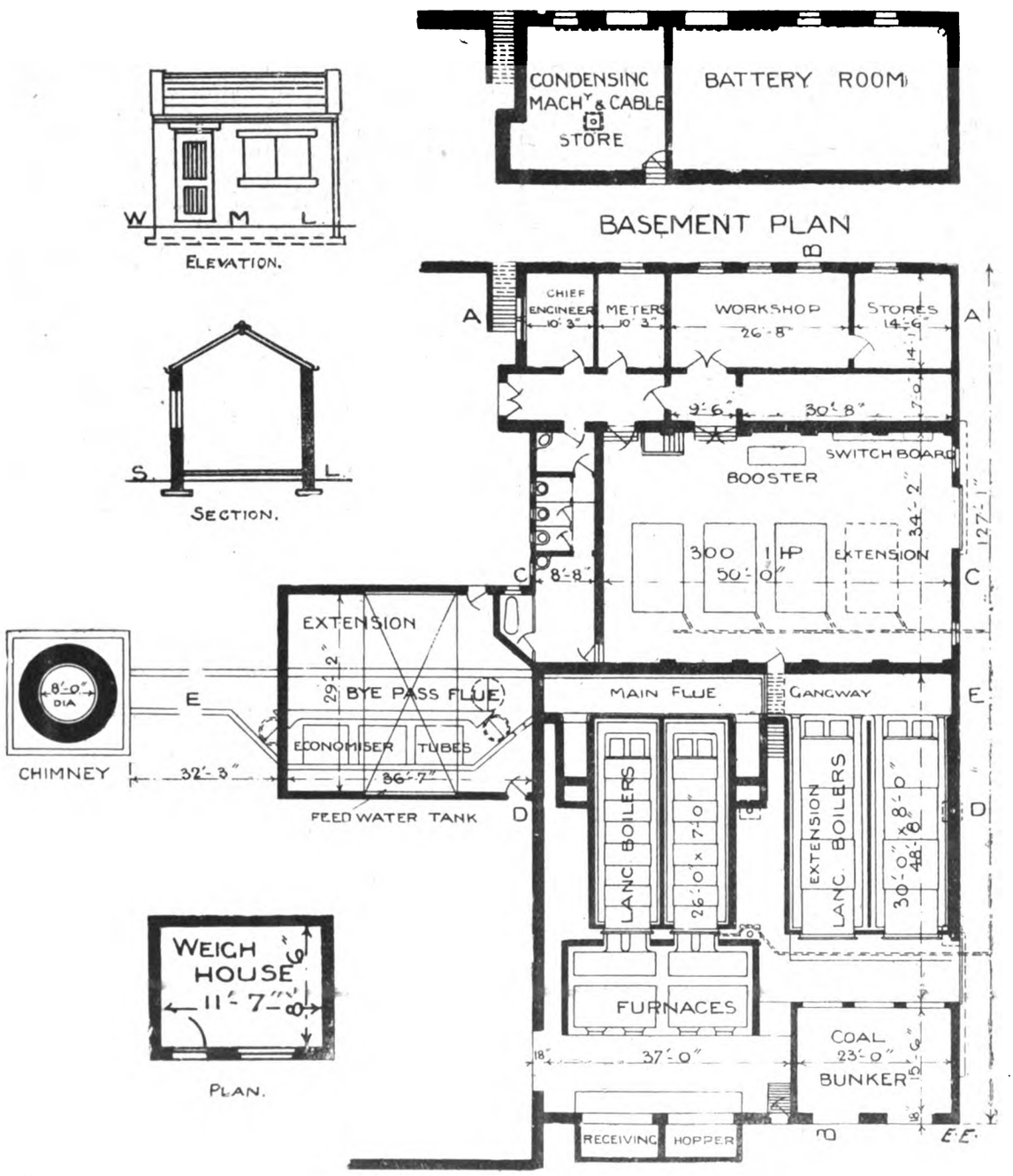

FIG. 1.—Plan of the Cleckheaton Electricity Works.

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Appleby, for whom Mr. C. A. Baker has had entire control both in the design and the carrying out of the engineering equipment of the works and mains. The design of the station buildings and the erection of the same has been the charge of Mr. Clifton Lund, the surveyor of the

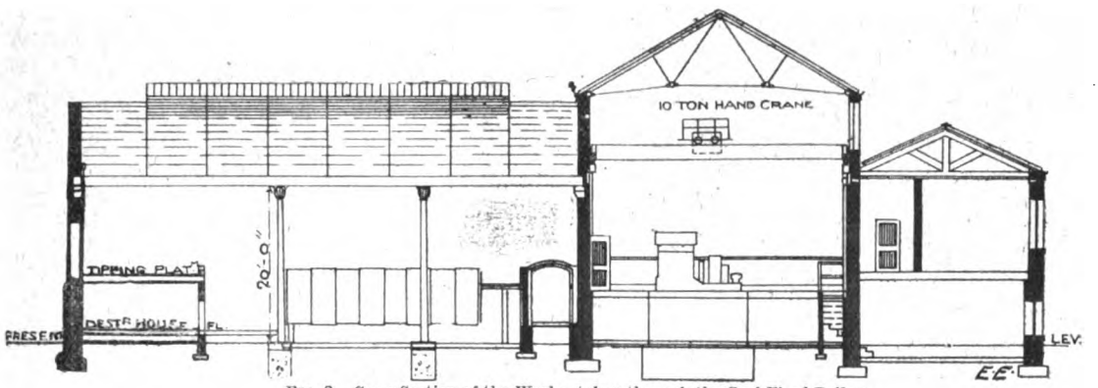
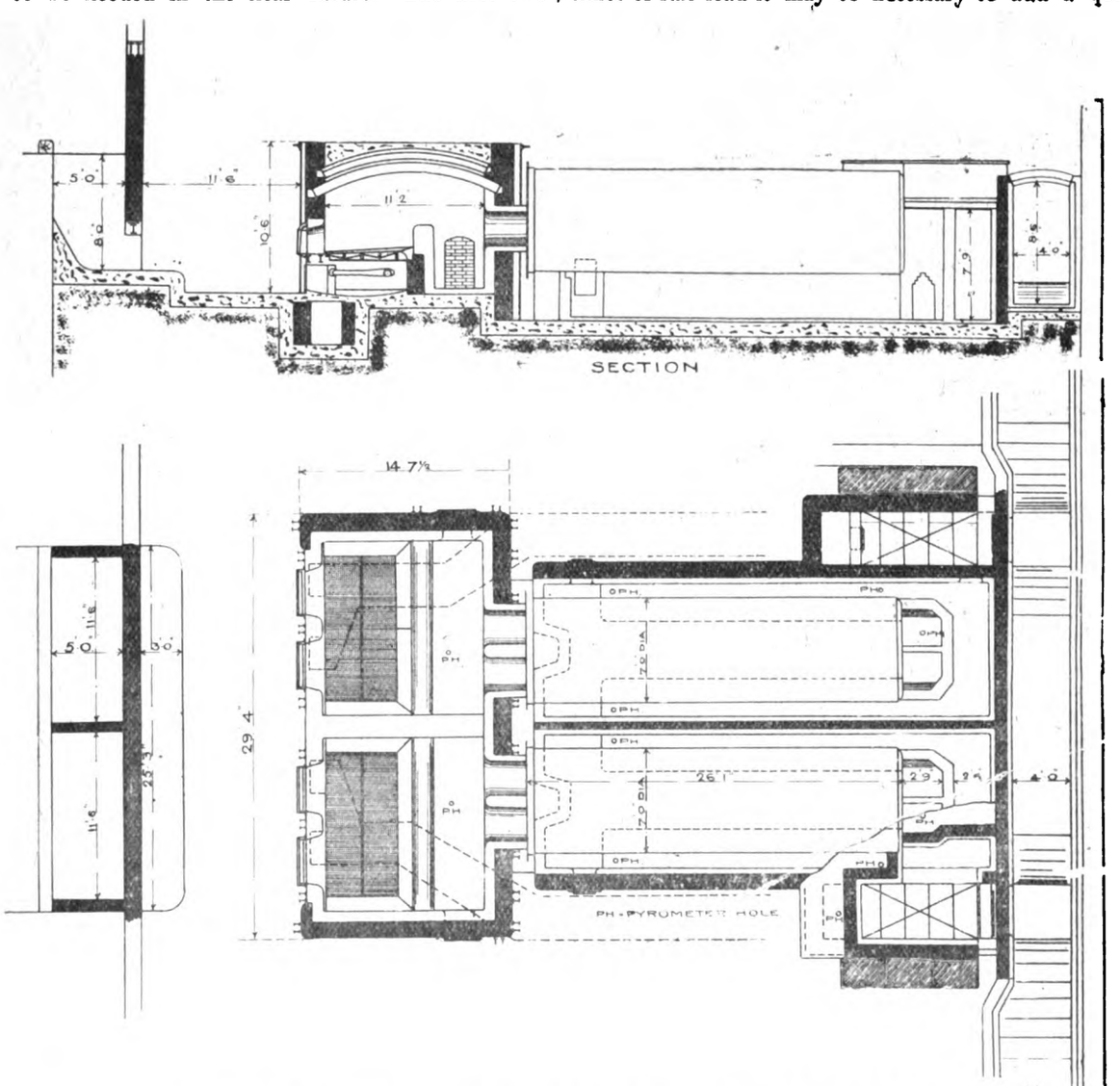


FIG. 2.—Cross-Section of the Works, taken through the Coal-Fired Boilers.

Urban District Council. It will be seen from the drawings (Figs. 1 and 2) that these buildings are essentially useful ones. Money has not been wasted in giving extravagant frontages, but, on the other hand, the buildings have been designed to afford ample accommodation for the plant likely to be needed in the near future. The first two boilers which have been erected have been equipped with furnaces for burning the ashbin refuse of the district. These furnaces are of the Meldrum type, and they are equipped with the usual forced-draught apparatus. The boilers, manufactured by Mr. J. J. Horsfield, of Dewsbury, are of the Lancashire type, 26ft. long and 7ft in diameter. The thickness of the plates is $\frac{3}{4}$in., and the boilers, in order to meet Mr. C. A. Baker's specification, have to be suitable for a working pressure of 180lb. per square inch. The normal working pressure at the station will be 160lb., but the insurance companies frequently require the working pressure to be reduced as the boilers age. This reduction is thus provided for in the present case by having an ample margin in the first instance. It is hoped to get a very considerable proportion of the steam required from the burning of the refuse in the destructor furnaces, but at times of full load it may be necessary to add a quantity of small coal to the fires It will be seen from the plans that the next two boilers to be erected will be of the ordinary coal-fed type. The placing of the orders for these and also for the fourth generating set for the engine-room is now under consideration.



FIGS. 3 AND 4.—Plan and Section of the Meldrum Refuse-Destroying Furnaces and Horsfield Boilers.

The steam-pipes are not shown on the drawing, and they

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are exceptional in arrangement. They consist of two totally distinct systems for connecting up the engines to the boilers. The connections in each case start from Y pieces on the boilers, and end at Y pieces on the engines. In the first system of pipes, which will be in use under normal conditions, a considerable number of valves have been introduced in order that the length of pipe under steam at any time may be kept down to the lowest possible limit in order to save condensation losses. The auxiliary system of steam-pipes, on the other hand, has exceedingly few valves, except, of course, those on the junctions to the Y pieces. In many ways this duplicate system is to be preferred to the ring main so commonly found in electricity works, which is quite dependent for its advantages on the tightness on emergency of steam-valves which are very seldom shut. The fittings on the boilers are of the Hopkinson type. The valves in the steam-piping are of the Marchent make, and the whole of this part of the work was carried out by Messrs. Aiton and Co., of Willesden. The auxiliary plant, including a jet condenser by Alley and McLellan, two 1,000-gallon feed pumps, and a 4,000-gallon supply pump, are all electrically driven, in order that the great waste of steam usually found in direct-acting steam-pumps may be avoided. In the same way the scrapers of the Green's economiser, with its 192 tubes, are driven by a motor. The whole of the water for the works is taken from the Spen Beck, which is comparatively close to the works. The supply pump above referred to draws water through 500ft. of pipe from the stream, and delivers it into a tank, 30ft. by 14ft. by 5ft., placed over the economiser. The town mains are also led into the works to act as a stand-by water supply, but we understand that the extensions now in hand include a duplicate supply pump to take water from the Spen Beck.

Coming now to the plant in the engine-room, this consists of three 150-kw. steam dynamos. The engines are of the Belliss and Morcom make, while the dynamos were supplied by Messrs. J. H. Holmes and Co., of Newcastle. They are of the Johnson-Lundell type with six poles each. These poles, as is usual in the case of the Johnson-Lundell dynamos, are split up the centre, and the design of the pole-pieces provides for a commutating field which varies with the requirements of the load, so that the machines run sparklessly without any shifting of the brushes. Mr. Baker subjected these machines before delivery to the following onerous test: they were run for 10 hours at full load, and then for half an hour 50 per cent. overload was taken from them. It speaks well for the designer that they stood this without sparking and without the increase in temperature exceeding 70deg. F. in any part of the machine. The dynamos are compound wound to give up to 550 volts. When used on lighting circuits the compound winding will be used short-circuited at the machine, as is indicated in the accompanying diagram of connections (Fig. 5). Besides these dynamos there is a balancing and boosting set supplied by the Phœnix Dynamo Manufacturing Company, of Bradford. These machines are of 7 kw. capacity.

The switchboard, supplied by Messrs. Dorman and Smith, of Salford, is constructed of slate slabs mounted on an iron framing. The arrangement of the circuits is somewhat different from that adopted in a good many of our central stations, and hence the diagram of connections (Fig. 5) will be of great interest to our readers. It will be seen that Mr. Baker has provided three distinct circuits to which each of the dynamos can be connected by means of two three-way switches, one on each pole. These switches are not coupled together. In each dynamo circuit there is also provided a maximum and a minimum automatic cut-out. The three main circuits above referred to are respectively for lighting, for charging accumulators, and for supplying the tramway load. The shunt breaking switches are of the Still type, in which a resistance is switched across the terminals of the shunt before connection from it to the 'bus bars is disconnected. The general arrangement of the switchboard is as follows: The middle panel contains the accumulator regulating switches and other switchgear connected with the accumulators, the whole of the dynamo switchgear is on the left of this, and the feeder switchgear and circuit breakers on the right. The gear connected with positive and negative poles respectively are divided from each other horizontally instead of vertically, as is frequently the case.

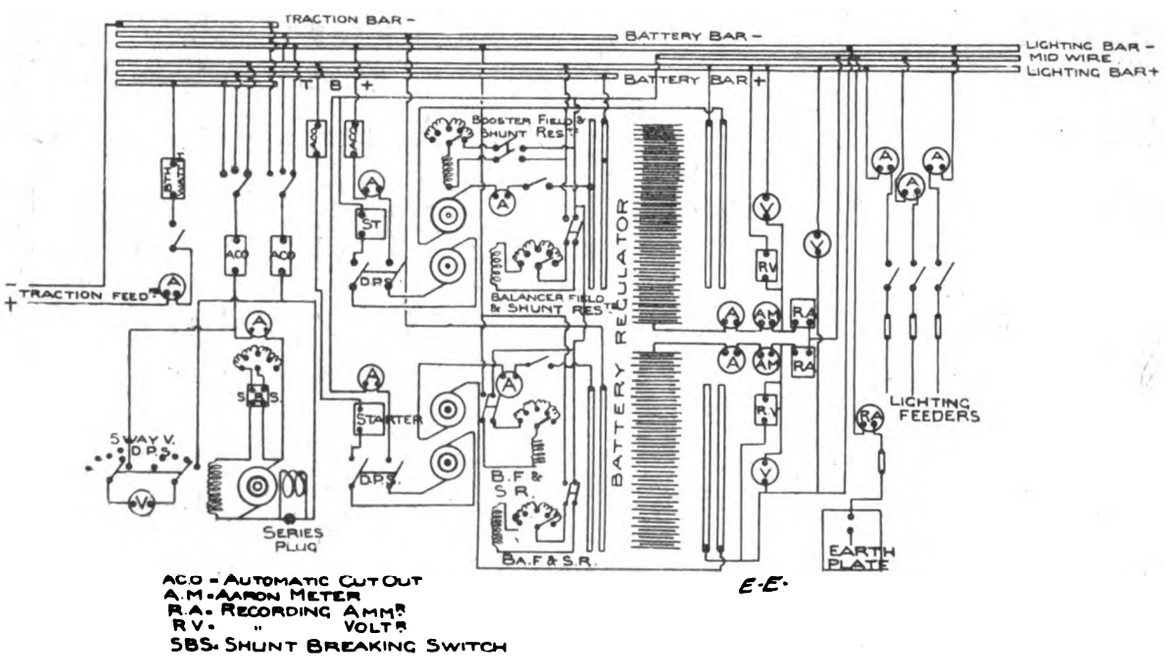

FIG. 5.—Diagram of Connections of the Cleckheaton Switchboard—only one Dynamo and Feeder are included.

The accumulators now installed consist of 270 cells of the Electrical Power Storage make; the output of these is 50 amperes on a 10-hour discharge rate, or 250 amperes for one hour. The plates are mounted in glass cells, with the usual stillages for supporting them. Since erection and charging, these accumulators have been tested by the consulting engineer and found to come well up to specification. The switchboard arrangements are such that the boosters can charge any section of the end cells that may require separate attention.

The whole of the cables have been supplied and laid by the British Insulated Wire Company. The electric lighting network is shown in Fig. 6, while the tramway system, with its feeding points, is shown in Fig. 7. The feeders to the electric lighting network are of the triple-concentric type. The two outer conductors have a section of 0·25 square inch, and the middle conductor of 0·1 square inch. The distributing cables have a section of 0·0789 square inch for the outer conductors and 0·035 for the middle wire. These cables, which are of the paper-insulated lead-covered type, are laid on the solid system throughout in wooden troughs filled in with bitumen compound, and

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covered over with bricks. The cables, both before delivery and after being laid and connected up in the streets, stood successfully a flashing test of 2,500 volts alternating between any conductor and earth. Pilot wires were laid under the contract to various parts of the system, to facilitate the maintenance of an even voltage distribution. The tramway feeders as far as they lay in the Cleckheaton district were supplied by the Council, but the electrical energy is paid for on the reading of meters placed in the central station. The current for the Liversedge section of the light railway is delivered to the British Electric Traction Company at the weighbridge

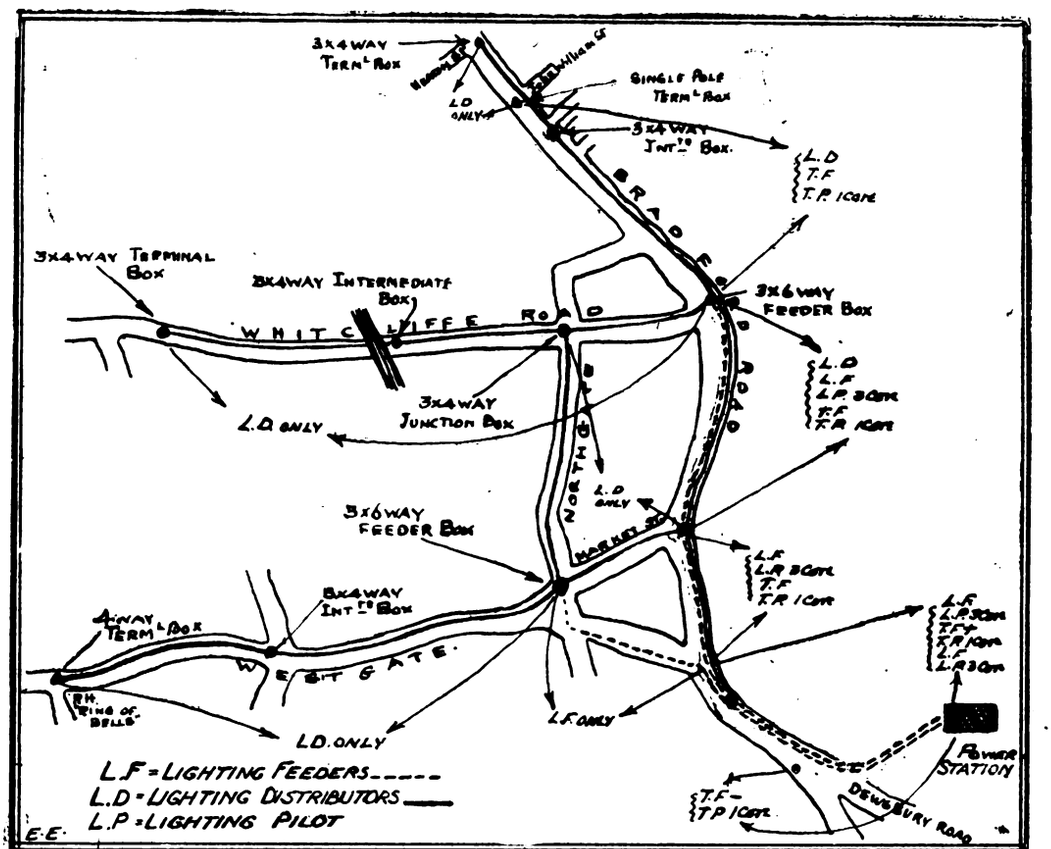

FIG. 6.—Diagrammatic Map of the Electric Lighting Mains at Cleckheaton. The letters T.F. and T.P. refer to Tramway Feeders and Pillars respectively.

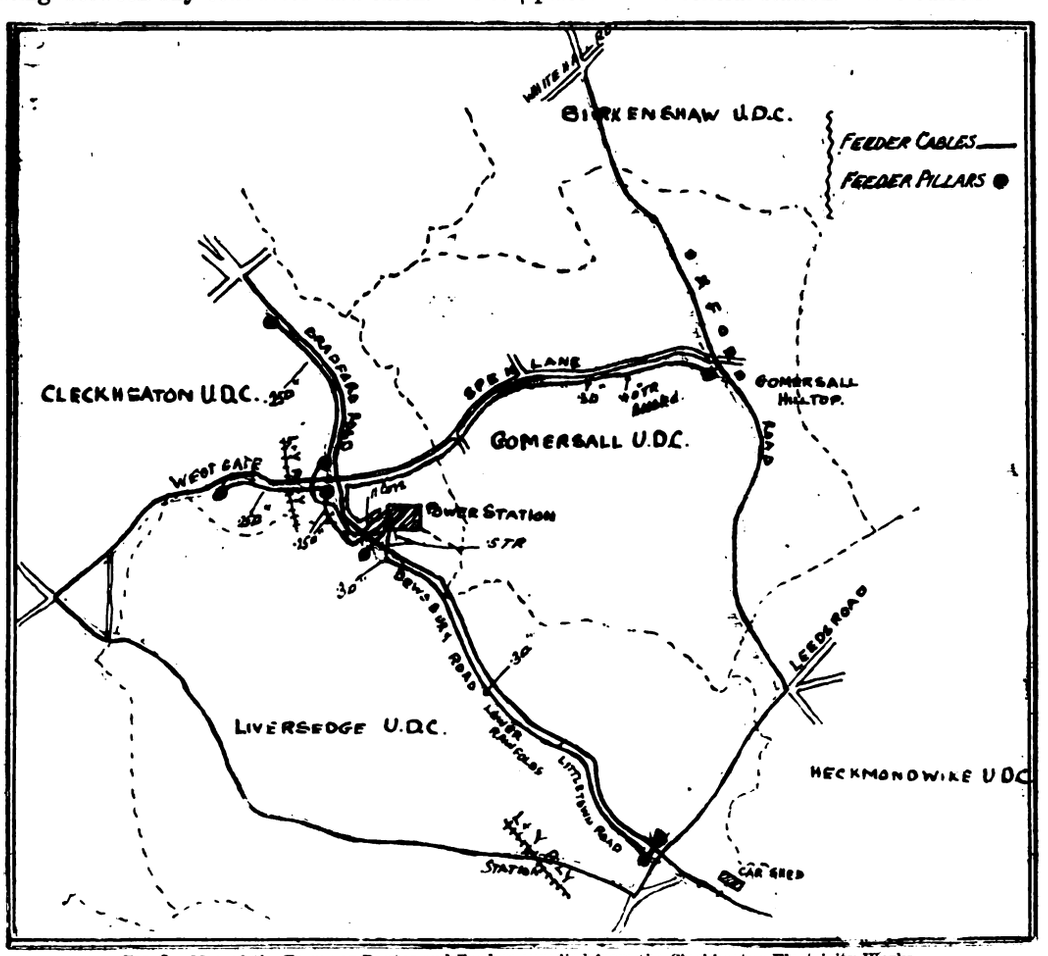

FIG. 7.—Map of the Tramway Routes and Feeders supplied from the Cleckheaton Electricity Works.

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house in the Dewsbury-road, a point within the Cleckheaton district. All tramway feeders outside this area are, of course, supplied by the company, which has two main routes, as indicated in Fig. 7. These are the Dewsbury and Batley line, which runs up Westgate and Spen-lane, and the Liversedge and Bradford-road line. The feeding points are indicated by the circular dots on the feeder routes.

As regards the financial details, the Council have had the permission of the Local Government Board to raise two sums of £25,000 and £6,000 respectively for their electric lighting and refuse destructor plant. The last loan, sanctioned in June last, is to provide for the extensions in plant referred to above. Under the advice of their consulting engineer, the Council are charging to private consumers 5d. per unit for electrical energy used for lighting and 2d. per unit for that required for power purposes. The town hall, which previously had its own dynamo driven by a gas-engine, has been transferred to the mains, and a few auxiliary arc lights are being erected in the streets. At present, however, the tramway load will be the main business of the station until more private consumers have been connected.

We have to thank Mr. C. A. Baker for the loan of working drawings for the purpose of illustrating this article.

MUNICIPAL TELEPHONY.

TUNBRIDGE WELLS PROTEST MEETING.

On the afternoon of the 20th inst., at the Cannon-street Hotel, a conference of those interested in the question of municipal telephones was held under the auspices of the Tunbridge Wells Protest Committee. The chair was occupied by Mr. Alderman Robinson, L.C.C., a resident in Tunbridge Wells, and representatives attended from different parts of the country—among others, from the Manchester, Hull, Halifax, Portsmouth, Eastbourne, and Brighton Corporations.

The CHAIRMAN explained that, in view of the proceedings before the Postmaster-General and his reply to the deputation that day, it was thought well to call this conference to consider the situation. In his opinion they need not be greatly discouraged by the result of that deputation. Mr. Chamberlain had shown a complete grasp of the subject, and while not considering it his duty to interfere in a purely local concern, made it clear that the Tunbridge Wells case had features which affected the whole country.

Mr. Councillor PLUMMER, of Manchester, moved the following resolution: "Having fully considered the subject of municipal telephones in the light of the facts laid before the Postmaster-General on behalf of the Tunbridge Wells Protest Committee, and his reply thereto, this meeting expresses its unabated confidence in the policy of establishing municipal telephones, it having been clearly demonstrated that the advantages accruing to the community from a system of telephones at once efficient and at a moderate cost, can best be obtained through the medium of the municipal corporations." In submitting this resolution Councillor Plummer contended that municipal enterprise could confer far greater benefits upon the community than could private enterprise. In the case of telephones the municipalities could give a service at a much cheaper rate than the National Telephone Company. This was clearly proved at Manchester, where the Corporation started the municipal service at a rate of £5 for unlimited user as against the company's charge of £10. He maintained that between the tariff at which it had been proved municipal telephones could be carried on and the old rate enforced by the National Telephone Company there was a great margin, upon which the corporations could work with a greater possibility of success. With regard to Tunbridge Wells, he pointed out that if the sale to the company were ratified, it would be an unspeakable blow to the establishment of municipal telephone systems throughout the country.

Mr. Councillor BROWN, chairman of the Hull Telephone Committee, seconded the resolution, contending that municipal trading in England had been proved to be a success. The municipalities could set up telephone exchanges now with the most modern and up-to-date apparatus at less cost than the company had done in the past, and in that they had a great advantage. He pointed out that if municipal telephony received its death-blow at Tunbridge Wells to-day, all the large towns and cities of, say, 200,000 inhabitants and above must continue at the company's charge of £10. If they were to have any reduction in the rates, the municipalities must help themselves. He mentioned that at Hull they had got as far as obtaining the consent of the Corporation to ask for borrowing powers to set up a municipal exchange.

Mr. Councillor SOLOMONS, of Swansea, remarked that his town was in the unique position of having secured the consent of the Local Government Board to a loan of £21,000 for a municipal system without the opposition either of the National Telephone Company or of the local ratepayers' association. This was a great national question, and one which affected the Post Office as well as the country at large. Indeed, he looked on the question as of so great importance that he thought Parliament should step in and over-ride any decision of the Postmaster-General which might be adverse to it.

Mr. T. LOUGH, M.P. for West Islington, observed that there had been a campaign conducted in, perhaps, the most influential newspaper in the country against municipal trading, and he believed that what had taken place at Tunbridge Wells was the direct outcome of that campaign. He described the situation at Tunbridge Wells as an attempt to set up Tammany against the municipalities—an attempt to suppress a public enterprise by a vulgar conspiracy, which had been hatched for months in secrecy. He also referred to the fact that by the sale at Tunbridge Wells the company's license in that area would be extended for nearly 15 years.

Mr. A. NICHOLSON, of Tunbridge Wells, also supported the resolution.

Mr. SNOWDEN WARD, speaking on behalf of one of the outlying districts of Tunbridge Wells, held that these districts were far better served by the Corporation than by the company.

The resolution was then put to the meeting and carried by acclamation.

Mr. WALKER CLARKE, of Halifax, moved that copies of the resolution be sent to the Prime Minister, the Postmaster-General, the municipal corporations of England, and the Association of Municipal Corporations. He remarked that Halifax at the present time possessed parliamentary powers to establish a system of municipal telephones, and expressed himself as being entirely in favour of the municipalities undertaking such work. The only way to meet the National Telephone Company was by fighting them.

Mr. Councillor DITMAN, of Portsmouth, in seconding the motion, said that in face of the unscrupulous opposition of the National Telephone Company his town was now in possession of a municipal system. Mr. Bennett had acted as consulting engineer to the Corporation in this matter, and he was glad to say that the work had been carried out at a cost well within the engineer's estimate.

The resolution was carried unanimously, and the conference separated.

DEPUTATION TO THE POSTMASTER-GENERAL.

On the 21st inst. a deputation representing the Town Council of Tunbridge Wells waited on the Postmaster-General at St. Martin's-le-Grand to ask his approval of the agreement of sale of the municipal undertaking to the National Telephone Company. The deputation was headed by the Mayor (Mr. Alderman Gilbert Finch), supported by Mr. Alderman Delves (deputy mayor), Mr. Alderman Stone, Mr. Alderwan Penn, Mr. Councillor Hicks, Mr. Councillor Wesley Smith, Mr. W. C. Cripps (the town clerk), Mr. J. W. Forster (the borough accountant), and Mr. G. S. Wallace (the manager of the telephone department).

The MAYOR, in laying the case for the Corporation before Mr. Austen Chamberlain, submitted that the agreement was one which protected them from all possible loss. It

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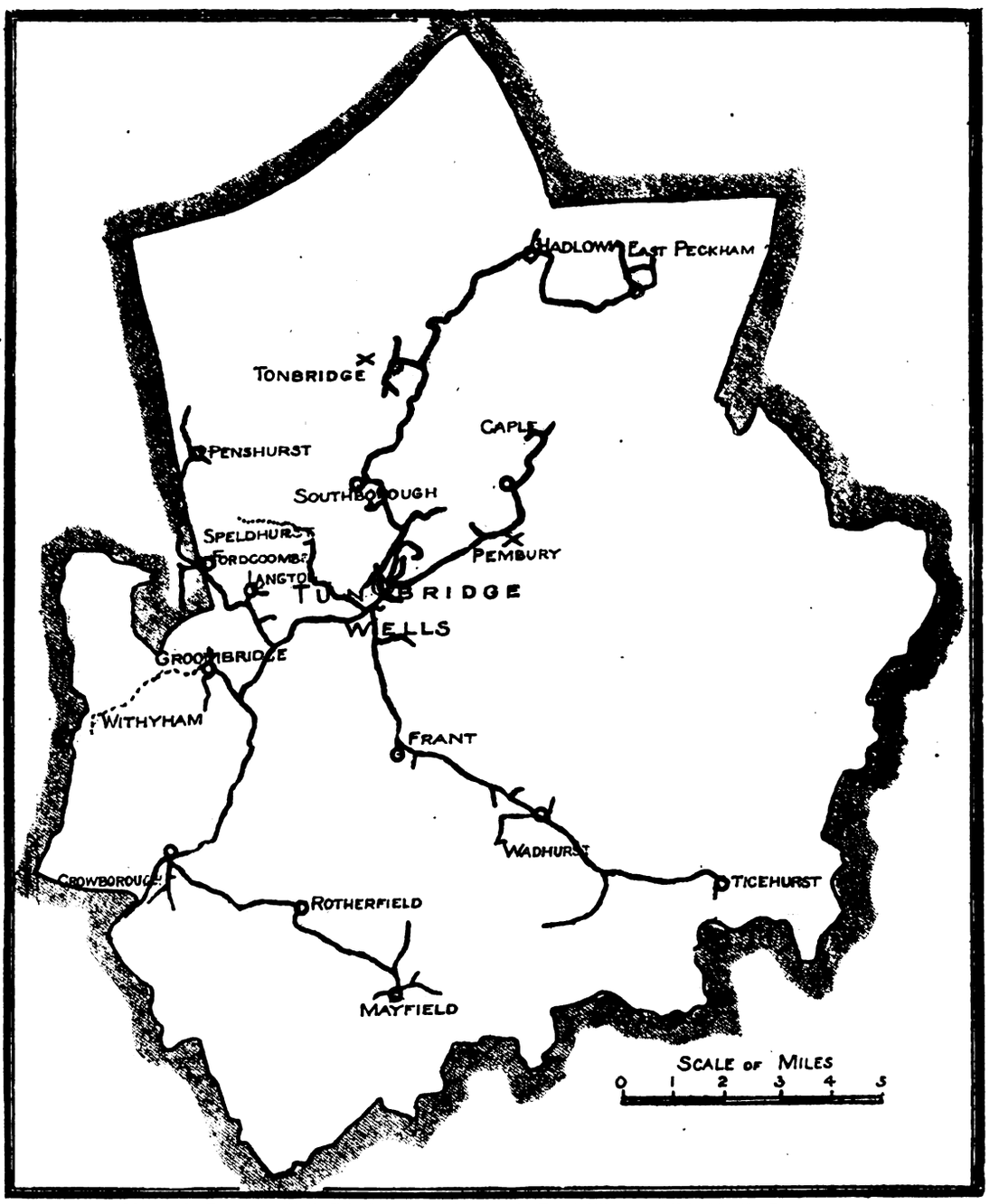
provided that the company should throughout the area give a proper, continuous, and efficient service, and the rate for unlimited user, which was originally £10, was to be reduced to £6. The reduced rates, however, would only be granted to those who gave their orders prior to March 25 next. Having described the principal features of the agreement (which were given in our issue for the 14th inst.) Mr. Finch dealt at length with the financial condition of the municipal undertaking. The Corporation felt that they had grave reasons to complain of the way in which they had been, no doubt unintentionally, misled by Mr. Bennett, the adviser whom they trusted. The report of it was believed, were possessed by hardly any other town in the country. If, however, the Post Office should be disposed to take over the Corporation undertaking on terms and conditions as advantageous to the ratepayers and telephone users as those which were contained in the proposed agreement with the National Telephone Company, the Corporation would readily accede. They had no feelings of affection towards the National Telephone Company, as it was the policy they adopted which forced upon the Corporation the necessity of competition.

Mr. Alderman DELVES, deputy-mayor, added a few words in support of the petition. He showed that the number of



Map of the Tunbridge Wells Telephone area, showing the Trunk Wires established by the Corporation.

the telephone manager, which had been submitted to the Corporation, showed that on the most favourable basis there must be a loss on the undertaking, and a consequent charge on the rates, as the estimated loss of £19 given in the report did not include anything for the probable expenditure on modernising plant or for stores or other contingencies, whereas on the figures laid before the Local Government Board in February last there ought to have been a surplus of £1,086 per annum to meet these matters. This, then, was the financial position of the undertaking, which the Council now sought to transfer to the National Telephone Company upon terms which would absolutely secure the ratepayers from any loss, and at the same time give to the telephone users facilities and advantages which, subscribers in the area served by the municipal system was about 720, out of which 436 resided in the borough. About 150 of these 436 subscribers were on both systems, and, therefore, only about 286 of the inhabitants of Tunbridge Wells were really dependent upon the municipal system. He further remarked that the estimated loss on the municipal undertaking for the year ending March 31 last was £925.

[The above figures do not agree with those given by the town clerk, as reported in our issue of the 14th inst.—ED. *E. E.*]

Mr. Alderman STONE urged that the sale of the undertaking to the company was the only course left open to the Corporation in the present circumstances. He stated,

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incidentally, that not a single member of the Corporation had the slightest interest in the National Telephone Company.

The POSTMASTER-GENERAL, in reply, said he was glad to have had an opportunity of hearing the views of the Corporation upon this matter, which was one, as he recognised, of such very great importance to the borough of Tunbridge Wells. As he had said to the other deputation which waited upon him the previous day, he could not constitute himself a court of appeal at the request of some dissatisfied ratepayers who disapproved of the action of their Corporation. There was, however, an aspect of this question which was not local, and in regard to which the effect of any action that he might take would not be confined to Tunbridge Wells, but would also bear upon the position of the Post Office for many years to come in respect of the telephone service. Any action he might take would not only decide what was to be the exact position of the Postmaster-General in regard to telephony in the Tunbridge Wells area, but it would no doubt be cited as a precedent to which he would be expected to conform in regard to other places, and also his successors in office. If the matter concerned Tunbridge Wells only, he did not think the Postmaster-General would be called upon to give very long consideration to it, or that he need dispute the wisdom of the course which the Corporation thought it right in the interest of Tunbridge Wells to take. But there was no doubt that when Parliament authorised municipal competition, it did so in the desire to promote an alternative service to the system of the National Telephone Company, both for the immediate benefit of telephone users in the different areas concerned, and for the protection of the public when the time should come when the National Telephone Company's license would naturally expire. And in giving this right of competition by license to the municipalities he conceived that it could not be doubted that Parliament believed that it was enabling a competition to be set up by the action of these municipalities, which, once set up, could never come under the control of the company, which at that time had a monopoly of the country. He did not think it was ever contemplated by Parliament as at all probable or even conceivable that within so short a period, or, indeed, during the currency of the license, the Postmaster-General would be asked to give his sanction to the transfer of the undertaking to the company. This was, therefore, a novel and an unexpected proposition which had been put before him After what had been said by the deputation, he recognised fully the seriousness of their position, and he did not wonder that it had cost them some anxiety. As to whether the Postmaster-General would be willing to purchase the undertaking "on terms equally advantageous to the ratepayers" as those offered by the company—he understood that the Corporation would be very glad that their system should fall into the hands of the Post Office rather than into the hands of the company—it was one of the possibilities which he had been considering, and as to which he did not wish to give absolutely a final answer that day. He was bound to say, however, that on the figures which the deputation had set before him he did not think that he would be justified or could justify to Parliament the payment of such a price for the undertaking as they had secured from the company. There might be reasons why the company, being in competition in the same area, might attach a value to the Corporation's property which it was not intrinsically worth, but whatever those reasons might be they could not apply in the case of the Post Office, and he could not hold out any expectation that he could pay in effect £28,000 for what had only cost £25,000 in cash, and what, on the Corporation's own showing, was not worth £25,000 as it stood to-day. It was, therefore, clear that it was not likely he could make an offer which would clear the Corporation from all loss. As he had said, he did not think that a license would have been granted to the Corporation if such an occurrence as this had been foreseen. The terms of the license were such that they affected not only the position of Tunbridge Wells, but of local authorities outside the borough, as well as the position of the Postmaster-General in the same area. If the competition, which was a valuable consideration, in respect of the extension of the company's license to 1925 were withdrawn, it became a very serious matter whether the extension of that license could be allowed to continue. It was because he thought that the Corporation's proposal, though it might be qualified upon its merits, was not what Parliament anticipated when the Telephone Act was passed, because the effect of their competition had altered the position of the Postmaster-General by practically automatically forcing him to extend the National Telephone Company's license in their area, and because outside the borough it had extended that company's license in the areas of other authorities, that he feared it was a matter in which he could not have regard to local conditions alone, but must exercise his judgment as to the wider interests involved.

The Mayor having thanked Mr. Chamberlain, the deputation withdrew.

VIEWS OF THE RATEPAYERS' LEAGUE.

Another deputation, making the third in the course of one week, waited upon Mr. Austen Chamberlain on Monday to lay before him the views of the Tunbridge Wells Ratepayers' League on the telephone question.

Colonel HOLLAND, as president of the league, argued that the municipal scheme at Tunbridge Wells had proved a financial failure, and, if allowed to continue in the hands of the Corporation, must become a heavy burden on the rates. He asked the Postmaster-General to give his sanction to the proposed sale to the company.

Mr. CHAMBERLAIN, in reply, repeated his decision that he was not prepared to purchase the undertaking on behalf of the Post Office on the same terms as those offered by the company, and again referred to the national importance of the point at issue. He had read in the papers that morning that the Mayor and the Corporation had changed their minds in this matter, but he was bound to assume that no change had taken place in the situation, because he could not take action on the strength of statements he had gathered in an unauthorised way by glancing through the newspapers. He hoped to be able to announce the decision of the Post Office before very long.

The deputation then withdrew.

Presumably as a reply to Mr. Chamberlain's remarks in above reported, the Mayor of Tunbridge Wells (Mr. G. Finch) has written a letter to the Postmaster-General, in which he complains of the reports in certain daily papers of a private conversation. These reports, he says, "give a very misleading account of what I understood to be a private and confidential conversation between myself and certain inhabitants of the town at my house late on Saturday night." "The remarks which I made are so garbled as to convey an entirely erroneous impression. It is perfectly true that I said I was in sympathy with the retention of the undertaking by the town provided it would not be a burden on the ratepayers. You will observe that the person who furnished the report has omitted this most important qualification. . . . So far as the local position is concerned it remains where it was—save that since the Council deputation waited upon you on Friday it has been discovered that a large claim on capital account, amounting to over £600, is outstanding, of which the telephone department was ignorant, though it would appear its existence was known to Mr. Bennett, who, without the knowledge of the Council or committee, has been corresponding on the subject with the persons to whom it is due."

Mr. Bennett's reply to the above will be found in our correspondence column. If the books kept by the municipality at Tunbridge Wells in connection with the telephone department are so arranged that they do not show the contract sums, it is entirely a fault in accountancy. The consulting engineer's certificates show exactly how much has been paid to each contractor, and how much is still due, but this record is only a secondary check on the accountant. We have up to the present refrained from introducing personal matters into our columns with respect to the Tunbridge Wells telephone affairs, but must express our strong disapproval of the many attempts made by the members of the Corporation and the officials to throw the responsibility for their own neglect on to the shoulders of

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their consulting engineer. The bulk of the labour in connecting up subscribers and running the trunk wires has been under the direct employ of the Corporation, and the question of wayleaves has also been dealt with locally. It remains to be seen how far these two factors account for the discrepancies between estimates and cost.

We give herewith a map of the Tunbridge Wells telephone area, showing how the trunk wires have been run by the Corporation to outlying villages. Before the introduction of the municipal system the two places marked with a cross—*i.e.*, Tonbridge and Pembury—were the only two which had telephone connection to Tunbridge Wells. Also, it is interesting to note that the subscribers at Crowborough alone are now more in number than the subscribers to the National system in Tunbridge Wells before competition was inaugurated.

A CONTRIBUTION TO THE THEORY OF COMMUTATION.*

BY ALEXANDER ROTHERT.

(Concluded from page 728.)

Fig. 11 shows the characteristic shape of the sparking voltage curve. It is composed of two parts, both of which

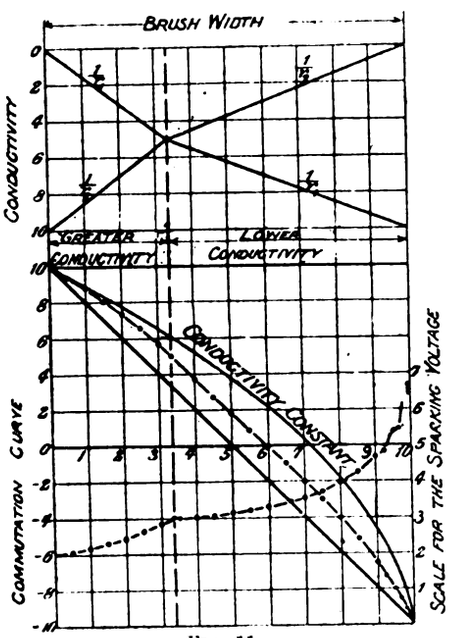

Fig. 11.

rise towards the end in consequence of the increase in brush resistance, this increase being in the ratio of 1 to 2 after the first third, and in the ratio of 2 to infinity at the end of the commutation period. The commutation curve has similar characteristics. The want of uniformity at the end of the sparking voltage curve is due to small irregularities in construction. I have not had the opportunity up to the present of practically testing the effect of such different specific resistances within the brush, which appear to be so favourable theoretically.† As these results may be of great practical importance, I have taken the trouble to investigate the matter from various points of view. I give some of my more general results below. In order to determine the effect of further graduation of the specific resistance within the brush, I have divided the latter into three equal parts, having conductivities in the ratio of 3 : 2 : 1, and so chosen as to leave the total brush resistance unchanged. Fig. 12 shows the reciprocals of the resistances in relation to the time, the tangents of the angles of inclination to the horizontal give the specific conductivities of the different parts of the brush. The figures and curves for the first third are exactly the same as in the previous example. In the case of these three last examples it is not correct to say that $\frac{x}{L} = 1$, for x is different for different sections of the brush. The ratio of total resistance to self-induction is, however, equal to 1. Fig. 12 shows that the commutation curve is particularly good in its last and most important part. The last part of the curve, in fact, is identical with the straight (inductionless) line, which is drawn in for comparison. This result is very interesting, as it shows that by suitably chosen brushes of relatively low resistance a commutation curve as satisfactory as that for inductionless commutation may be obtained. The curve for sparking voltage is naturally discontinuous, and the last two points are somewhat uncertain. It is, however, clear that the sparking voltage is about 4 at the end.

It occurred to me next to determine the conditions under which the commutation curve became a straight line. For this purpose we must return to equation (1). In this equation $\frac{d\,i}{d\,t}$ must be constant if the straight line condition is to be attained. We therefore have

$$\frac{J\,(r_1 - r_2) - i\,(r_1 + r_2 + r_3)}{L} = \text{constant.} \quad . \quad (4)$$

this constant being the tangent of the angle of inclination $= -\frac{2\,J}{T}$. As a further condition, we have the pure

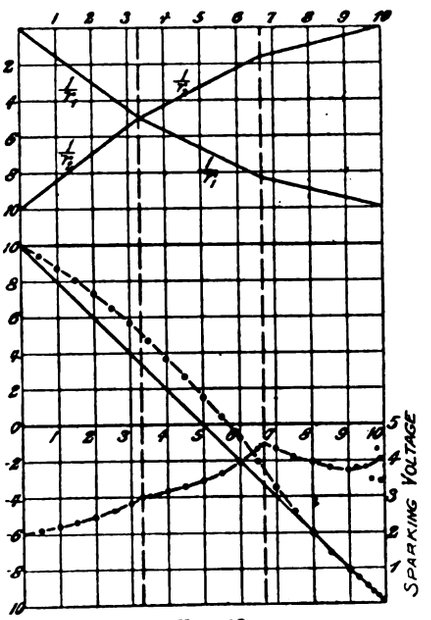

Fig. 12

geometrical equation for the straight line for inductionless commutation :

$$i = J\left(\frac{T - 2\,t}{T}\right) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Finally, there is the third equation :

$$\frac{1}{r_1} + \frac{1}{r_2} = \frac{1}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

which results from the fact that the two parts of the brush are to have the same combined conductivity as the whole brush had, R being the resistance of the whole brush. By putting $r_3 = 0$, we may write equation (4) as follows :

$$(J + i)\,r_2 - (J - i)\,r_1 = \frac{2\,J}{T}\,L.$$

Substituting for i its value from equation (5), we get

$$\left(1 + \frac{T - 2\,t}{T}\right) r_2 - \left(1 - \frac{T - 2\,t}{T}\right) r_1 = \frac{2\,J\,L}{T\,J} = \frac{2\,L}{T},$$

or, $$(T + T - 2\,t)\,r_2 - (T - T + 2\,t)\,r_1 = \frac{2\,L\,T}{T} = 2\,L,$$

or, when collected, $2\,(T - t)\,r_2 - 2\,t\,r_1 = 2\,L.$

Substituting for r_2 its value from equation (6), viz., $r_2 = \frac{r_1\,R}{r_1 - R}$, we get :

$$2\,(T - t)\,\frac{r_1\,R}{r_1 - R} - 2\,t\,r_1 = 2\,L,$$

* Translated from the *Elektrotechnische Zeitschrift* of Sept. 25, 1902, and Oct. 2, 1902.

† I believe that the Elektricitäts A.-G. (vorm. Schuckert und Co.) often employ a combination copper and carbon brush which complies with the above theory.

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Solving this with regard to t, we find :

$$t = \frac{T R}{r_1} - L \frac{r_1 - R}{r_1 2} \quad . \quad . \quad . \quad . \quad (7)$$

This equation of the second degree produces a parabola on plotting values of $\frac{1}{r_1}$ against t, as in Fig. 13. Thus, for $t_1 = \cdot 1$, $\frac{1}{r_1} = 1$; for $t = \cdot 4$, $\frac{1}{r_1} = 2$; for $t = \cdot 9$, $\frac{1}{r_1} = 3$; for $t = 1 \cdot 6$, $\frac{1}{r_1} = 4$, and so on.

Table V.* gives the resistances, etc., for $t = \cdot 5$, 1, $1 \cdot 5$, etc., as before. The reactance voltage is naturally

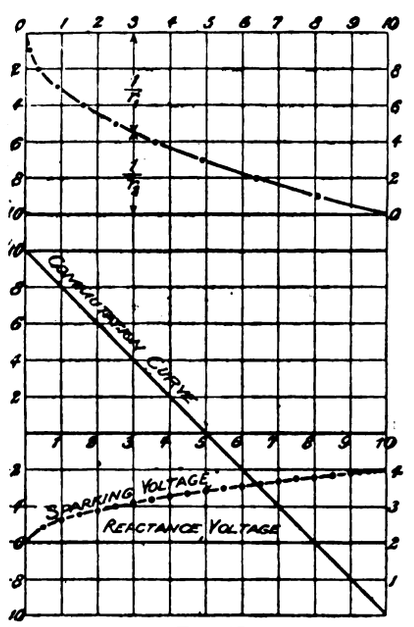

Fig. 13.

constant = 2, whilst the sparking voltage begins with 2, as before, and finally reaches the maximum value, 4. The current density is constant throughout the commutation. The conditions are exactly the same as for inductionless commutation, with the single exception of the sparking voltage, which is greater in the latter case. Table V. and Fig 13 are based on the values T = 10, J = 10, L = 1, R = ·1, as before.

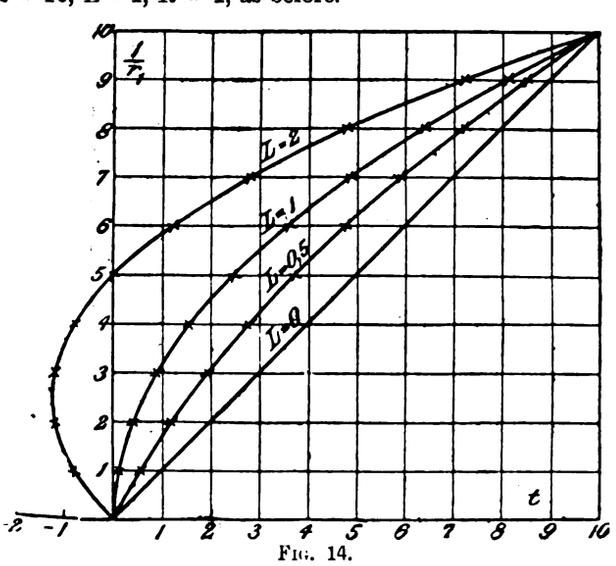

Fig. 14.

I have investigated equation (7) with a view to determining the effect of L, and whether with a given R and T the commutation curve remains a straight line for all values of L. For this purpose I have tried L = ·5 and L = 2. The resulting curves of $\frac{1}{r_1}$ in relation to t are shown in Fig. 14. We see that for R = ·1, T = 10, and L = 2 only an imaginary solution is possible, since t becomes negative at first. For all values of L which are smaller than 1, however, a solution is possible. In order that t shall not become negative, $\frac{T R}{r_1}$ in equation (7) must be greater than or equal to $L \frac{r_1 - R}{r_1^2}$, and from this it follows that $\frac{T R}{L} > \frac{r_1 - R}{r_1}$. Now, for the early part of the commutation period—*i.e.*, for small values of t, where t might become negative—r_1 is very great compared with R, so that the right side may be called 1. If, therefore, $\frac{T R}{L}$ is greater than 1, a straight line commutation curve can be obtained by suitably graduating the brush. Fig. 15 suggests the question as to what would happen if, for instance, with L = ·5 the conductivity were arranged, not as for L = ·5 in Fig. 14, but as for L = 1 in the same figure. From what we have seen up to the present we should expect the commutation curve to become still more favourable—*i.e.*, to become convex towards the axis of abscissæ. This expectation is fulfilled as shown in Fig. 15. This figure is constructed for L = ·5, T = 10, J = 10, R = ·1, whilst r_1 and r_2 vary as shown in Fig. 13. For the sake of comparison the straight line is added. The shape of the sparking voltage curve is especially noticeable in this case. It begins at 2, rises comparatively quickly to a constant value of 2·65, and ends at 2·6. This last small drop as well as the slight irregularity of the points are probably due to inaccuracies in construction.

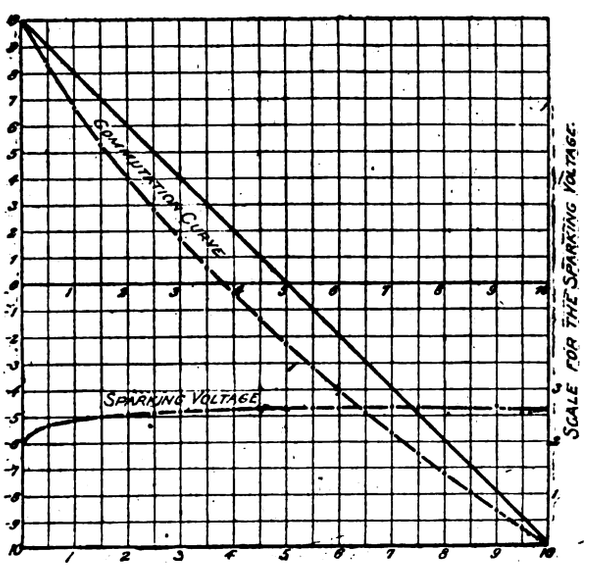

Fig. 15.

I have devoted a good deal of space to the discussion of the artificial straight line commutation, although it would hardly be possible in practice to produce a brush whose conductivity would vary according to a parabolic law in the way described above. I believe, however, that it would be easy and advantageous to divide the brush into two or more sections of different conductivity. In this case the resistances of the different sections should be chosen so that their reciprocals follow a parabola as nearly as possible.

All the above considerations are on the assumption that the brush only covers a single segment—*i.e.*, that the brush width is equal to the spacing of the segments, and that the insulation between segments is infinitely thin. I have not been successful up to the present in applying the method to the general case of a wider brush. The attempt, in fact, leads to very complicated equations, with many unknowns. A solution of this general case would be full of interest, especially if it took into account the mutual induction of the various simultaneously short-circuited coils. When the brush covers several segments it is only the two extreme coils whose resistance changes. The middle coils have a constant resistance for a certain period, so that it looks as if the further commutation of these coils only occurred owing to the effect of mutual induction. It

* Omitted here.—Translator.

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would therefore be necessary to investigate the extent to which this mutual induction is harmful, and whether, on the other hand, it may not be useful. A further limitation has been tacitly made up to the present—viz., that in the case of series armature windings (wave windings) only two sets of brushes are employed. Series-parallel windings would also require separate treatment.

APPENDIX.

Arnold has shown analytically that the current density must become infinite if $\frac{RT}{L}$ is greater than 1—*i.e.*, the commutation curve must become a tangent to the ordinate at the end. This fact follows from equation (1). At the

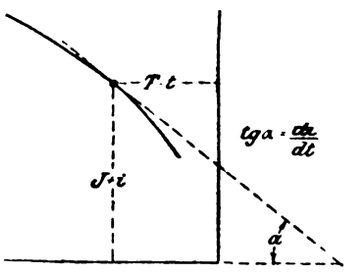

FIG. 16.

end of the commutation period r_2 is very great compared with r_1 and r_3. We can therefore neglect r_1 and r_3 and write $L\frac{di}{dt}+i\,r_2+J\,r_2=0$, or $\frac{di}{dt}=-(J+i)\frac{r_2}{L}$; and after inserting the value of $r_2=\frac{x}{T-t}=\frac{RT}{T-t}$, we get

$$\frac{di}{dt}=-\frac{RT}{L}\left(\frac{J+i}{T-t}\right).$$

In this equation $\frac{di}{dt}$ represents the tangent of the angle of inclination of the commutation curve, as before, $J+i$ and $T-t$ represent the ordinate and abscissa respectively of a point of the commutation curve, reckoned from the starting point. Let us consider an instant of time very near the end of the commutation. If $\frac{RT}{L}=1$, then $-\frac{di}{dt}=\frac{J+i}{T-t}$; *i.e.*, the tangent of the commutation curve, just before the end, will pass through the end point and

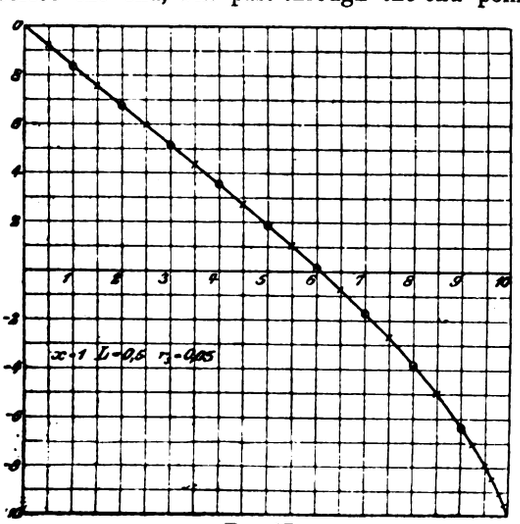

FIG. 17.

the curve itself will make a definite angle, $a < 90$deg., with the horizontal.

If now $\frac{RT}{L}<1$, the tangent must obviously cut the ordinate, since $\frac{di}{dt}$ is less than $\frac{J+i}{T-t}$. We have the conditions represented in Fig. 16. The curve will coincide with the ordinate before the end of the commutation.

Arnold has calculated the commutation curve for $J=100$ $\frac{x}{L}=\frac{RT}{L}=2$, and $r_3=\frac{R}{2}$. In order to check my method I have constructed the curve for the above conditions (for $J=10$) and find that the agreement with the calculation is practically exact. This curve is shown in Fig. 17, and it will be seen that the large round points from Arnold's table agree exactly with my curve. For the purpose of this comparison I have worked the same number of points as in the other examples, but in most cases a much smaller number will be quite sufficient; for instance, $t=1$, 3, 5, 7, and then several more nearer the end. Numerous similar calculations confirm the importance of the quotient $\frac{RT}{L}$. Almost everything depends on its amount, and $\frac{RT}{L}=1$ always forms a limit.

I have not attempted in this article to determine the connection between the reactance voltage of Parshall and Hobart and the above-described results. The connection is not a direct one, and I may, perhaps, return to it when I have had the opportunity of testing the commutation theory in practice.

NOTES ON POLYPHASE MOTORS.

At the present time it is almost impossible to look through any electrical journal without noting the great number of polyphase contracts which are either in hand or proposed for installations in this country. At first it would almost appear as though this system of working was the one most in vogue in England; as a matter of fact, the contrary is the case, and the prominence given to polyphase work is partly due to the effects of judicious advertising, and is partly due to the fact that the system is comparatively new, and therefore it attracts special attention in the trade journals. The majority of electrical engineers in England, especially amongst the rank and file, are essentially direct-current men. So long as the only system of alternating work was the monophase there was little inducement to take up this branch of dynamo building. Owing to the smallness of the country and the absence of any great source of water power such as Niagara, there was no call for long transmission lines in which there would have been a considerable saving by working transmitting at 10,000 volts or more, and then transforming down by means of rotary converters to low direct current. The difficulty of getting monophase motors to start under load, added to the desire of all the supply companies, whether privately owned or belonging to the various corporations, to create a power day load, was also a factor that prevented the advance to any appreciable extent as compared with direct current of the alternating system. While the additional fact that all the trams were operated by means of direct current, and that modern practice tended towards making the central stations combined power and lighting stations, so arranged that if the plant for either purpose were at any time abnormally overloaded or under repair the plant designed for the other part of the station's work could be brought in as reserve, was a strong argument with nearly all corporations against employing alternating current for their lighting stations, especially when, as at Hull and Morecambe, for instance, it was found to be perfectly easy and safe to generate the direct current at over 2,000 volts, this pressure being quite sufficient to give economical transmission over the limited areas supplied from the respective stations.

The adoption abroad, where the conditions of working are altogether different to what they are here, of the polyphase system of alternating currents, and the great benefits that were claimed for it, especially as regards its adaptability for power work, owing to the readiness with which motors of either the synchronous or the induction type could be started on open circuit or under load, led to its properties being carefully studied in England, and to a few trial installations on this system being put down. For some little time no great advance was made; a small amount of this class of machinery was imported, and an even smaller amount was manufactured in this country. The advantages claimed for this method

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have, however, been steadily pushed forward, so that with the lapsing of the master patents on the induction motor many firms have commenced to make polyphase machinery. The frequent advertisements in the papers for men accustomed to the designing and building of polyphase machinery, and the entire absence of capable men seeking such situations, shows that there is a great scarcity of English electrical engineers who have more than a very elementary knowledge of this system; unfortunately, there is also a great dearth of good books or articles on this subject, and it is very doubtful if many of our direct-current designers and other engineers connected with the building of the standard continuous-current machines really do know what are the principles underlying the construction and working of polyphase induction motors. The case of the polyphase generator and the synchronous motor is different, and more easily understood. In stating that there are few good books or articles dealing with the subject, the writer is well aware that Prof. Silvanus Thompson has published a work on the subject, and he is also acquainted with the many learned and able articles published by Mr. Eborall; but the former is a text-book more suitable for a person anxious to learn to design polyphase machines after having obtained a good knowledge of their principles and their functions, while the latter are couched in too mathematical language to be much read by the ordinary engineer. Although mathematics are the bed rock on which the whole fabric of electrical engineering has been raised, it is unfortunately true that the majority of our engineers will not follow mathematical proofs which involve higher mathematics than the simplest algebra or trigonometry, while even proofs which do not exceed these low limits are generally not worked through, but taken as read and found correct. In the following articles we will attempt to describe the principle on which the polyphase system is based without the use of any high mathematics, and with the use of the simplest diagrams, and we will also show what are the advantages claimed for this method over the more customary direct system.

In his presidential address before the American Institute of Electrical Engineers Mr. Steinmetz this year remarked: "In electrical engineering, and more still in all allied branches, nothing beyond the general principles is needed for success, but the principles should be fully understood, and with the limited time at disposition this cannot be done if time is wasted in memorising things to be forgotten afterwards. . . . When needed, formulæ can be derived from the fundamental principles, or looked up in literature, and their memorising is a mere waste of valuable time, useless, since the memory cannot retain them if the understanding cannot reproduce them from their premises." These remarks apply with their full force to all polyphase work; the whole structure has been built up from a few simple fundamental principles, and it is advisable to fully prove the first simple cases so as to get a thorough grasp of the fundamental principles. The complex cases will then follow as a matter of course, and provided the first principles have been securely grasped, their proof can be easily derived. The writer, therefore, makes no apology for commencing with the most elementary laws and formulæ derived from these laws or established by repeated experiment. If the elementary part is well grasped, the rest of the subject presents no difficulty; if it be only imperfectly understood, it is worse than useless, and is, in fact, only a waste of time, that might with advantage be employed in other directions, to study further the subject.

Every modern dynamo, whether for direct current or alternating current, is designed in accordance with the fundamental principle, discovered by Faraday in 1831, that an electric difference of potential is created in any wire which is moved in a magnetic field, and that if the two ends of the conductor be joined so as to form a closed circuit a current will flow through the circuit. As the E.M.F. generated is dependent upon the relative motion of the conductor and the field, it is immaterial whether the conductor is moved across the field or whether the field is moved across the conductor. Every electrical engineer knows that this E.M.F. will be produced in a direction at right angles at once to the direction of the lines of force of the field and of the direction of motion, and that if the direction of either of these be reversed, so will the direction of the E.M.F. He is also aware that if the conductor cuts 100,000,000 lines of force in a second that an E.M.F. of one volt will be generated; or, expressed as a general formula, that if ϕ is the value of the total field in lines of force, C the number of conductors in series, and N the number of revolutions per second, then if E represents the E.M.F. in volts generated by the revolution of the conductors,

$$E = (\phi \times C \times N) \div 10^8.$$

The electrical engineer is also aware that the value of the resulting current flowing through any circuit, where R represents in ohms the total value of the internal and external resistance of the circuit, will be, in accordance with Ohm's law,

$$C = E \div R.$$

The two formulæ given above are of universal application in all electrical work, but when dealing with fluctuating currents, whether alternating or not, it must be remembered that the formulæ are modified by the action of other principles. In direct-current dynamo work, there are a few occasions when the electrical engineer has to consider the effects due to induction. The chief occasions are (1) when dealing with the theory of commutation; (2) when considering the result of suddenly breaking the shunt connections of any dynamo or motor; (3) when dealing with the breaking of any large current. In the first case he will remember that the action of induction is to oppose any alteration in the value or direction of a flowing current, or, in other words, that it opposes the increase in the value of a current, and maintains a dying current at its old strength; in the other two cases he will find that the effect of the self-induction when a circuit is suddenly broken is to enormously raise the E.M.F. of that circuit. In the case of alternating work the engineer is dealing with currents whose direction is being reversed 40, 60, 80 or more times per second, and each reversal means that the current, which may be of some considerable magnitude, has to die entirely away and then rise again to its former value in the opposite direction. The effects of induction will therefore be of the utmost importance in this system of dynamo-electric machinery.

It is necessary to remember that when a wire carries an electric current, this current creates round the wire a magnetic field; the lines of force due to a straight wire form closed circles round the wire which is the common centre; the strength of the field depends entirely upon the number of amperes flowing, hence any alteration in the value of the current will immediately affect the strength of the field. This field acts not only on the wire to which it owes its birth, but also on any other wire which may lie within its influence. So long as we are dealing with direct currents, and that the value of the current is constant, this magnetic field has no effect, but as soon as there is any alteration in the value of the current flowing the strength of the field will vary, and either additional lines of force will be called into being or else some of the existing lines will die away. In either case the effect of this alteration in the field strength on the wire itself or on any other wires lying within the influence of the field is the same as though the given wire were moved across a magnetic field, the resulting E.M.F. tending to cause a current to flow in one direction or the other according as the strength of the field is increased or decreased. With an alternating current the effects of the rapid reversals of the current is greater than the effect of the fluctuations in the case of a direct current. The magnetic field due to the passage of a current through a conductor will obtain throughout the entire circuit, both in the external wires and also in the conductors of the generator and motor. The effect of the induction due to the alternating current in the latter case on the magnetic field of the machine will be dealt with when studying the induction motor. The effect of the induction in the external wires we will study now. From the general formula that

$$E = (\phi \times C \times N) \div 10^8,$$

we see by making both C and N each equal to unity that E is a variable dependent upon ϕ; or, in other words, that the E.M.F. generated at any instant of time depends

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solely upon the number of lines of force cut during that instant of time.

Let us assume, as shown in Fig. 1, that we have a conductor revolving in a magnetic field, N S, round the centre, O, with a uniform angular speed. The E.M.F. generated in any instant will, we know, depend upon the actual number of lines of force cut per instant. If the magnetic field be uniform, the number of lines cut per instant will steadily increase as the conductor moves from *a* to *b*, then it will decrease as the conductor moves further from *b* to *c*. It will again increase as the conductor moves from *c* to *d*, but in this case, as the conductor is cutting the lines in the opposite direction to that which it did before, the resulting E.M.F. will cause a current to flow in the opposite direction, the number of lines will decrease as the conductor moves from *d* to its original position, *a*. Let the conductor be represented by P, then the instantaneous value of the E.M.F. generated will be represented both in sense and direction by the position of P on the circle it sweeps out during each revolution. This position may be

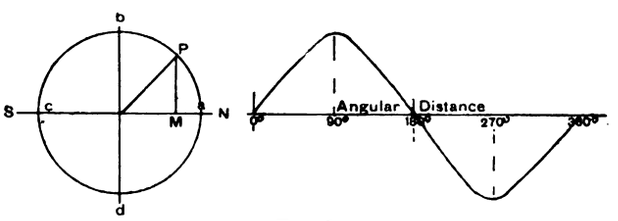

FIG. 1.

given by the ordinate P M, but we know that the length of P M depends upon the sine of the angle through which P has moved from *a*. If then the instantaneous values of the E.M.F.'s are plotted out on a straight line, X Y, we shall get as the loci of these values a sine curve. In actual practice a sine curve is not always obtained, for everything depends upon the uniformity of the magnetic field, and the arrangement of the poles and the windings may give a resultant magnetic field which will prevent a sine curve being obtained for the loci of the instantaneous values of the E.M.F., but for present purposes we may safely assume that when the momentary values of the E.M.F.'s are plotted out they form a sine curve.

(To be continued.)

BRADFORD CORPORATION NEW ELECTRICITY WORKS.

On Friday last, the 14th inst., the first large 2,000-h.p. engine and generator installed at the new Corporation electricity station in Valley-road was put on to the circuit for the supply of the electric tramways. For the first few days the load on the engine was kept comparatively light in order to make sure that the working was satisfactory. On Monday, the 17th inst., full load was put on the engine for the first time, and the full tramway service was resumed and has been maintained since. The engine has been running for six hours each day since this date, and has proved itself to be thoroughly reliable and satisfactory. The contractors for the engine, Messrs. Cole, Marchent, and Morley, Limited, of Bradford, are to be congratulated upon the expeditious way in which they have carried out the erection, and the same must apply to Messrs. the Westinghouse Electric and Manufacturing Company, Limited, of London and Manchester, who were responsible for the erection of the generator. Owing to the very short time at their disposal the work has had to be pushed on with the utmost dispatch, and it is highly satisfactory to find that, in spite of this high pressure of work, not the slightest hitch has occurred in starting the engine and getting it on to the load.

It was only in the spring of this year that it was possible to commence building operations on the new station in earnest, and in the nine months that have elapsed since then the large engine-house and boiler-house have been completed, and 4,000 h.p. of plant, comprising boilers, economisers, engines, and dynamos, with the numerous accessories that go to make up an electric lighting station, have been installed. The carrying out of this work in the way that it has been done reflects the greatest credit upon the staff of the Corporation electricity department, and Mr. R. A. Chattock, the city electrical engineer, is to be congratulated upon a performance that has been rarely equalled in the history of electric lighting undertakings. Mr. W. Jones, the superintendent engineer at the works, and Mr. N. A. Atkinson, the clerk of works, must also be mentioned as having contributed very materially to the success that has attended the carrying out of this work. Thanks are due to the members of the Electricity Committee, and to the late chairmen and deputy-chairmen (Mr. T. H. Shaw, Mr. J. B. Moorhouse, Mr. F. Croft, and Mr. J. Akam), and also to the existing chairman (Mr. Councillor C. E. Dowson), and the deputy-chairman (Mr. Alderman J. Hustler), for the very close personal interest that they have taken in the work, and for the great assistance that they have given in carrying it out.

ELECTRICAL ENGINEERS IN SOUTH AFRICA.

The Trojan services rendered by the Electrical Engineers Volunteers who took part in the late South African war were concisely stated in a question put to the Secretary of State for War by Sir John Leng in the House of Commons on Wednesday afternoon. Sir John interrogated Mr. Brodrick as to whether he was aware that five companies of electrical engineers in South Africa, nearly all highly-skilled professional men, who gave up lucrative appointments for the service of their country, received ordinary soldier's rate of pay; that they furnished upwards of 80 working parties, and successfully carried out all kinds of electrical installations for light, power, and communication in connection with hospitals, bridges, camps, and blockhouses over an extensive territory; and whether any volunteer officer or man in this recently returned battalion had received any distinction or reward; and, if not, whether it was contemplated to recognise their service in any way. Mr. Brodrick stated, in reply, that the electrical engineers received the ordinary rates of pay like the other volunteers serving in South Africa. The valuable and excellent work performed by them was fully appreciated by Lord Kitchener. Three officers were mentioned in dispatches, and the sergeant-major received a distinguished conduct medal. In view of the scale on which rewards were available, it was not found possible in justice to others to grant further rewards.

"BREAK, BREAK, BREAK."

(*Vide* an esteemed contemporary's pages during the last few weeks.)

Brakes, brakes, brakes
For all: advertisement free;
And that the chance has not been lost
Is perfectly plain to see.

O! well for the slipper type
That its "users" can speak so plain.
O! well for the magnet kind
That is mentioned again and again.

And the *noms-de-plume* write on
To their haven on Ludgate-hill;
You can see the touch of the patentee's hand,
Though he changes his name with skill.

Brakes, brakes, brakes—
Sea-snake and great gooseberry—
But columns filled up with such transparent puffs
Are not of much use to me.

B. C. H. J.

METALLIC PACKING.—From the United States Metallic Packing Company, Limited, Soho Works, Bradford, we have received a copy of a booklet just issued by them, which, besides being descriptive of their automatic self-adjusting metallic packing for locomotive, marine, and stationary engines, also contains a list of British users covering about 100 pages.

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CONTENTS.

Notes	757	Forthcoming Events	777
Cleckheaton Electricity Works	762	Questions and Answers	778
Municipal Telephony	766	Legal Intelligence	782
A Contribution to the Theory of Commutation	769	Companies' Meetings and Reports	782
Notes on Polyphase Motors	771	New Companies Registered	782
Bradford Corporation New Electricity Works	773	Appointments Vacant	783
Electrical Engineers in South Africa	773	Contracts for Electrical Supplies	783
"Break, Break, Break"	773	Lighting Notes	784
Taunton	774	Traction Notes	787
Correspondence	775	Provisional Patents, 1902	790
Forthcoming Bills and Orders	775	Complete Specifications	791
Trade Notices and Novelties	776	Companies' Stock and Share List	791
Physical Society	776	Traffic Returns	792

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TAUNTON.

The lot of a public official is always a hard one, and if he be of a sensitive nature is sometimes almost unbearable. Indeed, many men have found it quite so, and left official life for something quieter. One of the most eminent judges that ever graced the English Law Courts gave as his dictum of a blackmailer's deserts that nothing was so effective in stopping that kind of thing as a good horsewhipping. We believe his words were somewhat stronger, but a little unparliamentary. The people who gird a public official in his public capacity for the purpose of making his life miserable, or for the purpose of effecting his resignation or removal, are not far removed from the blackmailers, and deserve all the condemnation honest men can give. If a citizen or a ratepayer or a purchaser has a grievance, there is always a right and a wrong way of obtaining satisfaction. Unfortunately, many men deliberately select the wrong way, and this not for the purpose of righting a wrong, but from personal motives. A case of this kind seems to have happened at Taunton, and our sympathies in the matter are altogether with Mr. Thornhill, the electrical engineer to the Council. The facts are as follows: In charging for energy supplied, a general reliance is placed upon meter records. But meters are canny things. All, not only electrical meters, but other kinds of meters as well, have the name of being of doubtful accuracy; hence periodical testing and examination is made. Restricting our remarks to electrical meters, these have to be tested, and if when under test they are found to register inaccurately, surely the responsible authorities are bound in honesty to themselves and to their customers to make such corrections as the case requires. If a meter registers too fast, the record is incorrect and too high. The customer obtains a diminution of his meter account. If the meter registers too slow, then a corresponding correction must be made for the benefit of the supplier. In a well-organised undertaking the tests and corrections, if necessary, are made according to office routine. These are the broad features that hold in all cases, and are well recognised in all businesses whether controlled by a local authority or by a private company. At Taunton, under the direction of Mr. Thornhill as the responsible official, the system held good. He was not personally interested in the matter, except as an honest man to do his duty both to his employers and to his customers. Nothing was heard against this system till, owing to necessary changes in the staff, an assistant left. So far as we can gather, the father of this particular assistant was formerly employed under the then electrical engineer, and also left. Raking among the rubbish of the waste-paper basket, the father seems to have come across memoranda which, without explanation, might be used to disparage the position of those responsible for the electric light undertaking of Taunton. One or more of the customers whose meter readings had to be extended were approached and induced to take the matter up in a manner which to us was the very worst and most disgraceful method of approaching the matter. A criminal prosecution was commenced against Mr. Thornhill at the instance of a boot company. The plaintiffs put forward their case before the magistrates, who without hearing the evidence on behalf of the defendant dismissed the case, not being satisfied that a sufficient case had been made out to commit the defendant for trial. This result may be, in a measure, looked upon as extremely satisfactory; but, on the other hand, there may be a good many people who on reading the charge put forward by the plaintiffs will be unable to understand the extreme frivolousness of the case. It is for these people that we have thus briefly sketched the situation.

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One of the worst features in this case is that the whole subject had formed the text of a report of the Electric Lighting Committee to the Council, was fully discussed by the Council, and the report adopted. This report and the explanation given by the chairman of the committee showed that the practice followed at Taunton was similar to that followed at other towns. After such discussion by the Council, and the exoneration of the electrical engineer, it certainly seems a curious thing that he should be subjected to a criminal prosecution. The work of an official, as we said above, is arduous enough at all times, but becomes intolerable when he is made to suffer mentally, if not physically, because someone has a petty spite against him. Another singularity in this particular case is that the legal action was taken by the owner of a branch business, the central business being in Bristol. This would indicate that the citizens themselves, knowing more of the matter, were not dissatisfied, and only those who did not know all the circumstances were opposed to the system. So far as we know the history of the Taunton works, we cordially agree with Mr. Westlake in his estimate of the services of the Electric Lighting Committee. He said: "In the chairman and members of the Electric Lighting Committee they had a set of gentlemen whose conduct in the treatment of this matter had been quite above suspicion."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TUNBRIDGE WELLS TELEPHONES.

SIR,—In a letter to the Postmaster-General, I see that the Mayor of Tunbridge Wells states that a new liability has been discovered in connection with the telephone undertaking, of which I was cognisant. I deduce from his observations that the cable contract detention money, payable when the cables had proved satisfactory, is meant

In September or October—before the slightest hint of the deal with the National Telephone Company had leaked out—the contractors wrote me, as engineer, enquiring when it was proposed to pay the detention money. I replied in December. This was all the correspondence, and there was nothing to refer to the committee. Why was not the liability known at the town hall? I cannot say, but presume that divided responsibility is claiming its usual tribute. Previous certificates were on printed forms, and showed (1) the total amount of contract; (2) the amount then certified for; (3) the amount remaining unpaid, so that the books—over which I had not the remotest control—ought to have shown the exact position of the contract.

Six hundred pounds at 3½ per cent. represents only £21 per annum, a charge which can have no real bearing on the success of the undertaking, in the future prosperity of which, if fairly treated, I retain undiminished confidence.—Yours, etc., A. R. BENNETT.

ELECTRICITY FROM REFUSE.

SIR,—Some remarks of Mr. Goodrich's with regard to Partick in your issue of 14th inst. are so misleading that I feel compelled in justice, not only to the contractors, but also to ourselves, to make some comments thereon. In a table on p. 6 six different destructors are tabulated with the units generated per ton of refuse. A list of this description is absolutely useless except as an advertisement for Messrs. Meldrum Bros. I do not wish in any way to say anything detrimental to their destructors, but I do object to figures relating to my department being published which are misleading, and which have not been obtained from an authoritative source.

Most modern destructors are fitted with a by-pass, so that, when not steaming, the refuse can still be consumed; and I find, on reference to our log, that during the month of August hardly one-third of the material consumed was used for raising steam, the rest being burnt through the by-pass. In addition, the plant was shut down for some eight hours each day *and steam left on the pipes*, and the fans and pumps were supplied with steam. Again, the refuse obtained in Partick in August has an average calorific value of only about 70 per cent. of the winter refuse owing to the smaller quantity of coal used and to the larger percentage of shop refuse, such as sawdust, vegetables, etc. At present we are working non-condensing, and the steam is fairly wet, and these facts considerably affect the units generated per ton of refuse, although they have nothing to do with the design of the destructor. If the whole of these things were taken into consideration, the figures obtained would be more like 70 units per ton, a by no means unattainable figure with economical engines, pumps, etc It is, however, impossible to regulate the load on an electricity works so that a destructor shall be equally loaded for the whole 24 hours.

It must be apparent to all that before a comparison can be made between several destructors as to the units generated per ton of refuse, the following items must be taken into consideration—viz.: (1) whether the whole of the refuse consumed was used for steam raising; (2) whether the cells were laid off for any length of time; (3) whether steam was left on the pipes during that period; (4) the steam consumption of the steam dynamos at the load at which they were running; (5) the steam consumption of the pumps and fans; and (6) the quality of the refuse consumed.

During the eight weeks ending Nov. 22 last, 1,900 tons of refuse were consumed and 76,750 units generated, which averages 40 units per ton of refuse, and during the last week of the eight 12,000 units were generated from 255 tons, which averages 47 units per ton, whilst on Saturday, Nov. 22, alone 2,500 units were generated from 49 tons, or an average of over 50 units per ton. All of these figures are greatly in excess of Mr. Goodrich's figures, in spite of the facts that almost every day some of the refuse is burnt over the by-pass, that pumps and fans are also supplied with steam, that the engines work non-condensing, and at about one-third load for the greater part of the day, and that steam is on the pipes continuously.—Yours, etc., H. B. MAXWELL, Burgh Electrical Engineer.

Partick, Nov. 24, 1902.

FORTHCOMING BILLS AND ORDERS.

Notices have appeared in the *London Gazette* of the following applications:

A.—TO THE BOARD OF TRADE.

1. *Electric Lighting.*—Walton-on-Thames (U.D.C.), Tadcaster (Electricity Company), Llantrisant and Llantwit Fardre (R.D.C.), Caerphilly (U.D.C.), South Shields (Durham Power Distribution Company), Isle of Sheppey, Sittingbourne, and District (Company), Cambridge and District (Company), Bridgwater and District (Company), Ingleton (Company), Wilmslow (Company).

2. *Electric Tramways.*—Barrow-in-Furness (B.E.T. Co.), Huddersfield (Corporation), Burton-on-Trent (Corporation), Bury (Corporation), Newcastle-on-Tyne (Corporation).

B.—TO PARLIAMENT.

1. *Electric Lighting.*—Chard (Corporation), North-Western Electricity and Power Gas (Company), Dover (Corporation), Woolwich (Borough Council).

2. *Electricity Supply.*—Leigh (Corporation), Newcastle (Company), Stoke Newington (Borough Council).

3. *Electric Tramways.*—Hove, Worthing, and District (Company), Manchester and South Lancashire (Company), Macclesfield and District (Company), Stockport (Corporation), Birmingham (Corporation), Croydon and District (B.E.T. Co.), Manchester (Company), Sutton Coldfield (Corporation), Coventry (Company), Poole and District (Electric Traction Company), Birkenhead and Chester (Company), Harrow-road and Paddington (Company), Brighton (Corporation), Hove (Corporation), South Staffordshire (Company), North-Eastern Railway (Company) Improvements, Tynemouth and District Extensions (Company), Dudley, Stourbridge, and District (Company), North Cheshire (B.E.T. Co.), Wellingborough and District (B.E.T. Co.), Wigan (Corporation), London United Tramways (Company), Romford and District (Company), Beckenham (U.D.C.), Stroud District and Cheltenham (Company), Mid-Yorkshire (Company), Erith (U.D.C.).

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TRADE NOTICES AND NOVELTIES.

Detachable Candelabra.

Some time ago we mentioned a new type of detachable candelabra patented by Messrs. Simmons Bros., of Newton-street, High Holborn, which they had fixed up at the Guildhall

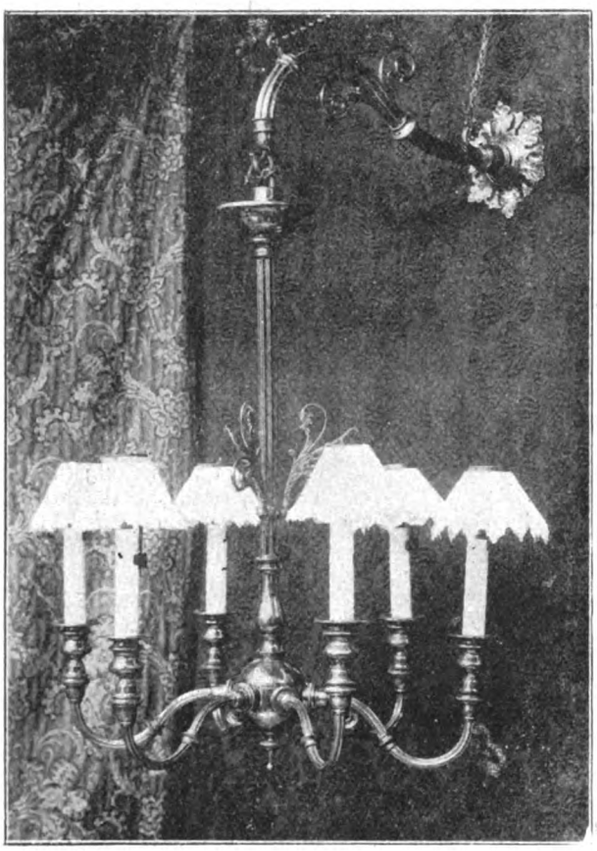
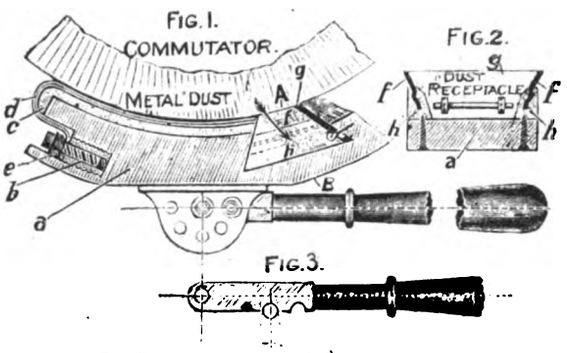


FIG. 1.

on the occasion of the King's visit, and which are of great convenience for temporary installations. They can be taken to pieces or fixed in about five minutes, no wiring having to be done, as all ends are plugged. The accompanying illustrations show the candelabra fixed up (Fig. 1) and taken to pieces



Details of Commutator Grinding Apparatus.

stretching strain transmitted to the apparatus by the friction of the moving commutator is taken up by the brush pin. In larger apparatus the small handle is replaced by a longer

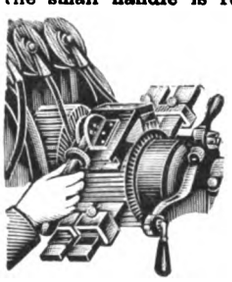


FIG. 4.—Application of Commutator Grinding Apparatus.

pressure lever, which bears on a stationary pin. In Fig. 4 the application of the apparatus to a commutator of small diameter is shown.

PHYSICAL SOCIETY.

At the meeting of the society held on Nov. 14, Prof. S. P. Thompson (president) in the chair,

A paper on "**The Theory of the Aluminium Anode,**" by **W. W. Taylor** and **J. K. H. Inglis,** was read by Mr. Inglis. Aluminium is very slowly acted upon by dilute sulphuric acid even at moderately

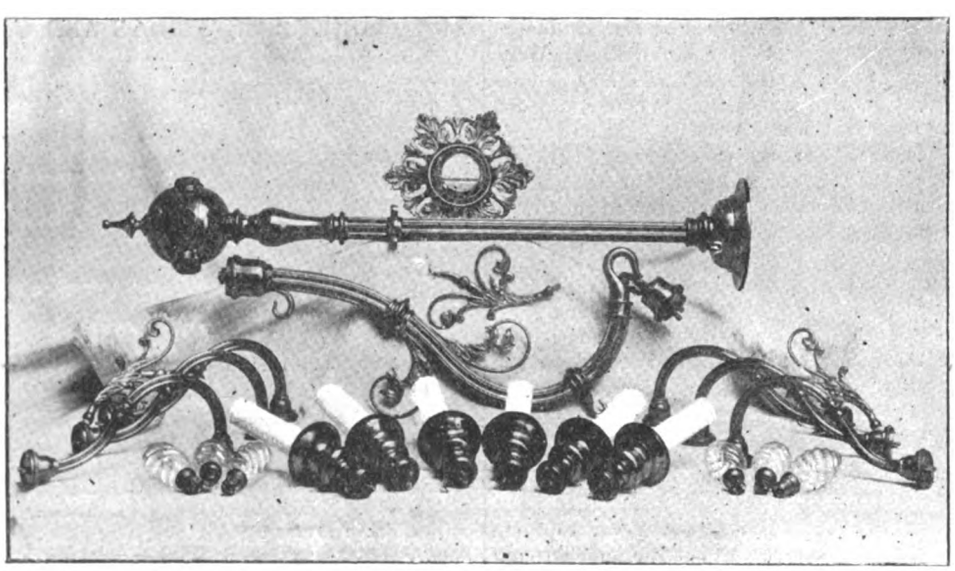


FIG. 2.

(Fig. 2), and speak for themselves. We understand that these articles are shortly to be put upon the market.

Commutator Grinding and Polishing Apparatus.

We illustrate herewith a commutator grinding and polishing apparatus introduced to our notice by Mr. A. Strauss-Collin, Bush-lane House, Cannon-street, E.C., and previously briefly referred to in these columns. The apparatus is of simple construction. Fig. 1 represents a longitudinal section, Fig. 2 a cross-section, and Fig. 3 the long pressure lever used in applying the apparatus to large machines. A is the polishing body proper, which carries at its front end a clamping device for the emery canvas, and at its rear end a metal-dust receptacle with finishing brush. The receptacle for metal dust is shut off on both sides and behind by adjustable rubber walls, which press against the commutator and thus prevent the copper dust from flying out. A plate capable of vertical adjustment is arranged to bear against the brush-holders of the machine, whereby the

high temperatures. With dilute hydrochloric acid the action is violent, and it is found that if a little hydrochloric acid or soluble chloride be added to dilute sulphuric acid the action is as violent as with hydrochloric acid of the same concentration. The object of the present paper is to find an explanation of this anomalous behaviour of sulphuric acid, and of the effect produced by the addition of chloride. It has long been known that when an aluminium electrode is employed as anode in a solution of a sulphate or sulphuric acid there is a very great resistance offered to the current, and that this resistance is due to a film which separates the electrode from the solution. If the aluminium is the cathode, or if other acids are substituted for sulphuric acid, this great resistance does not exist. It seems probable that the

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two phenomena are related, and that the film is also the cause of the slow action of sulphuric acid on aluminium. The authors have attempted to establish a theory which will explain these phenomena. The paper opens with a historical account of the subject, and it is pointed out that the question is now of practical importance in connection with the use of aluminium electrodes for the conversion of alternating currents into direct currents. The first experiments were made with a cell consisting of aluminium and platinum electrodes in dilute sulphuric acid, and were carried out to ascertain in what way the addition of certain salts affected the aluminium anode. The influence of potassium chloride, bromide, nitrate, acetate, chlorate, and thiocyanate in various concentrations was investigated, and the authors conclude that the presence of certain ions enables a large current to pass through the cell. The reason seems to be that the film of aluminium hydroxide with which the anode is covered is permeable to certain ions but impermeable to others. The anomalous behaviour in sulphuric acid would then be due to the impermeability of the film to the SO_4'' ions and also to the Al''' ions. This explanation is in accord with the fact that reversal of the potential difference acting upon the cell immediately causes a current to pass, the film being permeable to H' ions. Experiments were next made upon the rates of diffusion of various ions through a film of aluminium hydroxide. It was found that several salts of potassium diffused rapidly through such a film, but that the sulphate passed through very slowly. This strengthens the argument that the abnormal behaviour of aluminium anodes in sulphuric acid is due to impermeability. It is suggested that the very small current which does pass may be due to a secondary action at the anode, in which the ions of water take part. The theory is confirmed by a series of experiments in which the peculiarities of the aluminium anode are reproduced by means of a platinum anode coated with a film of aluminium hydroxide. A further test was applied in the direct measurement of the resistance of a film of aluminium hydroxide to the passage of different ions. Quantitative experiments which the authors have performed on the effect of the presence of different ions on the reaction between aluminium and sulphuric acid show that this reaction is considerably accelerated by the addition of potassium chloride.

Dr. Lehfeldt said that the lines of explanation were probably correct. Referring to the behaviour of an aluminium anode in sulphuric acid, he said that the small amount of conduction might be due to the fact that the film was not quite impermeable.

The **Chairman** called attention to one of the experiments described in the paper, in which a potential difference of 50 volts applied to a cell with a membrane of aluminium hydroxide between the electrodes produced a current of 0·07 ampere, and asked what the current would have been if the voltage had been reversed.

Mr. Campbell mentioned some experiments which he had seen performed with an aluminium rectifier. He said that if an alternating E.M.F. of small magnitude was applied to the electrodes of a cell consisting of two aluminium plates immersed in strong sulphuric acid, the electrostatic capacity of the cell was large, but if the E.M.F. was increased the capacity fell considerably, and then did not recover on reducing the applied E.M.F. till the cell had been allowed to rest for some considerable time. He asked for an explanation of this phenomenon.

Prof. Ayrton asked the authors whether the rectifying power of an aluminium anode was a question of resistance or of back E.M.F. He said that if an aluminium anode and a lead cathode were placed in a solution of Rochelle salt and an E.M.F. applied for about an hour, it was then impossible to send a current through the cell even by increasing the E.M.F. to 120 volts. If such a cell was used as a rectifier, a black deposit was formed on the aluminium plate, which remained constant in weight. If a direct current was sent through the cell, a white deposit was formed and the aluminium plate lost in weight. Prof. Ayrton described some experiments which seemed to show that the properties of these cells were connected with changes in the liquids of the cells.

Mr. Inglis, in reply to the Chairman, said that in the particular experiment referred to a reversal of the E.M.F. would have given a current of about 30 amperes. In the experiment mentioned by Mr Campbell the explanation might be that when the E.M.F. was large the ions could permeate into the interstices of the film and produce an effect corresponding to a diminution of electrostatic capacity. He thought that the power of an aluminium anode as a rectifier was due to increased resistance and not to back E.M.F.

A paper on **"A Determination of the Ratio of the Specific Heats at Constant Pressure and at Constant Volume for Air and Steam,"** was read by **Mr. Mackower.** The method employed in this paper is similar to that used by Lummer and Pringsheim, and consists in allowing the gas under investigation to expend adiabatically and measuring the lowering of temperature caused by such expansion. The chief modification introduced was the substitution of a platinum thermometer with compensating leads for a bolometer strip. The electrical contacts were made by a specially constructed mercury switch, instead of by hand, and it was found possible to work with smaller quantities of gas than Lummer and Pringsheim had used. In the experiments with air the vessel used was about 50 litres capacity. The pressures were measured with an oil manometer, and the temperatures with the platinum thermometer. The time which elapsed between the instant of reducing the pressure and the reading of the final temperature was determined by means of a chronograph, and varied in the experiments described in the paper from ·5 second to 5 seconds. The value of γ must be corrected on account of conduction and convection during this interval. A correction was also applied to eliminate the effect of radiation from the vessel to the thermometer. The author's value for the ratio of the two specific heats in the case of air is 1·401. In the case of steam, a cylindrical copper vessel of about 9·3 litres capacity was used. The vessel was enclosed in a copper jacket filled with steam so that the steam in the inner vessel was superheated about 10deg. C. The pressure in the jacket was kept constant by means of an automatic gas regulator devised by Prof. Callendar, which controlled the supply of coal gas reaching the burner employed for the generation of the steam. The observations with steam were similar to those in the preceding experiments, but special precautions were necessary to prevent the condensation of the steam in the tubes leading to the vessel. The results for steam were not sufficiently accurate to justify the application of corrections for radiation and for conduction and convection. The values of γ deduced from two series of experiments were 1·307 and 1·304.

Prof. Callendar congratulated the author upon the good agreement of the results of a difficult experiment. He mentioned the difficulties in overcoming conduction when working with steam at a high temperature, and pointed out that the author's value for the ratio between the specific heats of steam agreed closely with that which he (Prof. Callendar) had recently deduced from theoretical considerations. An important feature of the present paper was that experiments had been performed in which different periods of time elapsed between the releasing of the pressure and the determination of the final temperature. Referring to the fact that the author had used a platinum thermometer instead of a bolometer strip, he said that although a bolometer strip was more sensitive than a platinum thermometer, it was more sensitive than necessary in such an experiment. Another point in the experiments was the use of smaller quantities of gas than had hitherto been employed, an advantage of importance when dealing with rare gases. Prof. Callendar then exhibited and described the pressure gauge referred to by the author and used in his experiments.

The society then adjourned until Nov. 28.

FORTHCOMING EVENTS.

SATURDAY, NOV. 29.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Potentiometer," by Mr. J. W. Peck, M.A.

MONDAY, DEC. 1.

Society of Engineers.—At 7.30 p.m., ordinary meeting. Paper: "Depreciation of Plant and Works under Municipal and Company Management," by Mr. Chas. H. W. Biggs.

Society of Arts.—At 8 p.m., Cantor Lecture: "The Future of Coal Gas and Allied Illuminants," by Prof. Vivian B. Lewes. (Lecture II.)

Royal Institution.—At 5 p.m., general monthly meeting.

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "Experiments on Synchronous Converters," by Dr. W. M. Thornton.

TUESDAY, DEC. 2.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "High-Speed Electrical Generating Plant," by Mr. T. H. Minshall.

London Electrical Contractors' Association.—At 8 p.m., Restaurant Frascati, Oxford-street, W. Paper: "Electricity as a Competitor of Gas," by Mr. W. R. Rawlings.

WEDNESDAY, DEC. 3.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Some Aspects of Photographic Development," by Mr. A. Watkins.

Faraday Club.—At 8.30 p.m., St. Ermin's Hotel. Lecture, "Photography in Natural Colours," by Mr. Sanger Shepherd.

Institution of Electrical Engineers (Students' Section.—At 7.30 p.m., ordinary meeting. Paper: "Notes on the Construction of Dynamo Electric Machinery," by Mr. J. R. Hewett.

THURSDAY, DEC. 4.

Institution of Electrical Engineers.—At 8 p.m., extra meeting. Inaugural address of Mr. James Swinburne, president.

Rontgen Society.—At 8.30 p.m., ordinary meeting. Papers: "An Observation bearing upon the Therapeutic Action of the Focus Tube," by Dr. D. Walsh; "X Rays in Ophthalmic Work," by Mr. Stephen Mayou. Mr. Lenthal will show the Nodon electric valve for converting alternating into continuous current.

Civil and Mechanical Engineers' Society.—At 8 p.m., ordinary meeting. Paper: "Some Notes on Tunnelling," by Mr A. W. Manton.

Chemical Society—At 8 p.m., ordinary meeting.

FRIDAY, DEC. 5.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "The Erection of Steel Bridges," by Mr. A. Reynolds.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "The Planimeter explained simply without Mathematics," by Mr. Wm. J. Tennant.

SATURDAY, DEC. 6.

Institution of Electrical Engineers.—At 2 p.m., students' visit to the generating station of the Central London Railway.

British Association of Waterworks Engineers.—At 10.30 a.m., at the Geological Society's Rooms, Burlington House, W., seventh winter meeting. Papers: "The Coating of Cast-Iron Water-Pipes," by Mr. W. H. Humphreys; "Description of Softening Plant at Wilmslow—Stockport Corporation Waterworks," by Mr. T. Molyneux; "The Detection and Prevention of Underground Pollution," by Mr. John Shaw.

King's College Engineering Society.—At 7 for 7.30 p.m., annual dinner, Hotel Cecil.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

537. Will the brake horse-power of an engine driving a Thomson-Houston arc lighter vary in proportion to the output, seeing that the current, field, and speed are constant for all outputs? N.B.—The amount of movement of the throttle-valve spindle is not perceptible for an output of 1,500 volts and 2,500 volts at seven amperes. Steam pressure constant.—A. W.

538. In a certain town in which the voltage of supply is 460 across outers, 230 being the declared voltage at consumer's terminals, a complaint has been made by a consumer, who states that on switching on his shop incandescent lamps they glow *very* brilliantly for three seconds or so, and then burst, showing that voltage must be considerably more than the declared standard—viz., 230 volts. At the supply station the volts on the night in question were normal, as recorder's cards proved. What is the cause of this? And although consumer was connected between neutral and an outer, is it possible he could have been getting voltage across outers, and, if so, what should be done to make a similar occurrence impossible?—R. M.

ANSWERS.

Question No. 531.—How can you connect up a three-phase machine as a single-phase machine, and what is the ratio of the powers you can get from it in the two cases?

Best Answer to No. 531 (*awarded* 10*s.*).—The question may refer to either a generator or a motor. Considering a generator first, a single-phase current can, of course, be obtained by using the winding of one of the three phases alone, but the output of the machine as a single-phase generator would in that case be little more than one-third

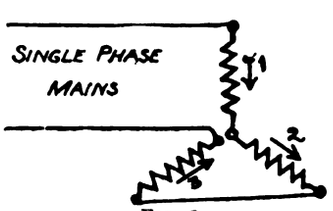

FIG. 1.

of the three-phase power. Or, again, two of the phases may be coupled in series to give a single-phase current, and the output will then be about $\frac{1}{\sqrt{3}}$, or 57 per cent. of that as a three-phase machine. The most efficient arrange-

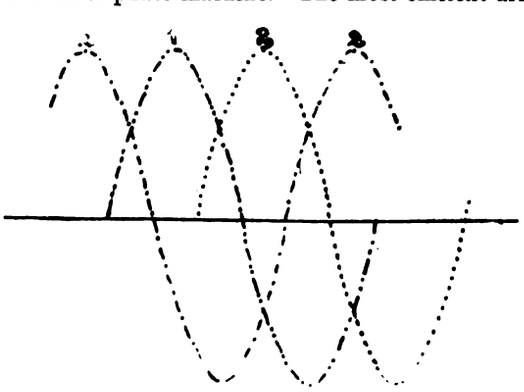

FIG. 2.

ment, however, consists in coupling the windings of all three phases in series, in which case a single-phase output equal to two-thirds of the three-phase output is obtainable. If the armature is star coupled, one of the phases must be disconnected from the neutral point and connected in series with the other two phases in such a way that all three voltages act in unison when at their maximum value (Fig. 1). Fig. 2 shows the relative positions of the voltage curves of the three phases all measured with regard to the neutral point. In order to obtain the vectorial sum of the three voltages when the three phases are connected in series it is necessary to reverse Curve 2, as the voltage of phase 2 (Fig. 1) is only added to the voltages of phases 1 and 3 when the voltage of phase 2, measured relatively to the neutral point, is of opposite sign to the voltages of phases 1 and 3 measured in the same way. This reversal of Curve 2, together with the vectorial sum of the three voltages, is shown in Fig. 3. It will be seen that the

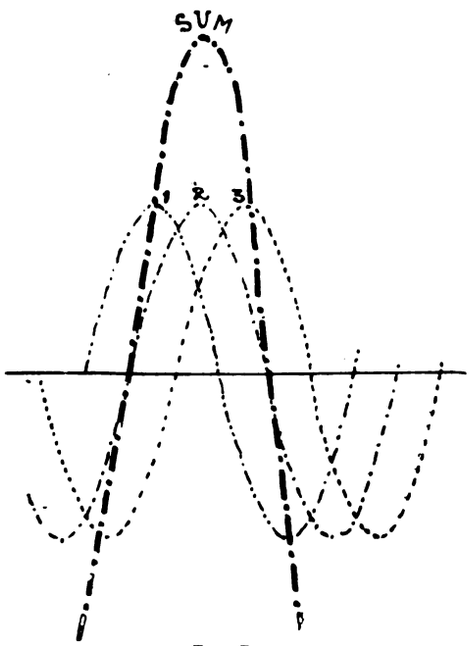

FIG. 3.

resultant voltage (shown heavily dotted) is double the voltage of any one phase, and consequently the output as a single-phase machine is twice the voltage of one phase × the current of one phase, whilst the total output as a three-phase machine would have been three times the voltage of one phase × the current of one phase. The percentage drop in voltage as a single-phase machine with this relative output would be about one and a half times as great as for the three-phase machine, for, whilst the terminal voltage is only double the voltage of one phase, the current has to traverse the whole winding of three phases having three times the resistance and three times the leakage flux of one phase. When the armature is a mesh-coupled one, it must be opened at the two ends of one of the phases, and all three phases must be connected in series, reversing the ends of the disconnected phase (see Fig. 4). The relative

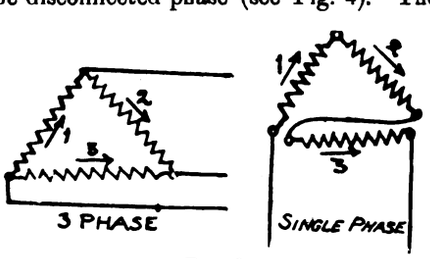

FIG. 4.

outputs of the one-phase and three-phase machine are exactly the same as above, the only difference being that in a mesh winding the "voltage per phase" is the same as the line voltage, and the current per phase is $\frac{1}{\sqrt{3}}$ times the line current, whilst in the case of the star-connected winding, the voltage per phase is $\frac{1}{\sqrt{3}}$ times the line voltage, and the current per phase is equal to the line current.

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Turning next to the question of motors, the above remarks apply if they are of the synchronous type, and a three-phase synchronous motor will give, roughly, two-thirds of its rated output as a single-phase motor if the armature is coupled up (as shown in Figs. 1 or 4). If of the induction type, a three-phase motor cannot be converted into a satisfactory and efficient single-phase motor without rewinding the stator, though it may be converted into a makeshift single-phase motor, which will start under light loads and give about one-third of its rated output. For this purpose one of the stator phases is disconnected altogether (see Fig. 5), and one of the remaining two

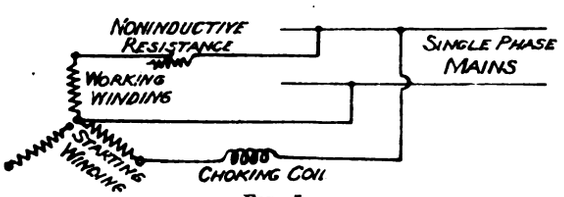

FIG. 5.

phases is used as the "working" winding and the other as the "starting" winding of the motor. The working winding is connected to the single-phase supply mains, either directly or through a non-inductive resistance when starting, and the starting winding is connected to the mains through a choking coil sufficient to cause the currents in the two phases to differ by about 60deg. in phase. The motor will then run up to practically synchronous speed as a modified two-phase motor, and if the starting phase and the non-inductive resistance in the working phase are then cut out, the motor will continue to run as a single-phase motor and give out the power mentioned, though the efficiency will, of course, be low.—Q.

Answer to No. 531 (*awarded* 5*s.*).—The application of three-phase induction motors to single-phase circuits cannot be said to be a great deal in evidence, although several firms manufacture three-phase motors for such conditions, using some compensating device as described below. A three-phase induction motor will, however, run well on a single-phase excitation if, when running on the three phases at normal speed, one of the lines is disconnected from the motor terminals. But the motor will not be self-starting on a single-phase circuit, and so must be brought up to speed by some independent source before switching in. This condition being fulfilled, the motor will run satisfactorily, and will take 1·5 times the current which it took when running as a three-phaser (assuming load constant), or, assuming current constant, it will obviously carry a proportionate load.

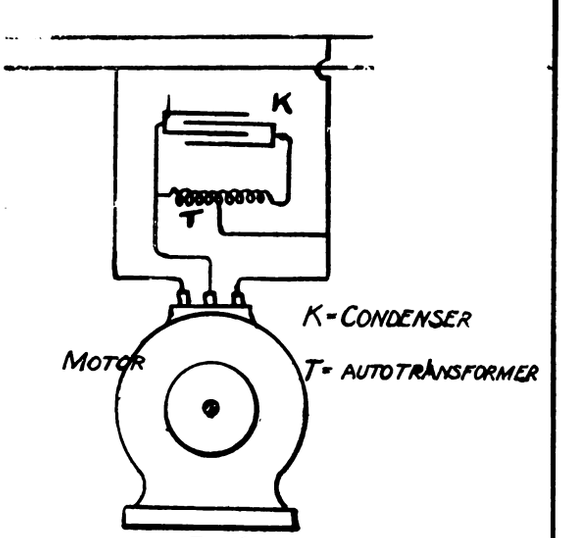

FIG. 1

But the performance of the machine will naturally not be as good as it would be if running on the three phases, either in efficiency, power factor, or uniformity of turning moment, although the irregularities of the turning moment are much too frequent to be noticed in practice. The method of running three-phase induction motors on single-phase circuits consists of placing inductances or condensers in series with one of the motor circuits, as shown in Fig. 1, which shows an arrangement used by the General Electric Company. It consists of an auto-transformer and condenser device. The mains are connected directly to two of the motor terminals. From either main a lead is taken and connected to an auto-transformer, the other terminal of the auto-transformer being connected to the third motor terminal. Across the high-potential terminals of the auto-transformer a condenser is connected. This arrangement causes the current in this circuit to "lead" the current in the other motor circuit, and so produces a rotating field. It has been found by experiment more economical to have the condenser and auto-transformer always in circuit on account of the increased efficiency and power factor. By arranging the condenser and auto-transformer to have a suitable impedance, the power factor of the motor can be kept practically unity for all loads, the small losses in transformer being more than compensated by this increase of efficiency, etc. The use of the auto-transformer is to raise the voltage across the terminals of the condenser, thus allowing the use of a smaller condenser than would be necessary otherwise. The British Thomson-Houston Company also use a similar device.—ERG.

Answer to No. 531 (*awarded* 5*s.*).—With the armature mesh-connected, let A be the maximum current that an armature winding can carry, and let V be the volts between the slip-rings at full load. The output of the machine as a three-phaser will be $3\ V\ A$, and the current in each external main will be $A\ \sqrt{3}$. If we only used one phase, then we would have a single-phase machine, and the maximum power would be V A. In this case, then, we would only get one-third the power. If, however (Fig. 1),

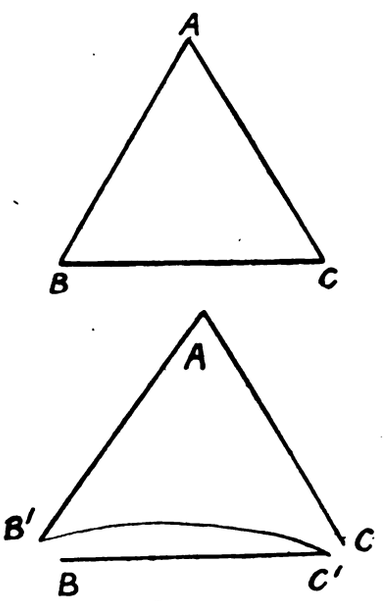

FIG. 1.

we disconnect the end of the coil, A B′, from the slip-ring, B, and the end of the coil B C′ from the slip-ring C, and connect B′ C′, then the vectorial sum of the three E.M.F.'s, V (Fig 2), will be 2 V, and hence the maximum output

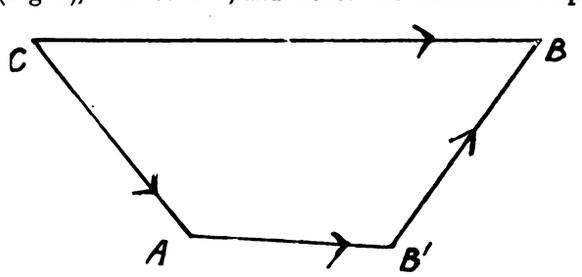

FIG. 2.

will be 2 V A, or two-thirds that of the machine used as a three-phaser. If we cut out the coil, B C, altogether, then the output will be $\sqrt{3}$ V A. Hence, in general, the most efficient case is to join the three coils in series, one of them being reversed. In this case, the heating of the armature is the same as when used as a three-phaser, but

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the output is 33⅓ per cent. less. If, however, the armature is badly ventilated, so that it gets rid of its heat slowly, then it might be better to use only two coils. To prove this, suppose the heating of the armatures the same in the two cases, then

$$2r\,A_2^2 = 3r\,A^2,$$

hence the current the armature could stand in the case of two coils would be given by

$$A_2 = \sqrt{\frac{3}{2}}A.$$

Output for two coils $= A_2\sqrt{3}\,V = \frac{3}{\sqrt{2}}V\,A = 2{\cdot}12\,V\,A.$

Output for three coils $= 2\,V\,A.$

Hence in this case the output is greater, and the required ratio is 0·707, as compared with 0·667 in the preceding case.

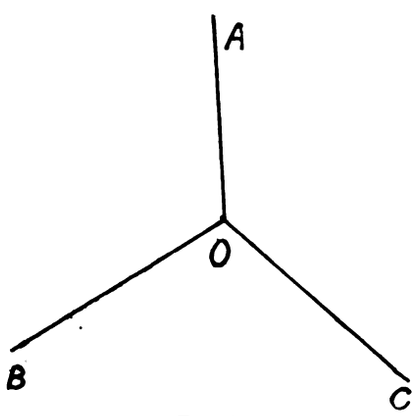

FIG. 3.

With the armature star-connected, if we connect one of the windings, O B, in Fig. 3 as in Fig. 4, then the vector sum of the volts will be 2 V, and hence the reasoning

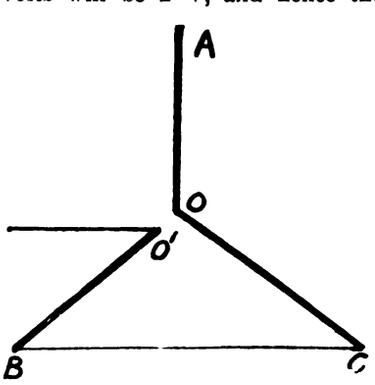

FIG. 4.

will be exactly the same as in the preceding case. The maximum value of the power we can get from the single-phase machine being only about seven-tenths of what we can get from the three-phaser.—J. C. R.

Answer to No. 531 (*awarded* 5*s.*).—A three-phase machine can be used as a single phase machine by disconnecting any single one of its phases and running with the other two in series with their respective line wires. The output of the machine will now be less than when run as a three-phaser, but if it has been well designed it should still give about

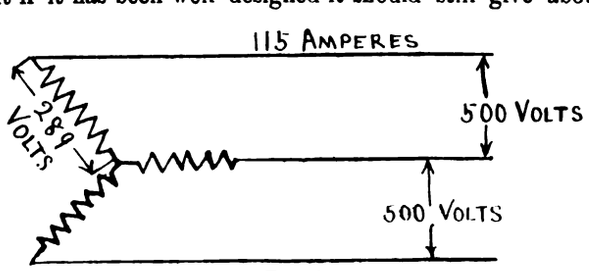

FIG. 1

75 per cent. of its rated output. If the speed is kept the same as before, the line voltage will also remain the same, and the current may be safely increased by about 30 per cent. over its former value. Take, for example, a three-phase generator having a rated output of 100 kw. As the majority of machines are star wound, we will suppose this one to be so.

1. When run as a three-phaser (connections to line are as in Fig. 1): Take line pressure as 500 volts. Then volts per phase $= \frac{500}{\sqrt{3}} = 289$; where V = volts per phase, and C = current per phase. For a three-phase machine, output in watts = 3 C V; therefore, current per phase $= \frac{\text{output}}{3\,V} = \frac{100{,}000}{3 \times 289} = 115$ amperes.

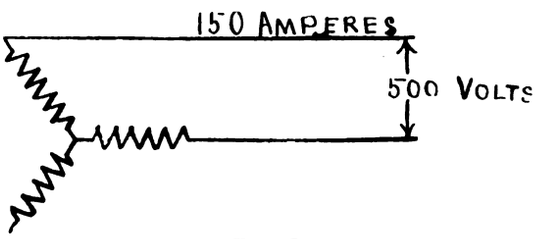

FIG. 2.

2. When run as a single-phaser (connections to line are as in Fig. 2): Current increased by 30 per cent. $= \frac{115 \times 130}{100} = 150$ amperes; output = line voltage × current 500 × 150 = 75 kw., which is 75 per cent. of its former output.—G. M.

Question No. 532.—How would you determine the amount of steam used by an injector?

Best Answer to No. 532 (*awarded* 10*s.*).—Undoubtedly the simplest and most practical way of ascertaining the quantity of steam used by an injector is, to put it briefly, first to take the quantity and temperature of the water supplied to the injector, and the temperature of the water delivered by it, and then to find by a simple calculation the amount of steam supplied. The method is as follows: The water taken from the supply tank must be measured either by a water-meter on inlet to tank, or by direct measurement by filling the tank from a smaller one of known capacity, and leaving the water at the same level at the beginning and end of the test. The temperature of the water in the tank is then taken, and also the temperature of water delivered by injector. If there is no pocket on delivery pipe, a convenient method is to lay the thermometer on delivery pipe and wrap waste round it. The quantity of steam used can then be calculated as follows: The steam pressure being known, the total heat per pound of steam, H, can be found by referring to a table of the properties of saturated steam, as given in any engineering pocket-book. It must be noted that the absolute pressure (boiler pressure on gauge + 14·7) must be taken. Then let

H = total heat per pound of steam from water at 32deg. F.;
θ_1 = degrees F. above 32deg. of delivery water;
θ_2 = degrees F. above 32deg. of water in tank;
W_1 = weight of steam;
W_2 = weight of water taken from tank;

then $$W_1(H - \theta_1) = W_2(\theta_1 - \theta_2)$$

(*i.e.*, heat lost by steam = heat given to water),

$$\therefore W_1 = W_2\left(\frac{\theta_1 - \theta_2}{H - \theta_1}\right).$$

Thus taking two set of figures obtained in practice with similar injectors on (1) a water-tube boiler evaporating 1,060 gallons per hour, and (2) a Lancashire boiler evaporating 600 gallons per hour, we find in the first case, where temperature of tank water was 66deg. F., and ditto of delivery from injector was 157deg. F., that

$$W_1 = 10{,}600\left(\frac{125 - 34}{1{,}191 - 125}\right)$$

$$= 10{,}600\left(\frac{91}{1{,}069}\right)$$

= 910lb. steam per hour (nearly).

In the second case temperature of tank was 60deg., and that of delivery 170deg., from which the steam used was found to be 666lb. per hour. It will be noticed that the proportion of steam used by injector to that generated

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was in the first case 8·6 per cent. and in the second 11·1 per cent. At first sight this may seem a very formidable proportion, but it must be remembered that an injector is presumably only used as a regular means for feeding a boiler when, from lack of an economiser or other feed heater, the only alternative is to pump cold water direct. In such case the use of an injector would not only prove more economical, but also far less injurious to the boiler; more economical, because although the pump would certainly take less steam than the injector, yet the water going in cold would more than counterbalance this, as the boiler would not raise so much steam. Also the water going in cold would bring more strains to bear due to increased expansion and contraction.

It is somewhat difficult to determine the best size of injector to put on a boiler, as, on the one hand, if a small one is put in there is the danger of being unable to keep the right water level owing to increase of load on boiler or to water having got low through carelessness or inability to start injector. On the other hand, if a large one be used, it takes steam and delivers water so rapidly as to drop boiler pressure considerably, which is particularly annoying if, as often happens, more load comes on at the same time. Probably the best plan in a case where injectors are used as a regular means for feeding would be to use two of different sizes, running the small one when possible, to reduce fluctuations of pressure, and keeping the large one as stand-by in case of emergency. The injectors should be of the restarting type, or there will be continual bother and much time wasted in starting over again if the injector should happen to lose its water. It is also very advisable to supply feed from a point above injector, and thus make it work non-lifting. Attention to these two points would save the fireman endless trouble and the engineer-in-charge much worry.—R. S. B.

Answer to No. 532 (*awarded* 7*s.* 6*d.*).—In a case such as this many complications may come in which will upset the accuracy of results worked out theoretically, such as a long length of discharge pipe or a large number of bends; or, again, the discharge pipe may be too small in its diameter to allow the water to flow freely In all of these cases the extra friction will materially affect the result. Another case which should not be omitted is that of a suction pipe with a considerable lift. However, neglecting all errors due to any of the above, and supposing a case where the water is drawn from the same level as the ejector, the question as it stands is short of data. First of all, the pressure of steam must be known. I will take this case first. Suppose the pressure of steam to be 85lb. by a gauge, or 100lb. gross, the energy of this steam escaping equals $\frac{\text{velocity}^2}{2\,g}$. The velocity of this steam is equal to 70·5 times $\sqrt{\text{P V}}$, where P is the gross pressure and V is the volume of 1lb. of steam at that pressure; therefore the velocity is equal to

$$70{\cdot}6\sqrt{100 \times 4{\cdot}35} = 70{\cdot}5\sqrt{435} = 70{\cdot}5 \times 20{\cdot}8.$$

$$\therefore \text{velocity} = 1{,}470 \text{ foot-seconds.}$$

$$\therefore \text{the energy} = \frac{1{,}470 \times 1{,}470}{64} \text{ foot-pounds;}$$

$$= 33{,}800 \text{ foot-pounds.}$$

This is employed in overcoming a boiler pressure of 85lb., and is equal to the energy required to overcome this pressure through a distance of $\frac{33{,}800}{85}$ft., say 400ft. of pipe one square inch in area—*i.e.*, 1lb. of this steam will put a mixture of steam and water into the boiler equal in volume to 400 cubic inches. This is equivalent to $\frac{62{\cdot}5 \times 400}{1{,}728}$lb. = 14·5lb. But 1lb. of this was originally steam, making the proportion $\frac{\text{steam}}{\text{water}} = \frac{1}{13{\cdot}5}$; *i.e.*, 1lb. of steam to 13·5lb. of water. In actual practice this will probably be about 12lb., allowing for errors due to the causes before mentioned.

To take another case, where the temperature of the feed water as it enters the boiler, and also the temperature of the feed water as it leaves the feed tank, is known, the question may be easily solved, as it resolves itself into merely a question of the proportionate mixture of steam of a given pressure, and consequently known temperature with water, also of a given temperature, to give a final resulting temperature equal to that of the feed entering the boiler, *e.g.* Taking the same steam of 85lb. by gauge, and supposing the temperature on entering the boiler to be 130deg. F., and the temperature of the feed on leaving the feed tank to be 60deg. F., given 1lb. of water at 60deg. F., what weight of steam at the above pressure will be required to raise the resulting mixture to 130? Let x = quantity of steam required; then $x\,(1{,}115 - {\cdot}3\,\text{T})$ = total heat in that steam, and temperature of water before mixture = 60deg. F., then $x\,(1{,}115 - {\cdot}3\,\text{T}) + 60 = (x + 1) \times 130$deg.

$$\therefore 1{,}115\,x - 98\,x - 130\,x = 130 - 60.$$

$$\therefore 887\,x = 70.$$

$$\therefore x = \frac{70}{887}\text{lb.}$$

$$\therefore x = {\cdot}079\text{lb.}$$

i.e., the proportion of $\frac{\text{steam}}{\text{water raised}} = \frac{79}{1{,}000}$. —G. G S.

Answer to No. 532 (*awarded* 5*s.*).—The simplest way to find the amount of steam used by a live-steam injector (it is assumed that the injector alluded to in the question is worked by live steam) is to take the difference of the temperature of the water as it enters the injector and as it leaves it by means of ordinary thermometers. The difference between these two readings will be the heat added to the water by the condensation of the live steam used in the injector. If the quantity of the water passing through be known, it is easy to find the amount of steam used from these figures. Thus, assuming the water enters the injector at 60deg. F. and leaves it at 120deg. F., and 60lb. of water pass through per minute, the amount of heat added to the water in British thermal units per minute will be (120 – 60) × 60 = 3,600. This is not quite correct, owing to the amount of heat necessary to raise 1lb. of water 1deg. not being the same over the whole scale, but it is usually assumed so in text-books on the subject and introduces no serious error. The quantity of steam containing 3,600 British thermal units depends on its temperature. If the "latent heat" of the steam is divided into 2,400, the result would be the number of pounds of steam used per minute. The latent heat of the steam can be found from the formula

$$\text{L} = 966 - {\cdot}71\,(t - 212\text{deg.}),$$

where t = temperature of steam. As the latent heat of steam does not vary exactly in inverse proportion with the temperature, this formula is only approximately correct, but should be sufficiently accurate for ordinary purposes. Assume the steam pressure in the above case is 165lb. per square inch absolute, the temperature equivalent being 366deg. F., then the latent heat of such steam will be

$$966 - {\cdot}71\,(366 - 212) = 856{\cdot}7.$$

The steam used will, therefore, be $\frac{3{,}600}{856{\cdot}7} = 4{\cdot}2$lb. per minute. Combining these results, we get the amount of steam used per minute from the formula

$$\frac{\text{W}\,(\text{T}_2 - \text{T}_1)}{966 - {\cdot}71\,(t - 212)},$$

where T_1 = temperature of water entering injector;
T_2 = temperature of water leaving injector; and
W = pounds of water passing through injector per minute.

With regard to a method of finding the amount of water passing through the injector, perhaps the most convenient would be to, during the test, shut off the inflow of water to the feed tank, and measure the fall in level in feet or a fraction of a foot per minute. This, multiplied by area of tank in square feet, would give the amount of water used per minute in cubic feet, or if divided by 62·5, the weight of a cubic foot of water in pounds per minute.—A. J. J. G. W.

Answer to No. 532 (*awarded* 5*s.*).—There is no doubt that the injector to be experimented with in this case is a live-

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steam injector, and it appears that as there is as yet no instrument which will reliably measure the amount of steam that passes through a pipe, the only way to measure it is by considering the amount of heat added to the feed water by the steam. It is known from experiments the amount of heat contained in 1lb of steam at a certain temperature, and if the amount of heat added to the feed water be also known, clearly the amount of steam can be found from these figures. Considering, firstly, the heat contained in the steam, assume the temperature to be $t°$ F. when it passes to the injector. The steam is first reduced to a state of water. During this reduction the latent heat of the steam is given to the feed water, and the water resulting from the condensation of the steam is further reduced in temperature when it mixes with the feed water. If, therefore, the latent heat of the steam and the heat given by the condensed steam—*i.e.*, the resulting water—be added, it will be equivalent to the increase of heat of the feed water. This amount of heat is called the total heat of steam, which is found by the formula

$$H = 1{,}082 + {\cdot}305 \times t - h,$$

where t = temperature of steam;
h = amount of heat necessary to raise 1lb. of water from t_1 to t, when t_1 = initial temperature of water.

Taking next the amount of heat given to the water, this can be found by taking the difference of temperature between the inlet to and outlet from the injector and multiplying by the number of pounds of water that passes through. Thus if S pounds of water pass through per minute and the temperature of inlet and outlet are respectively t_0 and t_1, then the amount of heat taken per minute will be $S(t_1 - t_0)$, which is equivalent to $V \times H$, where V = pounds of steam used per minute. Thus we get

$$S(t_1 - t_0) = V(1{,}082 + {\cdot}305\ t - h),$$

and

$$V = \frac{S(t_1 - t_0}{1{,}082 + {\cdot}305\ t - h}.$$

For example, suppose the water enters the injector at 40deg. F. and leaves it at 100deg., also 25lb. of water pass through per minute, the heat added will be

$$25(100 - 40) = 1{,}500.$$

If in this case the temperature of steam be 338deg. F., the steam used per minute will be

$$= \frac{1{,}500}{1{,}082 + {\cdot}305 \times 338 - 238} = 1{\cdot}6\text{lb}.$$

Here $h = t - t_1 = {\cdot}338 - 100 = 238$ B.T.U.

—A. J. SWANSEA.

LEGAL INTELLIGENCE.

ACETYLENE ILLUMINATING COMPANY v. UNITED ALKALI COMPANY.

In the Court of Appeal, composed of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, on Wednesday this case came on for hearing on the appeal of the plaintiff company from a decision of Mr. Justice Buckley in the Chancery Division. The action was brought to restrain the United Alkali Company from an alleged infringement of Willson's patent of 1894 for the manufacture of calcium carbide. It was claimed for Willson's patent, which consisted of passing a powerful electric current through carbon and lime, by which an intense heat was obtained, that it enabled that which was before known only as a chemical curiosity to be manufactured commercially. The defence was that the patent of 1894 was anticipated by a previous patent of Willson's and by papers communicated by a man named Moissan to a French scientific institution. The defendant company also denied that it had infringed the plaintiff company's patent.

In the result the Court held that the Acetylene Illuminating Company's patent was bad on the grounds both of anticipation and want of subject matter, and the appeal was dismissed with costs.

WORKMEN'S COMPENSATION CASE.

At Newport County Court on Thursday last week Judge Owen heard a claim under the Workmen's Compensation Act, brought by Walter John Gough, bricklayer, who claimed £300 from Messrs. A. L. Morgan and Co., contractors, Newport. The case for the applicant was that he was working on the chimney stack at the Newport Corporation electric power station, for which the respondents were the contractors. Stone was raised by means of shearlegs, the feet of which rested in the holes upon the platform. On May 28 a block of stone was swung over to the edge of the stack by means of the wire ropes, when the shearlegs toppled over on to the applicant, who was knocked over the outside of the stack, and was pinned against it by the wire rope. Gough sustained a fracture of the left arm and other injuries.

His Honour, in giving judgment, pointed out that the respondent had not shown that the workmen had been given any instructions as to the way the stone was to be moved, or as to the danger in swinging it in the way which caused the accident. He held that the applicant had made out his case, and awarded him £50 compensation and costs.

A TELEPHONE AGREEMENT.

At the Brighton County Court this week Judge Martineau had before him a case in which the National Telephone Company sued A. Girling, of Brighton, bootmaker and grocer, for 9s. 9d. for use and occupation of a telephone line and instrument from June 16 to Aug. 15 last.

Plaintiff's Manager said the defendant entered into an agreement for an instrument for local calls at 1d. a call. There was no annual rental, but defendant guaranteed a minimum payment of 2d. per day, which had to be placed in an automatic box attached to the instrument, the agreement being that the contents of the box had to be made up to this minimum at the end of every month. At the end of a month there was 4s. 9d. short, and as the defendant would not pay, the company, in accordance with the terms of their agreement, disconnected the line, and another month's payments became due.

His Honour: He has to pay although he doesn't have the use of the line?

Witness: Yes, that's the only remedy we have against bad payers except coming here.

His Honour: It seems uncommonly unjust.

The **Defendant:** I've paid every penny I owe for the use of the telephone.

His Honour: I'm afraid you will have to pay to the end of the year, but I think the company ought to connect you again.

The **Manager:** We shall be very happy to do so.

His Honour gave judgment for the plaintiffs for the amount claimed, with costs.

WINDING-UP PETITION.

In the Chancery Division on Tuesday Mr. Justice Byrne, in the case of the British Power, Traction, and Lighting Company, had before him the petition of L. Hannen, judgment creditor, for a winding-up order. The petition was directed to stand for three weeks on the usual undertaking, it being stated that hopes were entertained of a reconstruction of the company.

COMPANIES' MEETINGS AND REPORTS.

POWER GAS.

The report of the directors for the period ended Sept. 30 last, to be submitted at the meeting on the 4th prox., states that the whole of the share capital offered for subscription was applied for and duly allotted, and the Company was authorised to commence business on Aug. 16, 1901. The Company has completed the purchase of the whole of the properties to be acquired in the terms of the prospectus. The shareholders are aware that the purchase included the entire share capital of Ashmore, Benson, Pease, and Co., Limited, of Stockton-on-Tees, where the manufacturing business of the Company is carried on. The extension and remodelling of the works was taken in hand at once, and they have now been thoroughly equipped with modern tools and appliances, enabling them to turn out a large amount of work. The expenditure incurred on this account is included under the heading of investments and advances, on the assets side of the balance-sheet. The directors announce that contracts for a number of important installations have been secured (including the plant for the South Staffordshire Mond Gas Company), and that the works are fully employed. The balance-sheet shows a balance to the credit of profit and loss account of £14,967, which the directors propose to apply as follows: amount to be written off preliminary expenses account, £2,000; dividend at 6 per cent. per annum upon the ordinary shares, £8,868; dividend at 4 per cent. per annum upon the deferred shares, £2,691; balance to be carried forward to next account, £1,408.

NEW COMPANIES REGISTERED.

Bridgwater and District Electric Supply and Traction Company, Limited.—Capital, £15,000. Objects: to carry on in all its branches the business of a light, heat, and power company; for the purposes of the Company to lay any cables, wires, lines; as manufacturers of accumulators; to lay down in Bridgwater and elsewhere rail and tram roads; to build and run electric omnibuses and vans; as builders of locomotives, dynamos, etc.

Midgley's Electric Therapeutical Company, Limited.—Capital, £1,000. Objects: to take over the benefits and obligations of the lessee; also agreements with W. S. Thomson and F. Murgatroyd for the lease of an installation and light treatment, with all rooms, appliances, machinery, etc., for medical and surgical purposes; to fit up hospitals and other institutions.

Webster's, Limited.—Capital, £2,000. Objects: to carry on in all or any of its branches the business of electrical engineers as now and hitherto carried on by W. M. Storr, St. John's-lane, Dudley Port, as Webster, Michelson, and Co., etc.

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Birkenhead and Chester Tramways Company, Limited.—Capital, £5,000. Objects: to lay down trams and light railways; as manufacturers of and dealers in rails and all necessary appliances, rolling-stock, vans, cabs, and other vehicles and carriages, whether propelled by compressed air, gas, electricity, steam, or otherwise, etc.

Londonderry-Movill Electric Syndicate, Limited.—Capital, £10,000. Objects: to acquire the benefit of certain work already done by the Londonderry-Movill electric railway scheme; to continue the same; to construct light railways, etc.

Metropolitan Electric Tubes Syndicate, Limited.—Capital, £15,000. Objects: to adopt an agreement with Thomas Hunter, and to carry on the general business of an electric light works, etc.

Motor Power Company, Limited.—Capital, £100. Objects: to carry on in all or any of their respective branches the businesses of cycle makers, motor and motorcar builders, and engineers, etc.

Carl Oppermann Electric Carriage Company, Limited.—Capital, £50,000. Objects: to acquire as a going concern and carry on the business of an electrical engineer and motor-carriage maker as carried on by C. Tunstill J. Oppermann, at 2, Wynyatt-street, and Rawstone-street, Clerkenwell, with the plant, machinery, assets, etc., thereof; to acquire and turn to account three inventions of the said C. T. J. Oppermann for improvements in electrical controllers in motor road vehicles and in secondary batteries; as producers and suppliers of electricity; as electrical and mechanical engineers, etc.

APPOINTMENTS VACANT.

Station Superintendent, Ilford Urban District Council, £150 per annum, Dec. 1. See advertisement.

Assistant Mains Superintendent, Aberdeen Corporation Electricity Department, £2 per week, Dec. 1. See advertisement.

Electrical Engineers. Elland Urban District Council, Dec. 22. Fulham Borough Council, £400 per annum, rising by £25 per annum to £600 per annum, Dec. 15. See advertisements.

Test-Room Assistant, Aberdeen Corporation Electricity Department, 30s. per week, Dec. 8. See advertisement.

Mechanical Draughtsmen, experienced in the design of central-station switchgear. See advertisement.

Works Manager for large electrical switch works. See advertisement.

Meter Tester, Swiss, German, or French, thoroughly conversant with Vulcan, Aron, and Chamberlain and Hookham meters. See advertisement.

Apprentice for direct-current central station. See advertisement.

Improver for direct-current station, able to take entire charge of shift; concentric mains experience a recommendation. See advertisement.

Gentleman to represent firm of manufacturers dealing in materials for electrical industry. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hebden Bridge.—The Urban District Council require tenders for electricity plant estimated at £12,000.

St. Pancras.—The Borough Council invite tenders for supplying a covered testing truck. Tenders by Dec. 9. See advertisement.

Swansea.—The Corporation invite tenders for the supply of electric motors and starting switches for a period of 12 months. Tenders by Dec. 1. See advertisement.

Bristol.—The Electrical Committee invite tenders (from boiler makers only) for water-tube boilers and accessories. Tenders by Dec. 11. See advertisement.

Bethnal Green.—The Board of Guardians invite tenders for the wiring of the administrative offices, Bishop's-road, Victoria Park, N.E. Tenders by Dec. 4. See advertisement.

Bristol.—The Electricity Committee invite tenders (from arc lamp manufacturers only) for 380 5-ampere direct-current open-type arc lamps. Tenders by Dec. 8. See advertisement.

Croydon.—The Town Council invite tenders for the extension of the car-shed at the Brighton-road (Purley) depot. Specifications, etc., may be seen and obtained at the Deputy Borough Engineer's Office, Town Hall, Croydon. Tenders by 11 a.m. on Dec. 8.

Bexley.—The Electric Lighting and Traction Committee invite tenders for car-shed buildings and steelwork. Specification, etc., may be seen at the Public Hall, Bexleyheath, and obtained at the offices of the Engineers, 82, Victoria-street, S.W. Tenders by Dec. 8.

Caen (Calvados, France).—The Prefect at this place requires tenders for the concession and working of a light railway between Trouville and Honfleur, a distance of about 10 miles, for goods and passenger traffic. Electric traction preferred. Tenders by Jan. 1, 1903.

Sidmouth.—The Urban District Council invite tenders from electrical engineers and others for the lease for a period of 42 years of a provisional order for the supply of electricity for lighting, heating, and power throughout their district. Tenders by Dec. 20. See advertisement.

Manchester.—The Electricity Committee invite tenders for the supply and delivery, as and when required, of 600 electricity meters. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by Dec. 3.

Dublin.—The Dublin United Tramways Company invite tenders for the supply of general stores, including car fittings, iron, steel, castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, timber, etc., during year ending Dec. 31, 1903. Tenders by Dec. 8. See advertisement.

Manchester.—The Trafford Park Estates Company, Limited, invite tenders for permanent way, roadmaking, draining, etc., overhead equipment, and steel poles, etc. Specification, etc., can be obtained from Messrs Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Dec. 13.

Brighton.—The Council invite tenders for the construction of the permanent way of the tramroads in London-road, St. Peter's-parade, and Old-steine, etc., including the bonding and all contingent works, and paving with wood the whole of the area of such roads, including the tramway tracks. Tenders by Dec. 23. See advertisement.

La Valette.—The Municipality invite tenders for the establishment and working for 99 years of a tramway between La Valette and Senglea Cospiena, Vettoriosa and Casal Zebbug. Deposit £300. Tenders by Nov. 25 to Wm. Casolani, receiver-general and director of contracts, La Valette. Plans and particulars will be ready by March 1, 1903.

Dumfries (Scotland).—The Town Council invite tenders from companies as follows—viz.: (1) for the burgh's electric light provisional order, and alternately (2) for light and traction combined; (3) for a supply of electricity to drive the cars, if the Council resolve to conduct the traction; (4) if the Council construct the works, tenders for a lease of each. Tenders by Dec. 1. See advertisement.

Clacton.—The Urban District Council invite tenders for the supply and erection of boiler-house plant, two Economic boilers with fittings and accessories, steam and exhaust piping, two high-speed engines, two 100-kw. dynamos, balancer and boosters, switchboard, street work, underground cables, switch pillars, etc., accumulators, travelling crane, and rails. Tenders by Dec. 22. See advertisement.

Mansfield.—The Corporation invite tenders for the complete wiring and equipment of their electricity works for power, light, and bells. Specification, etc., may be inspected and obtained at the office of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Corporation, 64, Victoria-street, London, S.W., or at the office of Mr. E. Holcombe Hewlett, clerk of the works, at the Electricity Works, Mansfield. Tenders by Dec. 1.

London, S.W.—The Wandsworth and Clapham Board of Guardians invite tenders for providing and fixing up an electric wiring installation, and the fittings thereto, to the new buildings now being erected, and known as the receiving ward block, servants' block, and waiting-hall block at their infirmary, St. John's-hill, Wandsworth. Specification, etc., may be obtained up to and including Dec. 8, between 10 a.m. and 4 p.m. (Saturdays until 1 p.m.), upon application to the Guardians' architects, Messrs. Lansdell and Harrison, 65 and 66, Basinghall-street, E.C. Tenders by 12 noon on Dec. 10.

Durban (Natal).—Tenders are invited for the following in connection with the new municipal telephone system: a complete exchange equipment for an ultimate capacity of 7,200 lines, the present contract to make immediate provision for 2,520 lines. The equipment comprises all distribution and switchroom boards, power plant, and wiring. The contract also includes the work of erection in Durban and maintenance for three months; and underground dry-core air-space cables, comprising approximately 15,000ft. 200 pair, 12,000ft. 150 pair, 25,000ft. 100 pair, 6,000ft. 75 pair, 7,000ft. 50 pair, 12,000ft. 25 pair. Tenders by Dec. 5. See advertisement.

Shanghai.—The Board of Trade have received through the Foreign Office, from H.M. Commercial Attaché at Shanghai, copy of an advertisement issued by the Municipal Secretary at Tientsin, calling for proposals for the lighting of the British concessions by electricity—as follows: British Municipality and British Municipal Extension, Tienstin. Notice—The British Municipal Councils, in accordance with the terms of the resolution passed at the general meeting of landowners, fuers, etc., held on May 2, are now prepared to receive proposals for the lighting of the concessions by electricity, such proposals to be submitted by Nov. 30. Mr. A. W. Harvey Pellingham, A.M.I.C.E., secretary and engineer. Note.—It is understood that no details or specification will be furnished.

RESULTS OF TENDERS.

Mansfield.—The Corporation have accepted the tender of the Mansfield Engineering Company, Mansfield, for the wiring of the town hall premises.

Bridgend.—The Urban District Council have accepted the tender of Callender's Cable and Construction Company for electric mains for public lighting, at £4,031.

Swindon.—The Corporation have accepted the tender of Venner and Co., 6, Old Queen-street, Westminster, at £216. 7s. 6d., for direct-current electricity meters.

Adelaide.—The Electric Lighting and Traction Company of Australia have accepted the tender of D. Bruce Peebles, Edinburgh, for duplicate 350-h.p. generators, with Willans engines.

Newcastle-on-Tyne.—The City Council have accepted the tender of Russell and Co. for supply and erection of overhead tramway poles on the extension routes to Benwell and Walker, at £7,131.

Grimsby.—The Corporation have accepted the following tenders for the supply of continuous-current motors for letting on the hire system: Crompton and Co., Chelmsford, ¼ h.p. and ½ h.p.; Keighley Electrical Company, Keighley, 1 h.p. to 10 h.p.

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Fulham.—At a meeting of the Borough Council a committee recommended the acceptance of the tender of Aiton and Co. for extensions to pipework at the electric lighting and destructor works, at £1,872; and that of P. B. Cow and Co. for the supply of 25 large indiarubber mats, at £69. 6s.

Batley.—The Corporation have accepted the tender of Baker, Bauer, and Co. for a battery of accumulators having 770 ampere-hours capacity on a 10-hour discharge and 400 ampere-hours on a one-hour discharge. The above firm are the agents for the Accumulatoren Werke, Witten-a/d-Ruhr.

London County Council.—The Council have received the following tenders for the supply of the low-tension switchboards for use at the sub-stations now being erected at Brixton, Clapham, and the Elephant and Castle:

J. G. Statter and Co., Birmingham	£1,604	9	0
Electric and Ordnance Accessories Company, Limited (Messrs. Vickers, Sons, and Maxim), Birmingham	2,248	0	0
Allgemeine Elektricitäts-Gesellschaft, Berlin	2,260	0	0
Cowans, Limited, Manchester	2,310	0	0
A. Kramer, London	2,448	8	0
Cox-Walkers, Limited, Darlington	2,459	0	0
Consolidated Telephone Construction and Manufacturing Company, Limited, London	2,500	0	0
Kelvin and J. White, Limited, Glasgow	2,582	18	0
British Westinghouse Electric and Manufacturing Company, Limited, London	2,599	9	0
Electric Construction Company, Limited, Wolverhampton	2,754	0	0
B. Thomas, Manchester	2,772	0	0
Siemens Bros. and Co., Limited, Westminster	3,071	0	0
Johnson and Phillips, Old Charlton, Kent	3,087	17	0
Electrical Transmission Company, Hammersmith	3,216	4	0
Mather and Platt, Limited, Manchester	3,245	3	0
W. J. Fryer and Co., Harrow-road, W.	3,294	5	0
Edison and Swan United Electric Light Company, Limited, London	2,710	6	6
Ditto (alternative)	3,340	2	6
Ferranti Limited, Hollinwood, Lancaster	4,108	12	0
Ditto (alternative)	2,985	8	0
British Thomson-Houston Company, Limited, Rugby	4,311	15	0
Holland House Electrical Manufacturing Company, Limited, Glasgow	5,458	11	0
Heaton and Smith, Limited, Salford	6,044	3	0

The following recommendations have been made: (*a*) That, subject to the usual enquiries proving satisfactory, the tender of Messrs. Cowans, Limited, be accepted for the supply, for the sum of £2,310, of three low-tension switchboards for use at the sub-stations to be established at Brixton, Clapham, and near the Elephant and Castle respectively, in connection with the reconstruction for electrical traction of the Tooting-to-Westminster, etc., tramways. (*b*) That Messrs. Cowans, Limited, be allowed to sub-let the following portions of the work in connection with the manufacture and erection of the switchboards referred to in the foregoing resolution—namely: (1) to Messrs. Nalder Bros. and Thompson, London, the manufacture of the instruments; (2) to Messrs. E. Matthews and Co., London, the preparation and the enamelling of the slate panels; and (3) to the British Thomson-Houston Company, Limited, Rugby, the manufacture of the lightning arresters.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Shipley.—Application is to be made to borrow £45,000 for electric lighting and power purposes.

Lurgan.—The erection of a small electric lighting plant at Castor Bay pumping station is suggested.

Haverfordwest.—Discussion on the pumping scheme has been adjourned until next Council meeting.

Slough.—The Slough and Datchet Electric Light Company are making rapid progress with their generating station.

Montrose.—The School Board are obtaining an estimate as to the cost of introducing electric light at the cookery school.

Worcester.—The National Telephone Company have obtained permission to place wires underground in various places.

Nuneaton.—Next Monday, at 2.30 p.m., the Urban District Council's electricity supply undertaking will be formally opened.

Rawtenstall.—The Board of Trade have extended the Rawtenstall electric lighting order for a further period of one year from the 6th inst.

Falkirk.—Mr. Robert Sim, Edinburgh, has been appointed to the post of assistant to the resident electrical engineer at a salary of £100 per annum.

Stepney.—An independent expert is to be employed by the Guardians to examine the electrical plant at the houses and to report upon the whole subject.

Stirling.—The engineer's report for four weeks ending Nov. 1, 1902, shows that 18,011 units were generated, compared with 11,774 for the same period last year.

Parliament.—In the House of Commons on Monday the Electric Lighting Acts Amendment (Scotland) Bill passed through committee, and was read a third time.

Paris.—The Compagnie Générale d'Electricité has convened a general meeting of its shareholders for next month, when the issue of debentures is to be discussed.

Dover.—The Corporation have decided to apply for parliamentary powers to purchase the existing electric lighting undertaking in the borough and adjoining district.

Leven (Fife).—The Town Council have consented to the application of Messrs. Crompton and Co. as to the granting of a provisional order to the Electrical Supply Company.

Newton Abbot.—The offer of the Urban Electric Supply Company, Limited, to light the town by electricity for £900 per annum has been accepted, and a 10 years' agreement prepared.

Chatham.—The undertaking of the Chatham and Rochester Electric Lighting Company has been sold at a price, fixed at £62,791 by arbitration, to the Kent Electric Power Syndicate.

Auckland.—The Urban Council have decided that the powers for a provisional order given to Edmundsons' Electric Company should be transferred to the Durham Electric Power Company.

Whitworth.—The Council have appointed a committee to meet the Lancashire Electric Power Company's general manager, Mr. Herring, with regard to laying of mains in the district.

Jamaica.—The Local Government is arranging to introduce a Bill during the next session of the Legislative Council to grant facilities for the establishment of wireless telegraphy in the colony.

Brixham.—The Urban District Council have decided to apply for a provisional order and to fix the seal of the Council to an agreement with Messrs. Crompton and Co. for the electric lighting of the town.

Levenshulme.—The Urban District Council have received sanction to loans, amounting to a total of £11,885, for the purchase of a site for the erection of a refuse destructor and disinfector for the district.

East Barnet.—The Board of Trade have now approved of the system of electric lighting proposed to be introduced by the Council. The engineer's estimate of the cost of the proposed works are being printed.

Dodworth.—The question of lighting the district was referred to at the last meeting of the Urban District Council, and it was decided to hold a special meeting to consider estimates from different electric companies.

Apsley End.—The brushworks of Messrs. Kent Bros., Limited, at Apsley End, have been fitted up with electric light by Messrs. Miskin and Rice, electrical engineers, of St. Martin's-lane, London, W.C., and St. Albans.

Polmont.—On Friday evening last the formal inauguration of the electric light at the Co-operative Society's central premises took place. Mr. Robert Cunningham, jun., Glasgow, was responsible for the installation.

Gorton.—The Urban District Council have decided to apply for the consent of the Board of Trade to a further period of two years in which to carry out their obligations under the Gorton Electric Supply Order, 1899.

Sheffield.—The electric light extensions to Brightside, in response to applications from Cammells and Jessops, at a cost of £6,335, will not be made unless terms satisfactory to the committee are made by those asking for it.

Explosions.—The Maidstone gas explosion is *sub judice*. In Birmingham the top of a street box was blown out on the 24th owing to an accumulation of coal gas. There was nothing to show how the latter became ignited.

St. Pancras.—The Borough Council propose to increase the salary of Mr. David Arthur Smith, the collector in the electricity and public lighting department, from £168 to £180 per annum, and be further increased a year hence to £200 per annum.

Market Drayton.—On the 24th inst. the recently completed electric light and power works were publicly declared open by Mrs. Donaldson Hodson, of Cheswardine, who was presented with a charming letter-weight switch as a memento of the event.

Southwark.—At Wednesday's meeting of the Borough Council it was stated that 24,642 8-c.p. lamps had been connected with the Borough Council's mains for light and 2,618 for power. There had been an increase of 197 lamps connected during the fortnight.

Cark (North Lancs.).—Messrs. Dickinson Bros., corn millers, have installed a dynamo at their mill worked by water power, and the light has been taken throughout the mill and some private residences. The lighting of the village is only a question of time.

Brighton.—Mr. W. R. Galbraith is losing the services of his chief assistant, and the Corporation have consented to his finishing the work at Southwick in conjunction with Sir Alexander Binnie, which arrangement will not involve any additional expense to the Corporation.

Clyde Lighthouses Trust.—At the last meeting of the electors qualified by the Clyde Lighthouses Act, Mr. R. W. Muir, re-elected trustee, said the Cumbrae lighthouse, of 158,000 c.p., was the first lighthouse in Great Britain to have incandescent electric light fitted up.

Kingswear.—Edmundson's Electricity Corporation are arranging to run a cable across the river for the electric lighting of the village, and the Great Western Railway Company are to be asked for permission to lay the cable from the floating bridge to the village, a distance of about a mile.

Ormskirk.—The negotiations with the Southport Corporation for an electric light supply have come to an end, and steps will now be taken to dispose of the Council's provisional order to some firm who would work it and would give the Council the option of repurchasing at a price agreed upon.

Pontardulais.—The Local Government Board have intimated, in reply to an application by the Llandilo-Talybont Parish Council for power to borrow £1,250 for the electric lighting of Pontardulais, that

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parish councils are not empowered to undertake the generation or manufacture of electricity.

Personal.—We learn that Mr. Ernest Thompson, a director of Nalder Bros. and Thompson, Queen-street, E.C., has been ordered to take a voyage on account of his health. He left last Friday for New Zealand, and proposes to complete his trip by visiting Australia, Japan, Canada, and the United States.

Pangbourne.—The Council have consented to an application of the Whitchurch and Pangbourne Electric Supply Company, Limited, for sanction to an application which the company intend to make next session for a provisional order authorising the supply of electricity for public and private uses within the parish of Pangbourne

Exeter.—The Electric Lighting Committee have appointed Mr. F. Smith, of Exeter, as clerk of works to superintend the erection of the electric light works at the Basin. Steps are to be taken to improve the lighting of the Miles memorial clock tower and the surrounding area, at an estimated net increased cost per annum of £24. 14s.

Nantwich.—The Local Government Board have deferred their decision with reference to the Council's application to borrow £12,505 for electric lighting, and £1,275 for the provision of a refuse destructor, until they had before them the report of their inspector on the application of the Council to borrow £6,927 for works of sewage disposal.

Fire.—A fire occurred last Thursday at the Marconi wireless telegraphy station at the Lizard. The station is built entirely of wood covered with felt and tarred, and an overheated pipe of a stove fixed in the interior and carried through the wooden end up above the roof, and clamped to the end of the building, caused the felt to take fire and smoulder. No great damage was done.

Bridgend.—The Council are asking the South Wales Electrical Power Company to put a clause in their agreements with their power customers within the urban area prohibiting them from using the electrical power for lighting purposes, the company's agreement with the Council having reserved to the latter the sole power to supply electricity for lighting purposes within the urban area.

Kirkintilloch.—The Town Council were among the opponents of the Clyde Valley Electric Company before Parliament, and they were so far successful that a clause was inserted in the Bill giving power to the Council within two years to apply to the Board of Trade for a provisional order for the supply of electricity within the burgh. The Council now announce their intention of applying for an order.

Acton.—The Lighting Committee recommended at the last District Council meeting that the Council appoint a consulting engineer to advise and report to the committee as to the best and most economical manner of starting works for supplying electricity for the district, and also on the advisability of combining the electricity works with the dust destructor. The matter was deferred for further consideration.

Stoke Newington.—The Borough Council propose to proceed with a Bill in Parliament to enable them to obtain by agreement electrical energy from adjoining borough councils, and to obtain compulsory powers for the acquisition of land and premises for the purpose of the Baths and Wash-houses Acts, 1846 to 1896, and that the said Council shall be at liberty to incur the expenses of and incidental to the promotion of such Bill.

Pacific Commercial Cable.—It is reported that Mr. George G. Ward, general manager of the Commercial and Pacific Commercial Cable, has completed terms for extension of the cable to Shanghai, and now seeks the co-operation of the U.S.A. Navy Department in laying the cable from Hayti to the Philippines. He expects to be able to undertake by July next to send a cable round the world in less than 39 minutes.

Spain.—Concessions to take water for electrical power purposes have been obtained by Señor Eugenio Grasset, who will be allowed to take 1,000 litres per second from the Pajares, in the province of Oviedo, and by Señor Eusebio Pelegri y Camps, who will be allowed to take 9,000 litres per second from the Segre by Prat de Via, and 10,000 litres by Roca de San Armenque, and 2,500 litres from the River Aurasa, also at the latter place.

Rotherham.—At the last meeting of the Guardians a letter was read in which Mr. E. Cross, electric lighting engineer for the Corporation, gave the following comparative figures as to the cost of electric light *v.* gas at the Rotherham Hospital: Gas (1901)—June quarter, £25. 6s.; September quarter, £22. 10s. 9d.—total, £47. 16s. 9d. Electricity (1902)—June quarter, £21. 18s. 1d.; September quarter, £20. 13s 1d.—total, £42. 11s. 9d.

Hackney.—The Borough Council propose to consent to the laying of telephone wires by the Postmaster-General subject to the Council's right to withdraw such consent upon giving to the Postmaster-General three months' notice in writing, if at any time they deem proper so to do, and subject also to the condition that all paving, etc., disturbed shall be properly made good to the satisfaction of the borough surveyor, and at the expense of the Postal Telegraph Department.

Hamilton.—Plans have been passed at the instance of Edmundsons' Electricity Corporation for the erection of an electricity generating station at Almada Hill. They showed a substantial two-storey stone building with a frontage of 90ft. by 100ft., providing accommodation for engines, offices, and engineer's dwelling. During the erection of the building petitioners were granted power to erect a temporary structure in which meanwhile to carry on the work. The estimated cost is about £4,000.

Carmarthenshire Electric Power Co.—Application is intended to be made to Parliament in the next session for leave to introduce a Bill for the incorporation of a company, to be called the Carmarthenshire Electric Power Company, for the purpose of establishing and carrying on electric works in different parts of the county, including Llanelly, Pontyberem, Tirydail, St. Clears, Glanrhyd, and Carmarthen. At Carmarthen the intention is to acquire the Carmarthen Tinworks, which have been disused for many months past.

Stock Exchange.—The Stock Exchange Committee has appointed Dec. 3 as a special settling day in Bromley (Kent) Electric Light and Power Company's £50,000 4½ per cent. first debenture stock, and ordered the said securities to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the Bath Electric Tramways, Limited, 75,000 5 per cent. cumulative preference shares of £1 each and 100,000 preferred ordinary shares of £1 each.

West Ham.—The Council have adopted a resolution of the Lighting and Tramways Committee with regard to the question of the reappointment of Mr. J. J. Steinitz as consulting electrical engineer. The committee being of opinion that it was no longer necessary to have a consulting electrical engineer, recommended that he be not appointed. At the same time they "desired to place on record their appreciation of Mr. Steinitz's services, and recommended that a testimonial to this effect be given to him under the seal of the Council."

Gravesend.—On Sunday last the Roman Catholic Church of St. John was lighted for the first time by electricity, and much satisfaction was expressed at the excellence of the illumination, which pleasing result was in a large measure due to Mr. Sidney Blandford, A.I.E.E., of Windmill-street, who installed the new light, and was particularly fortunate in the choice of the sites for the lamps. Other installations of the same firm include the new premises of the London and Provincial Bank, Mitre Hotel, Nelson Hotel, etc.

Maidenhead.—The Town Council have adopted a report of the Electric Lighting Committee stating that the easy wiring contract had been agreed upon. Other paragraphs included consulting and resident engineer's reports, proposals for purchase of instruments, insurance of electric lighting station and machinery, extensions, charge per unit for power, and value of site of generating station for the purpose of including the same in the return for the Board of Trade. The report was adopted, and a tender for battery maintenance for five years was accepted.

Worksop.—The electrical engineer's last report on the progress made with the electric lighting states that the present number of consumers is 124, equal to 5,428 8-c.p. lamps, compared with 61 consumers, equal to 3,303 8-c.p. lamps a year ago. Since July 6,444 yards of cable had been laid, at a cost in labour of £220, and 65 street lamps had been connected. The Guardians have instructed Mr. Scaping, the architect for the new infirmary, to proceed with the installation at the laundry of an electric motor at a cost of £90, and also to light the porter's lodge by electricity.

Mansfield.—In reply to some criticisms, it was stated at the last Council meeting that the total cost of the electricity works (about £50,000) included the refuse destructor and inclined roadway, which approximately cost £10,000. The actual capital expenditure on the electricity works proper was, therefore, £40,000. The charges in Mansfield were extremely moderate. Already 55 applications had been received, equivalent to 3,500 8-c.p. lamps. This does not include public lighting. The works were planned to supply the proposed light railways, and the expenditure thus increased.

Luton.—The Town Council have signed an agreement to supply electric current to a new printing firm at the following charges: for lighting, for any amount up to 20 units per quarter a minimum charge of 13s. 4d. is to be made per quarter, and for over 20 units 6d. per unit for the equivalent of the first 20 hours' average daily consumption in each quarter of the maximum demand at any one time, and 3d. per unit for all in excess of such first 20 hours' average daily consumption and maximum demand; for power, 2d. per unit up to 50,000 units, 1½d. for the next 50,000 units, and 1½d. for every unit in excess of 100,000.

Shoreditch.—The Lighting Committee have only just discovered that the revenue from the electricity consumed in public street lamps during the year ended March, 1902, was understated by a sum of £226. 8s. 11d. Owing, it appears, to the incorrect transfer of units consumed in arc lamps from the day-sheets to the register-book, it has been found that the general rate was undercharged to the above extent, and the ratepayers are now called upon to pay this amount eight months after the accounts were closed. The officers who made the mistake have been censured, and the books of account kept at the electricity works altered accordingly on the sanction of the local Borough Council.

Newport (Mon.).—The Council have decided upon the following charges for the supply of electrical energy—(1) for lighting purposes: for dwelling-houses and places of worship, 5d. per unit, flat rate; shops, theatres, public-houses, schools, halls, etc., from 5½d. per unit for the first 2,000 units (per annum) to 3d. for the sixth 2,000; (2) for power consumers, from 8,000 units at a lighting rate of 4d. per unit, to 50,000 units at 2d. It is estimated that on the present basis of demand this scale of charges will mean a decrease in the receipts of the Corporation of about £600 a year, but it was also estimated that the increased demand will much more than make up for that loss in the first full year.

Hastings.—The appointment of resident electrical engineer has fallen to Mr. Russell F. Ferguson, of Fulham. The salary is to be £300 per annum, rising by annual increments of £25 to £500, with an allowance of £20 per annum for locomotion in connection with his duties, he to devote the whole of his time to the duties, to be allowed to have not more than two articled pupils at any one time, and to be allowed three weeks' holiday per annum. Application is to be made for a loan of £705 for an efficient oil separator, to prevent the accumulation of oil in the boilers, and a water-softening apparatus. Sanction has been received to the borrowing by the Corporation of the sum of £628 for purposes of electric lighting, the authorised period being 25 years.

Photography.—It is not very often in these days that we come across cases where something worth having is given away for nothing.

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When we do we are only too pleased to put our readers up to a good thing, and, therefore, draw their attention to the new edition of *Photogram* cards. The present set is made of a size to fit the pocket-book, and contains almost entirely with new tables, including guide to correct exposure in outdoor work and copying; table of enlargement and reduction telephoto rules; directions and chart for fixing the time of best lighting of any view; thermometer scale and photographic temperatures; weights and measures, British and metric; how to see stereoscopic slides without a stereoscope. The entire set is sent from the *Photogram* to anyone enclosing a penny stamp to Effingham House, Arundel-street, Strand, W.C.

Swansea.—Mr. Hopkins, who has acted as consulting engineer for the Corporation's telephone scheme, is being consulted upon certain points which had been recently raised in connection with it. Mr. Mackie, of Guernsey, has been appointed as manager of the undertaking. There was a preliminary test of the new generating engine at the Swansea electrical works on Sunday afternoon in the presence of Mr. Robinson (manager, Mannesmann Tube Company, suppliers of the steam-piping), Colonel W. D. Rees (of Messrs. Rees and Co., consulting engineers), representative of Messrs. Maclaren and Co., Leeds (the manufacturers of the engines), the Westinghouse Company (who supplied the dynamos), Mr. Prussman (the borough electrical engineer), and the engineering staff at the works. The test was, we understand, in all respects satisfactory, and the engine is capable of generating up to 600 kw.

St. Marylebone.—The following amended recommendation of the Infirmary Visiting Committee was discussed at the last meeting of the Guardians, and was finally defeated by 12 votes to 4: "That the principle of the installation of telephonic communication between the wards and a central point (13 points) at the infirmary be accepted, and that the matter be referred to the Infirmary Visiting Committee to submit formal tenders to the Board for carrying out such a scheme." At the meeting of the Borough Council last night it was decided to reply, with regard to the London County Council's question of renewing their application for wiring loans, that the Borough Council having their own policy of electric lighting under consideration, are not prepared to give an expression of opinion on the proposed application. A number of extensions of electric light mains and a number of notices from the Metropolitan Electric Supply Company, Limited, were agreed to.

Bath.—The Town Council has adopted a report of the Electric Light Committee recommending the purchase of water-softening plant at a cost of £320, the Ferranti switchgear at £1,312, and the hire of a motor alternator at £25 per month. The report also contained the accounts for the six months ended Sept. 30 last, which showed a deficiency on the half-year of £1,173 after paying sinking fund and interest; but it subsequently explained that, taking this period with the previous six months, which included the heavy consumption period, there was a net profit of £763, after paying interest and sinking fund, and £427 of extraordinary expenditure. Having regard to the opinion expressed by Mr. Teague, the committee are to obtain additional expert advice, and engage Mr. Manville to assist them as to their policy for next year, and, at the same time, to report on the present condition of the works. It was stated at the meeting that the committee did not ask for Mr. Manville's advice because they in any way doubted their own electrical engineer's abilities, or because they lacked confidence in him. Their present position and future policy were clearly interwoven.

Manchester.—At a meeting of the Electricity Committee of the Corporation on Wednesday the Chairman (Mr. Councillor Howarth) reported the receipt of a letter from Dr. Kennedy with regard to the provision of electric power in the southern districts of the city. According to the *Manchester Guardian*, Dr. Kennedy stated that unless some entirely unforeseen circumstance should occur the sub-stations at Moss Side, Rusholme, and Fallowfield would be ready on Monday to supply and transmit the current for the tram routes with which they were connected. It was further stated that on Friday the committee visited the Stuart-street station and inspected the works. They were entirely satisfied with their inspection, and were able to state that the engines would be ready for Monday, and would be equal to any demand upon them for current that was likely to arise for some time. The cabling and the sub-stations were also ready. The committee passed a resolution appointing a special sub-committee to consider and report upon the administration of the department. The names of those placed upon the sub-committee are the chairman (Councillor Howarth), the deputy-chairman (Councillor Hesketh), Mr. Alderman Richards, and Councillors Bowes, Dr. Dreyfus, Craven, Hart, Kay, James Simpson, and George Simpson.

Preston.—Owing to the increasing consumption of electricity in Preston, the National Electric Supply Company are at present making additions to their plant at the works in Bushell-street. Two years ago the company built a large new engine-house and boiler-house, two new engines of 900 h.p. each being then installed, with the necessary boilers, pumps, etc. A further increase has now been found necessary, and another engine of the same power and two boilers are being added to the already considerable plant. During the last three years the consumption has gone up with remarkable rapidity, the increase being no less than about 25 per cent. each year. The light is installed in practically all the principal streets in the town, and the electric mains extend through Fulwood to Broughton village, and on the other side to all the principal roads in Ashton. At the end of December last year there were 59,572 lamps connected, but this number must now be considerably higher. In 1898 there were 30,800 lamps, so that within three years the company has practically doubled its connections, and the output of the works is at least 14 times greater than it was 10 years ago. What makes the returns more favourable still is the fact that the increasing demand is not altogether due to the growing popularity of electricity for lighting purposes, but to the supply of motors and to a developing business in electric heaters.

Cleckheaton.—On the 21st inst. the combined electricity generating station and refuse destructor works of the District Council were formally opened by Mr. F. W. Birkett, chairman of the Council. Up to the present the scheme has involved an outlay of £25,000, but there is to be an extension on the electricity side, representing a further £6,000, to meet the demand for energy in connection with the British Electric Traction Company's tramways. The present installation comprises three engines and dynamos, with a capacity of 150 kw. each, and all accessories. One of these is to be used for electric lighting, being equal to 2,000-c.p. lights, another is to be used for tramway purposes, and one is for reserve. The provision in respect of the tramway is equal to 200,000 units per annum, but the company have intimated that they will require 400,000 units, and on this account an additional engine and dynamo are to be provided of similar capacity to the others. The dynamos are by Messrs. J. Holmes and Co., Newcastle; the engines by Messrs. Belliss and Morcom, Birmingham; the switchboard by Messrs. Dorman and Smith, Manchester; and the balancers and boosters by the Phœnix Dynamo Company, Bradford. The destructor system is that of Messrs. Meldrum Bros., Manchester. There are two boilers fired by refuse, and a third one is to be put in for coal firing. The buildings and chimney have been erected by Messrs. Robinson and Crowther, of Cleckheaton, under the supervision of Mr. Clifton Lund, the Council's surveyor. The electricity scheme was formulated by Messrs. Gibbings and Baker—now Messrs. Baker and Appleby, of Bradford—and the permanent engineer is Mr. A. Pickersgill, who was formerly in the service of the Dewsbury Corporation.

Pocket-Books.—We have received from the Technical Publishing Company, Limited, 31, Whitworth-street, Manchester, a copy of "The 'Practical Engineer' Electrical Pocket-Book for 1903," which represents the fourth annual edition of the same. The high standard of excellence and usefulness attained by previous editions of this pocket-book is well known, but still further additions and improvements are announced in the edition before us. Articles on the various conduit systems of wiring, a table of the comparative cost of working hydraulic and electric lifts, power gas, and the Board of Trade regulations under the Electric Lighting Act and Tramway Acts are amongst the most important additions made. From the same publishers we have received a copy of the fifteenth annual edition of "The 'Practical Engineer' Pocket-Book." With regard to additions, especial attention is drawn to the tables of equivalents of feet, inches, and fractions of an inch with millimetres. To make these tables as useful and concise as possible they have been divided into two sets, the first ranging from $\frac{1}{32}$in. to 2ft. by increments of $\frac{1}{32}$in., and the second ranging from 1in. to 20ft. by increments of 1in. Some additional notes on loss of head of water flowing through pipes, tests of steam-turbines, liquid fuel burners, and a chapter on the production of very low temperatures have also been added. Each of the above pocket-books is published at 1s. net; leather gilt, with diary on ruled section paper, 1s. 6d. net.; postage, 2d. extra. Notwithstanding the mass of useful information given, they are of convenient bulk for the pocket, and we have no hesitation in recommending them to engineers who want good value for their money.

Kensington.—On Tuesday the Borough Council agreed to an application by the Metropolitan Electric Supply Company with reference to the proposed laying of an extra high-pressure electric main along the south side of Harrow-road. At the same meeting a large number of applications were received from the Postmaster-General with regard to telephone wires. Consent to two of these was withheld—namely, across Ladbroke-grove and across Kensington Park-road—it being deemed inexpedient that such pipes should be laid across roads at short intervals for single services. It was further agreed that, provided a satisfactory arrangement can be made with the Post Office for the engagement of the necessary assistance at the expense of the Department for the proper supervision of the work on behalf of the Council, and subject to the roads and footways being reinstated to the satisfaction of the borough engineer, consent be given to the several other applications submitted. The Works Committee have obtained from the borough engineer a suggestion as to means which might be adopted to replace the ventilation of electric lighting conduits which has been interrupted by the removal of certain disused gas lamp columns; and a drawing of a combined street orderly bin and culvert ventilator which might be erected on the site of each of the ventilating columns removed has been approved. Prices have been obtained from three firms for the supply of bins in accordance with the drawings, Messrs. Bartle and Co. quoting £6. 5s. for making a sample bin, and £3 each for further orders of not less than 10. The committee now recommend that an order be given to Messrs. Bartle and Co. to supply a sample bin and 10 further bins.

Camberwell.—The Council is in favour of a renewed application by the London County Council as to wiring loans. Various notices of intention to lay mains have been received, and also a notice from the County of London and Brush Provincial Electric Lighting Company, Limited, under the Camberwell Electric Lighting Order, 1896, stating that the company proposes to commence the supply of continuous current at a declared pressure of 410 volts. The company will charge for energy supplied by it to any ordinary consumer, otherwise than by agreement: (*a*) by the actual amount of energy so supplied; (*b*) by the electrical quantity contained in such supply. A supply will be given in the Old Kent-road so far as the same lies within the area of the Camberwell electric lighting order. The Electric Lighting Committee presented a report of the delegates on the proposal to purchase the Brush Company's undertaking, which it had declined to deal with, and recommended that the reference to the delegates be discharged. The following amendment was discussed and defeated: "To add the words after the recommendation of the committee, 'And that the following conclusion of the delegates be referred to the Finance Committee for consideration and report: "That subject to the site being a satisfactory one, and the mains laid found to be in good working

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order, an offer should be made to purchase the Brush Company's installation within the confines of the borough, together with all their rights in relation to their Camberwell order, for a sum not exceeding £140,000, such offer to include the land and exclude the machinery at Wandsworth, with a proviso for the company to supply the Council with current in bulk at 1¾d. per unit for a period not exceeding three years."

Dudley.—On Monday Alderman G. H. Dunn, chairman of the Electric Lighting and Tramway Committee, invited the members of Dudley Town Council and their wives to inspect the generating station at Springsmire, where important additions have recently been made, including a new engine and generator of a capacity of 500 kw. During the inspection Mrs. Dunn and Mrs. Warmington (wife of the late town clerk) switched on the current in connection with the new electrical illumination of Woodside and Hart's Hill. By the recent additions the plant has been brought up to 1,200 kw. For the six months ending Sept. 20 last the output was as follows: 395,373 units for tramway purposes, 130,991 for private lighting, 10,703 for public lighting, and 7,824 used at the power station, making a total of 544,891 units, compared with 381,296 for the corresponding period of last year, being an increase of 163,595 units. At the present time the power supplied for illumination purposes is equal to about 15,000 c.p. or 16,000 c.p. The total capacity of the plant is 27,000 c.p., from which figure the power required for driving the trams has to be deducted. If the present rate of applications continues, further additions to the station will be necessary before long. There are at present over 6¼ miles of cables for private consumers and four miles of feeder cable, together with 750 yards of positive feeder and 500 yards of negative feeder cables, from which the energy is supplied to the tramways in connection with the cable and trolley wires. The tramway company is being supplied at 1½d. per unit. The average price of current, without any loss, for private consumers throughout the borough is only 2d. per unit. There are 56 arc lamps and 264 incandescent lights of 22 c.p. for public lighting.

London County Council.—At Tuesday's meeting of the Council the Establishment Committee presented a report and submitted proposals for improving the present inadequate telephone arrangements at the central offices, and recommended that the National Telephone Company's offer, amounting to £327. 15s., for, *inter alia*, providing five additional exchange lines, and connecting the existing 42 lines, and for providing 116 additional telephones and lines, be accepted. After discussion it was decided that the report be referred back, in order that the committee might ascertain the terms on which the Post Office would give the same service. During the debate it was remarked that the Post Office terms were 25 per cent. above those of the National Telephone Company. It should be borne in mind that this is work which is entirely outside the routine of the General Post Office, and, in fact, even of the principal work of the National Telephone Company, and there is little doubt that if the Council choose to advertise for tenders from private firms they might effect a saving even on the figures mentioned above. The Highways Committee presented a report, in which they stated that on July 29 last they accepted the tender of Messrs. J. Hitchen and Son for the supply and erection of a 25-ton electric travelling crane for use at the temporary electricity generating station near Loughborough Junction, and of three 10-ton hand cranes for three of the sub-stations to be established by the Council in connection with the electrical working of the Tooting-to-Westminster, etc., tramways, and allowed Messrs. Hitchen and Son to sub-let to the British Thomson-Houston Company, Limited, the manufacture of the electrical equipment for the crane for the generating station. Owing to delay in procuring motors from the original sub-contractors, Messrs. Hitchen and Son had asked to be allowed to purchase two of the three required from the British Westinghouse Electric Company, which could deliver them within a short time; and the committee thought that this request, which was made with the object of expediting the delivery and erection of the crane, should be acceded to. They recommended accordingly. A notice from the National Telephone Company terminating the agreement for placing a telephone pipe across Westminster Bridge has been accepted. A supplemental estimate of £2,000 was agreed to in connection with the establishment of the electric light installation for the Victoria-embankment and Westminster Bridge. Last year attention was called to the practice adopted by certain of the undertakers under Electric Lighting Acts and Orders of charging to capital account certain expenditure—*e.g.*, for directors' and auditors' fees, salaries and expenses of management, promotion money, and interest on loans and advances. The Board of Trade auditor in his certificate with regard to the accounts reported to the Board that this expenditure should be transferred to revenue account or to preliminary expenses account. The Board has no power of enforcing the requirements of its auditor; and, although the committee suggested to the Board that it was desirable in the interests of local authorities and consumers of electricity that the law should be amended so as to give this power, the Board has not seen its way to adopt the suggestion. The committee's attention has been called to another case in which the undertakers have adopted a similar course as regards their capital account, and they have again called the attention of the Board of Trade to the matter. Notices under Electric Lighting Acts and Orders have been agreed to as follows: from the Blackheath and Greenwich District Electric Light Company of intention to lay high and low tension mains along Norman-road, Bridge-street, and Church-street; the Charing Cross and Strand Electricity Supply Corporation of intention to lay mains along portions of Chandos-street and Agar-street; the County of London and Brush Provincial Electric Lighting Company to lay low-tension mains (*a*) along Radbourne-road, and (*b*) along Salford-road; the London Electric Supply Corporation of high and low tension mains along Broadwall, New-cut, Short-street, and Great Charlotte-street, and to construct underground converter chambers; and from the Metropolitan Electric Supply Company to lay high-tension mains along portions of Clifton-hill and Grove End-road.

TRACTION.

Doncaster.—It is proposed to place clocks in the tramcars.

Sheffield.—The Sheaf-street and Commercial-street tramway routes will shortly be opened for traffic.

Bath.—A site for the tramway power station has now been selected. It is in Walcot-street, next to the corn market

Exeter.—The Corporation will promote a Bill in Parliament next session for powers to lay down electric tramways in the city.

Lytham.—The date for the completion of the new electric tramway between Lytham, St. Annes, and South Shore is May 14 next.

Coventry.—The proposal of the tramway company to extend and electrify their system has been referred to a special committee of the City Council for a report.

Backford.—A public meeting of the residents in Backford and the adjoining townships is to be held to consider the question of a tramway between Birkenhead and Chester.

Wrexham.—Plans have been submitted by the British Electric Traction Company showing the electric cable route in the borough proposed to be followed for the new tramways.

Preston.—The Tramways Committee recommend that Mr. Walter H. Tittensor, of Dundee, be appointed resident electrical engineer for the design and construction of the electrical tramways.

Shelf.—The Bradford Tramways Committee have resolved to give careful attention to the request of a deputation for the extension of the electric tramway through this district to Buttershaw.

Poole.—The Town Council are in negotiation with the British Electric Traction Company with regard to the route to be followed in the construction of the proposed light railways running to the quay.

Peterborough.—Eight of the new electric tramcars have already arrived and are being housed in the shed at the tram depôt in the Lincoln-road pending the opening of the tramways for public traffic.

Maidenhead.—In view of the withdrawal of the application by the London United Tramways for a light railway in Maidenhead, the Corporation have decided to themselves apply for powers in May next.

Warrington.—Lieutenant-Colonel von Donop, of the Board of Trade, has made an inspection of the tramways in Manchester-road and Winwick-road, and these routes have now been opened for traffic.

Darlington.—A meeting of the Tramways Committee has been held for the purpose of considering the question of paving to be used for the track of the tramways, and it was decided that scoriæ bricks be used.

Luton.—A second committee has been appointed to consider a light railway scheme for the district. It will be remembered that the Light Railway Commissioners rejected the original scheme proposed some months ago.

Hove.—A special meeting of the Town Council will be held on Monday to further consider the promotion of a Bill in the ensuing session of Parliament authorising the Corporation to construct and work tramways.

Battersea.—The London County Council have posted the requisite street notices relative to their proposal to construct tramways from Battersea Park-road to Beaufort-street, Chelsea, *via* Bridge-road and Battersea Bridge.

Bromley.—At their last meeting the District Council decided to enter into negotiations with the British Electric Traction Company with a view to a Bill being promoted in Parliament for the construction of tramways in Bromley.

Dover.—In connection with the proposed light railway scheme, the lines in the borough are to be constructed by the Corporation, while the construction of the lines outside the borough boundaries is to be delayed for a couple of years.

Amesbury.—The Light Railway Commissioners have made an order for the construction of a light railway from Amesbury to the military camp at Bulford, and the order has been submitted to the Board of Trade for confirmation.

Paris Metropolitan Railway.—The directors of this railway have convened a meeting of shareholders for the 12th prox. to consider a proposal to increase the capital from 50,000,000fr. to 75,000,000fr. by the issue of 100,000 shares of 250fr. each.

Shipley.—It was resolved at the last meeting of the District Council that the attention of the Bradford Corporation should be called to Clause 76 in the Shipley Improvement Act, 1901, relating to cheap tramway fares for the labouring classes.

Hastings.—It is proposed to hold a conference of four members of the Town Council who are in favour of the tramways scheme, and four members who have hitherto opposed it, for the purpose of obtaining the best scheme in the interests of the town.

Swansea.—A special meeting of the Town Council on Tuesday adopted unanimously the formal resolution to give notice to the tramway company requiring them to sell the sections of their system authorised by the Swansea Improvements Act, 1874.

Wigan.—The Wigan light railway order, as modified and confirmed by the Board of Trade, was issued with the parliamentary papers on Saturday. The order authorises the construction of a light railway in the urban districts of Pemberton and Ashton-in-Makerfield.

Bury.—Work in connection with the laying of the new tramlines in the Knowsley-street section has been commenced this week. The first consignment of steel rails has arrived. The Corporation will apply in the next session for further parliamentary powers to lay down tramways in the town.

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Aberdeen.—Notice of the following motion has been given: "That it be remitted to the Tramways Committee to consider and report as the expediency of running workmen's cars in the early morning; also late cars for the convenience of citizens attending concerts and other places of amusement."

Pontypridd.—A public meeting held here last week decided to support the Council in their proposed application to Parliament next year for powers to lay down tramways in the district. The Electric and Tramways Committee on Tuesday decided to advertise for a loan of £25,000 for tramway purposes.

Acton.—The ratepayers' association has made representations to the London United Tramways Company on the following points: (1) the congested state of the Shepherd's Bush terminus; (2) the establishment of feeder 'buses to the electric cars; (3) the stopping of the cars; and (4) the service of cars in Acton.

Penarth.—The Urban District Council have refused to support either of the schemes for the construction of an electric tramway between Penarth and Cardiff. The schemes submitted were (1) by a syndicate and (2) by the Penarth Electric Lighting Company, which is an offshoot of and very largely controlled by the British Electric Traction Company.

Aston.—The protracted arbitration between the Birmingham and Aston Tramways Company and the Aston Manor Urban District Council for the purchase by the latter of the company's tramway undertaking, for which a sum of £80,000 was asked, has come to a conclusion. Sir Frederick Bramwell's award is not expected to be given for a few weeks.

Heckmondwike.—At a meeting of the District Council on Monday it was reported that the negotiations with the British Electric Traction Company had been completed, and a resolution was unanimously adopted authorising the signing of the necessary agreement, which has reference to the supply of current by the Council for the working of the tramways in the district.

Liverpool.—On Monday evening for the space of half an hour the current in the Pumpfields area was unavailable in consequence of one of the dynamos being deranged, and the tram service was completely stopped. This happened at about half-past six, when vast numbers of people were returning home at the end of their day's labour, and the interruption was keenly felt.

Chiswick.—A beautifully fitted-up billiard-room intended to provide amusement for the men during their time of recreation, has been opened at the Chiswick depôt of the London United Tramways Company. At the opening ceremony last week a game between Conductor Frost and Mr. Clifton Robinson was watched with great interest. The popular manager was beaten by 11 points.

Walsall.—On Wednesday afternoon, by special arrangement, a car conveying the Local Government Board inspector and representative Walsall gentlemen travelled over the new tramway lines which have been laid through Bloxwich, extending the system as far as the Bell Inn. The new line is of considerable length, and the car travelled satisfactorily over the whole route.

Halifax.—A new transforming station at Hebden Bridge in connection with the Halifax tramway and electric lighting system was opened on Wednesday by Alderman Josiah Wade, the mayor. The station has been constructed in connection with the supply of energy to the tramways between Halifax and Hebden Bridge, and also for lighting and motive power at the latter place.

Kalgoorlie.—A Kalgoorlie correspondent telegraphing on the 19th inst. states that the construction of the new Kalgoorlie electric tramways has just been completed. The route from the Firmiston block of the township goes through the centre of the principal mines of the "Golden Mile." The formal opening has resulted in a large increase of traffic, and it is expected that the undertaking will pay handsomely.

Solihull.—A letter was read at the monthly meeting of the Rural District Council on Tuesday from Mr. S. Sellon, stating that it was the intention of the City of Birmingham Tramways Company to promote a Bill for the construction and working of tramways within the Solihull district as extensions of the company's existing system A committee was appointed to watch the interests of the Council.

Barrow.—The agreement entered into between the Corporation and the British Electric Traction Company provides, amongst other things, that when a contemplated low road is made from Furness Abbey to Dalton the company shall construct a new tramway, to continue from the present terminus at Furness on to Dalton-in-Furness, a distance of about two miles, providing the necessary powers can be obtained.

Whitefield.—At a special meeting of the District Council last week it was decided to accept the terms of the Salford Corporation for the construction of electric tramways through the Whitefield urban district subject to certain clauses being agreed to. It was further decided to borrow the money required for the carrying out of the scheme, Salford Corporation to refund the same to the Council by annual instalments.

Deal.—A special meeting of the Town Council has been held to consider an application from the Kent Electric Power Syndicate, Limited, for the Council's consent to a provisional order being granted to the syndicate for an electric lighting and tramway scheme in this district. After a long discussion, the Council refused to give their consent to the proposed order without definite information as to its nature.

Tube Extension in Herts.—The promoters of the scheme authorised this year for the construction of a railway, partly underground, from a point near the North London Hospital at Hampstead to Edgware are preparing a Bill for power to extend this line to Watford. The scheme contemplates the working of the railway from Hampstead to Edgware and from Edgware to Watford as separate undertakings, but under mutual working agreements with each other and with the authorised Charing Cross, Euston, and Hampstead Railway Company.

Tramway Reconstruction in London.—On Wednesday a party of students of the Institution of Civil Engineers paid a visit to the tramway lines of the London County Council, which are now being converted for electric traction. The party was met at Westminster Bridge by Mr. Miller, the resident engineer, who conducted them over the lines and explained to them all the operations which are being carried on. As soon as the lines under construction are completed, operations will at once be begun on the line from the Elephant and Castle to New Cross and Woolwich.

Lancashire and Yorkshire Railway.—The general manager of this railway has issued the following notice: "Before the close of next year the whole of the passenger train service on the Liverpool and Southport line will be worked electrically and considerably increased and expedited, and the short service between Liverpool and Blundellsands will be extended to Hall-road. This notice is given with the object of enabling builders and others who are desirous of erecting houses in the district served by the railway to complete their work by the time the new electrical trains commence to run."

Additional Traffic Returns.—Anglo-Argentine, £471 increase; Barcelona Ensanche y Gracia, £21 increase; Barcelona, £77 increase; Brisbane, £257 increase (month of October, £10,359, increase, £979); Buenos Ayres and Belgrano Electric, £347 increase (month of October, £13,053, increase £183); Calcutta, £685 increase; Cape Town (month of October), receipts £16,507, expenditure £8,727; Isle of Thanet Electric, £28 decrease; Mexico Electric (month of October), receipts, £21,600, expenditure £12,580; Perth Electric, £122 increase; Port Elizabeth (month of October), receipts £3,832, expenditure £2,095.

Morecambe.—At the annual meeting of the shareholders of the Morecambe Tramways Company last week it was stated that so far back as 1888 the company was in a position, and was quite ready, to equip the tramways electrically, and it was a thing which ought to have been done. It would not only have been beneficial to the company and the shareholders, but it would have been very beneficial to the town. There was no doubt that electrical equipment in all towns had been to the advantage of the towns and the public generally. No doubt now that the town had entered upon a new phase it would take the trams over.

Lea Bridge.—The directors of the Lea Bridge, Leyton, and Walthamstow Tramways Company in their annual report refer to the statement in last year's report, that under the provisions of the Act 44 and 45 Vict., ch. 170, incorporating the company, it will be competent for some of the local authorities, between August, 1902, and February, 1903, to purchase, if they feel so disposed, certain portions of the tramways, pursuant to the provisions of the Tramways Act, 1870, and the directors are informed that the Leyton Urban District Council have passed the statutory resolution to enable them to do this, and that the Walthamstow Council have carried the necessary statutory meeting for the consideration of the matter.

London County Council.—The Highways Committee recommended the Council on Tuesday to so vary the resolution of July 29 last to allow Messrs. Hitchen and Son, the contractors for the supply and erection of the electric travelling crane for the electricity generating station near Loughborough Junction, to sub-let to the British Thomson-Houston Company, Limited, the manufacture of the electrical equipment for the crane, as to allow of Messrs. Hitchen and Son purchasing from the British Westinghouse Electric Company two of the three electrical motors specified in the contract. From last Saturday the undertaking of the South London Tramways Company is transferred to the London County Council, and will henceforward be worked as part of the Council's system. In connection with the general reconstruction for electrical traction already in progress south of the river, it is now proposed by the Highways Committee that certain sections hitherto worked by the above-named company, and the London, Deptford, and Greenwich Company's lines in Bermondsey New-road, between Old Kent-road and the Grange-road, should be similarly treated, and that new tramways should be constructed (1) between Newington-causeway and Southwark Bridge-road, and (2) along the new authorised street from Grange-road to Tooley-street. The total length of double track involved in these recommendations is three miles, and the estimated expenditure £133,000, of which a sum of £107,000, roughly speaking, would come under the head of roadwork and permanent way.

Chatham.—The coroner's enquiry into the tram accident at Westcourt-street-hill, Old Brompton, on Oct. 30, was concluded on Wednesday. The coroner, in summing up, reminded the jury that there was evidence that on reaching the top of Westcourt-hill the passengers exceeded the seating accommodation, which was for 24 inside and 26 outside. There was, however, no legal number prescribed, and the general provisions did not apply, as in the case of omnibuses and hackney carriages. In Major Pringle's opinion, the fact of the passengers being in excess of the seating accommodation did not materially contribute to the accident. The hill at Westcourt-street was very steep, with a sharp curve at the bottom, and it was laid down that the speed down the hill was not to exceed three miles an hour. The rails, owing undoubtedly to the weather, were in a slippery and greasy condition, and therefore extra care was required on the part of the driver (Fredk. Chas. Pearce). Broadly speaking, the accident seemed to be due to the fact that the driver, in direct contravention of his orders, started the car without waiting for the pilot. The jury came to the conclusion that the accident occurred through the negligence and incapacity of the driver of the car. They added that, in their opinion, the regulations of the company were not sufficiently enforced with regard to sanding and cleaning the rails, especially on the gradients, and also with regard to the conduct of drivers. The jury learned with satisfaction that the tramway line down Westcourt-hill, which, in their opinion, was a source of danger to the public, was to be abandoned.

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Maidstone.—The enquiry by the Light Railway Commissioners into the application of the Urban District Council to run a line of light railway in the district was held last week at Maidstone. The proposed length of the line is 2¼ miles and the gauge 4½ft. After a considerable body of evidence had been taken the commissioners adjourned the enquiry, and decided to hear the rest of the case in London at a later date.

Gosport.—The statutory notices have been posted in the districts concerned of the proposed Gosport, Fareham, Porchester, and Cosham electric tramways. It is mentioned that it is proposed to promote a Bill for the construction of this line in the ensuing session of Parliament. Under this new scheme the present tramway at Gosport will be relaid, and electricity, generated near Brockhurst will be the motive power.

Bradford.—The first large 2,000-h.p. engine and generator installed at the new electricity works of the Corporation in Valley-road has now been running for a week, and we understand has given entirely satisfactory results. Since Monday last the engine has been running under a full load, and the former shortage of current, which made it impossible at certain times of the day to run an adequate tram service, is no longer felt.

Nottingham.—Traffic has been opened on the Wilford road section of the Corporation electric tramway service, permission having been given by Major Pringle, R.E., on behalf of the Board of Trade, as the result of his inspection on Wednesday week. The completion of this route exhausts the scheme for which the Corporation originally sought powers, except for the construction of the connecting links in Hartley-road and Market-street.

Newcastle.—The Tramways General Purposes Committee on Tuesday decided to ask Mr. Rossignol to report further with respect to an extra supply of workmen's cars, more particularly from Stanhope-street to Scotswood-road, and from Westgate and Elswick-lane terminus to St. Anthony's and St. Peter's. The Chairman reported that the Westgate extension to Benwell would be completed in about a fortnight or three weeks.

Broughty Ferry.—A special meeting of the Town Council was held on Monday to confer with Mr. Balfour, the late consulting electrical engineer of the borough, concerning the proposal of a London syndicate to construct a tramway line between Broughty Ferry and Dundee. After a prolonged discussion it was agreed to defer consideration for a fortnight, in order that the Council might have further information on certain points.

London and North-Western Railway.—In furtherance of their proposal to introduce electric traction on a portion of their system at as early a date as practicable, the directors of this railway have discussed the question at Euston with the aid of a large and elaborate working model. Motors and carriages were provided, together with a double set of rails, signals, switches, etc., the electric energy for working the model being supplied from a battery.

British Electrical Friendly Society.—This society, which was established a little over a year ago, has issued its first annual report. It states that 28 of the associated companies have signed the trust deed, and 23 branches, with a net membership of 1,353, are now at work relieving sickness in their respective districts. Arrangements are now in progress to enable other branches to be formed, and the central committee rely upon members making every effort to induce non-members to join.

Warrington-Northwich Light Railway.—On Saturday the sanction of the Light Railway Commissioners was obtained to the construction of this railway. All that now remains is to obtain the formal approval of the Board of Trade. The Light Railway Commissioners have considered the suggested amendments of the Cheshire County Council, the Northwich and Runcorn Rural and Northwich Urban District Councils, and have embodied some and given reasons for the non-inclusion of the others.

Glasgow.—An important extension of the city tramway system—viz., from Shieldhall to Renfrew Cross—is to be opened for traffic on Saturday. The line is to be inspected in the forenoon by the Board of Trade inspector, and will immediately thereafter be open for public traffic. Notice of motion has been given for the next meeting of the Town Council that it be remitted to the Tramways Committee to consider the questions of the extension of ½d. fare distances, season tickets, and the adoption of a system of transfer tickets.

Convention.—With respect to the convention of the British Electric Associated Companies, held at Loughborough last week, we have received the official report, which we do not wish to publish, as the proceedings were strictly private. We gather, however, that amongst other matters under discussion an opinion was expressed against the use of the universal fare system in this country. This system is very general in America, but was not considered by those present to be applicable here. An adverse opinion was also expressed to season tickets being issued.

Belfast.—A deputation of electrical experts has waited on the Law Committee of the Corporation to enlist their support for an extensive electrical tramway project in the district. The scheme includes the electrification of all suburban lines running out of the city for a distance of about 12 miles in every direction, and the linking together of three termini by means of a "tube," which would be carried under the harbour in order to connect with the lines running to County Down watering places. The committee expressed willingness to consider the scheme when they had full details before them.

Tees-side.—The Imperial Tramways Company, Limited, in a new Bill which they propose to introduce in the next session of Parliament, seek to make extensive developments in their Middlesbrough, Stockton, and Thornaby system. The single line between Middlesbrough and Thornaby is to be made into a double track, and the company propose to extend the lines from North Ormesby right on to Eston, or another 8½ miles. In the new district which they are about to tap there is a population of nearly 50,000. It is also proposed to apply for power to run a double set of lines from Stockton to Haverton Hill, a distance of another eight miles.

Cardiff.—At the last meeting of the Cabs Committee applications were submitted for licenses for tram conductors and drivers, and it was remarked that some were for outsiders. The Chairman said there were numbers of men walking about Cardiff in enforced idleness. Employment was very scarce indeed just now, and he was besieged day after day by people asking for recommendations to the electrical engineer. They should decline to grant licenses for outsiders until they knew something about the local men who applied some months ago, and who had not yet secured employment. The matter was deferred for the attendance of the electrical engineer.

Batley.—Application is intended to be made to Parliament in the ensuing session by the British Electric Traction Company for leave to bring in a Bill authorising them to construct electric tramways at Mirfield; to convert the Dewsbury, Batley, Birstall, and Gomersal tramways to the electrical system; to confirm the agreements that have been entered into with the local authorities of Dewsbury, Gomersal, Birkenshaw, Soothill Upper, and Birstall for leases of the Bradford-road tramways to the company, and to confirm agreements that may be made with the Batley Corporation for lease of their lines and for the purchase of electrical current from the municipal generating station.

Dudley.—An accident occurred on Saturday evening on the electric tramways here. A car from Bilston descending the somewhat steep gradient in High-street jumped the points and left the line. The car sped across the street and crashed into the front of a big drapery warehouse, wrecking a large plate-glass window and damaging the goods therein. Three sets of lines were blocked for several hours. The agreement between the British Electric Traction Company and the Corporation, which has just been concluded, provides that the Corporation shall supply the current for all the lines within the municipal area, and also that they shall purchase during the ensuing 12 months the whole of the lines within the borough and lease the same to the company for a period of 21 years.

Covered Cars.—This week there were placed upon all the tramway routes in Liverpool covered cars, which not only ensure every passenger a dry seat, but also effectually screen him from wind, rain, and stormy weather. The new car, which is the invention of Mr. C. R. Bellamy, the general manager of the Liverpool tramways department, has already been briefly described in these columns. The upper deck of the car is fitted with a wood-clad steel frame, extending from one staircase to the other. At each end of the upper deck is erected a screen of wood and glass, with a sliding door in the centre similar to the doors in the lower portion of the car. One-third of the roof is permanently covered in along the whole length with wood; the remainder of the roof and the sides of the upper deck are entirely open, save for the thin steel rods which form the framework The protection against wind and rain is secured by means of a series of top and side curtains.

West Riding.—Application will be made in the ensuing session of Parliament for powers to construct tramways in two more parts of the West Riding. The most important of them is that which proposes to serve the Wharfedale Valley. It is intended to connect Keighley with the villages of East and West Morton, and to run a line through Bingley, Baildon, Otley, Esholt, Hawkesworth, Menston, Denton, Burley-in-Wharfedale, and Ilkley, a series of districts that have hitherto been dependent on railway communication. The second scheme is promoted by the Wakefield and District Light Railway Company. This company have had power for laying down tramways in Wakefield and the immediate district for a year or two, but so far little progress has been made. Now a second attempt is to be made to get that which the Light Railway Commissioners refused. The extension in question proposes to connect Wakefield with Dewsbury *via* Ossett, and to lay down a system in East and West Ardsley and Soothill Nether. The gauge of the tramway is to be 4ft. 8½in.

Birkenhead.—A recent addition to the tramway equipment in this town is a rail-washer and sprinkler. The tank is 5ft. 6in. deep, it has a similar breadth, and is 12ft. long, and its holding capacity is 11,000 gallons. It is divided into two compartments, with an equalising pipe to feed the compartments. An ordinary manhole is at each end, and the tank is filled from the top. The car contains two double-spray sprinklers and four rail-washers. There are also four scrapers for the purpose of clearing the grooves of the rails, and which are exceedingly useful in time of snow. It may be mentioned that when there has been a downfall of snow the tank is filled with salt water. The tank is mounted on a Peckham truck with two G.E. motors and a G.E. controller with a rheostatic brake. The car is also fitted with ordinary hand brakes and a slipper brake capable of holding the car on the heaviest grade there is in Birkenhead. There is the ordinary signalling apparatus from driver to conductor, and the electric light is used for night work. It is calculated that the tank will water a track five miles in length.

Lancaster.—Speaking at the twelfth annual meeting of the Lancaster and District Tramways Company on Saturday, Councillor A. Bell said that, respecting the negotiations with the Lancaster Corporation for the sale of the undertaking, there had been a hitch, because the Corporation did not for long agree to the appointment of a competent valuer as suggested by the company. One had at last been appointed, and he was at present engaged in the valuation. A considerable amount of interest has been centred during the week at Lancaster in trial runs by the electric tramcars. The first run, when three cars were tested, took place at an early hour on Sunday morning. Since Sunday trial runs have been made of one or more cars almost every night, and are stated to have been thoroughly satisfactory. The date when the public service of cars will be commenced is still a matter

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of uncertainty. The power station is practically completed, or, at any rate, sufficiently so to supply power for running purposes, and all the cars have been delivered, but there are other details still to be completed, such as the engaging and training of drivers and conductors.

Camberwell.—The London County Council have refused the request of the Borough Council that two relays of workmen be employed during the time the tramways are being reconstructed for electric traction in the borough, and that the whole of the work should be carried out under the supervision and to the satisfaction of the borough engineer The Works Committee of the Borough Council recommend the Borough Council to renew their request for these concessions. A deputation from the London Omnibus Owners' Federation has waited upon the Borough Council to urge that in the reconstruction of the tramways only 100 yards of road should be allowed to be disturbed at one time, and that only half the road—from the kerb to the centre—be closed. This latter proposal appears to us to be quite reasonable, and one which the County Council ought to accept. It may be stated that in the reconstruction of the lines at Tooting and Clapham, where the Council found it convenient to maintain the tram service while the work was going on, only one track was converted at a time, and hence traffic was not so much dislocated as it otherwise would have been.

Paris.—A Reuter's message from Paris dated Nov. 20 says that in the Chamber on that day M. Cantant, a Socialist, interpellated the Government with reference to tramways, including the system of the Paris Tramway Company and the lines running into the suburbs. He maintained that these companies had caused the smaller capitalists to suffer, adding that the Government should defend the small capitalists against the cosmopolitan financiers and should terminate the companies' leases. M. Maruéjouls, Minister of Public Works, said that if the companies had been prosperous his duty would have been easy, but the companies were in a moribund state, and it was necessary to proceed with caution, even in the interest of the public. To terminate their leases would make it necessary to find new concessionaries, and no serious man would consent to become one. All the companies were at the end of their resources. The remedy would be to municipalise the tramway services, but the Municipal Council would not be willing to accept the charge. The Minister estimated the loss suffered by the various companies at 210,000,000fr. He considered that the companies might be permitted to make a slight increase in their fares, but the authorisation of Parliament would first be necessary.

Carriage of Goods at Liverpool.—At the last meeting of the Mersey Docks and Harbour Board it was stated that on the previous Monday a deputation from the Tramways Committee of the Liverpool Corporation met the Traffic Committee, and Alderman Petrie gave an outline of the scheme by which it was proposed to carry goods over the Liverpool tramway lines. The idea was that the tramlines should be connected with the lines of rails at the sheds on the dock quays, that goods should be loaded into wagons electrically propelled, that then the wagons should go over the tramlines in Liverpool on to the lines of the South Lancashire Tramway Company, and be distributed to various manufacturing towns. It was considered that a very large decrease in the cost of carriage would in this way be effected. When the South Lancashire tramways system was finished it would comprise a large network of rails connecting with Liverpool practically every important town in South Lancashire. The object of the Liverpool Tramways Committee in seeing the Traffic Committee was to know whether they could count on the assistance of the Dock Board in maturing and developing their scheme, and they were assured that the Board would heartily co-operate with the Corporation in the matter, because any new departure which would diminish the handling of goods and lessen the cost of carriage would, of course, prove of immense advantage to the port. A detailed description of the scheme has already appeared in our columns.

Manchester.—We learn from the *Manchester Guardian* that the Tramways Committee of the Corporation hope to be able to place the electric cars on all the routes in the southern parts of the city next Monday. At the same time a system of through cars will be adopted which will have the effect of considerably reducing the great pressure of traffic in Market-street, the busiest thoroughfare in Manchester. The through services which have already been inaugurated since the Tramways Committee took over the tramways in June of last year have proved highly successful. Not only have they been useful to passengers wishing to travel from one suburb to another, but they have also had the good effect of expediting the tramways traffic in the centre of the city, and so to some extent relieving the congestion of the streets. As yet several districts on the north side of the city have not been provided with electric trams; probably the turn of the Oldham-road, Ashton New-road, and Ashton Old-road districts will come early in the new year. At their meeting on Tuesday the Tramways Committee approved an agreement with the Stretford District Council for the working of the tramways in that township. The agreement provides that on Monday next the Manchester Corporation shall, as contractors to the Stretford District Council, begin the reconstruction of the Stretford tramways for electric traction. The reconstruction of the tramways will be carried out as rapidly as possible so as to give an early service of electric cars to Stretford.

District Railway Electrification.—In connection with the conversion of the Inner Circle to electric traction, it is interesting to note that the engineers are at work in the Kensington district. Plans have been submitted to the Kensington Borough Council showing the electric conduit it is proposed to lay in Warwick-road and Finborough-road, which is a portion of the route sanctioned by the District Railway Company's Act. In a report to his committee the borough engineer of Kensington has pointed out that the work bristles with difficulties, and that it is impossible to say what these difficulties will be until the trench for the work is opened, and he has suggested certain conditions, which the committee have embodied in a recommendation to the Council, with the view of lessening the inconvenience to the public which will be entailed by the work. These conditions are as follows: (*a*) that no part of Warwick-road or Finborough-road be opened except under a license granted by the borough engineer specifying the section of work to proceed, under which license a sum of money, to be determined by the borough engineer, shall be deposited to cover the cost of reinstating the public way; (*b*) that no drain, sewer, gully, pipe, or other property or work vested in the Council be interfered with or altered without drawings being first submitted to and sanctioned in writing by the Council; (*c*) that the salary of a competent clerk of works, to be engaged by the Council for the supervision of the work on their behalf, be paid by the company; (*d*) that the works be carried out to the satisfaction of the Council and the borough engineer; (*e*) that the company enter into an agreement embodying these conditions, the same to be prepared at their expense by the Council's solicitors.

Automobile Notes.—The Automobile Club of France is holding a trial of passenger and delivery cars. There is no question of speed, but the cars are to be judged by regulations calculated to determine their general efficiency for their specific purpose. The Prince of Wales's new motor is described as an electric phaeton, four-seated, which will run 90 miles on one charge of the batteries, and has a top speed of 25 miles an hour. The Racing Committee of the Automobile Club is shortly to decide which makers are to have the honour of building cars for the Gordon-Bennett Cup contest. In view of Mr. S. F. Edge's victory last year, it cannot be doubted that the Napier cars will be among those selected; but one or two other firms are eager to show what they can do in the direction of racing vehicles. The Automobile Club secretary and Count Zborowski have just returned from Ireland, where they have been looking for a suitable course for the Gordon-Bennett Cup race. Their opinion has not yet been made known, but it is generally believed that a circular course of 50 miles may be found which would give fair running We are informed that Messrs. C. S. Rolls and Co. have taken Lillie Hall, Earl's Court, London, S.W., which they have fitted with the latest model of electrical power plant. An efficient staff is being kept for repairs of motors, also a stock of duplicate parts, tyres, and accessories for the leading makes of cars, which will be forwarded anywhere on receipt of wire, together with an expert fitter if required. Other departments are the garage (storage room for 200 cars and locker for each owner); hiring department (Panhard cars only); the training and supplying of drivers; and the electrical department, where we find special charging boards for charging electric carriages and small ignition cells, the department being in charge of a trained electrician. The firm hold a license for the sale in the United Kingdom and Colonies of the cars built by Panhard and Levassor, of Paris.

PROVISIONAL PATENTS, 1902.

Nov. 17.

25175. Improvements in and relating to pendant, electrolier, and bracket switch connections. Joseph Frank Smith, 67A, Corporation-street, Birmingham.

25182. Improvements in trolley heads for electric railways and tramways. Stainer Hutchins and Charles Edmund Fry, 23, Regent-road, Hanley, Staffs.

25195. Improvements in electrical apparatus suitable for the ignition of gases and inflammable vapours and for other purposes. August Eckstein and Herbert John Coates, Peel Works, Adelphi, Salford, Manchester.

25197. Improved means for operating electric switches, taps, valves, and the like. Leo Schüler, 4, St. Ann's-square, Manchester.

25216. Improvements in electrical cut-outs and regulators and their application. Henry Leitner and Richard Norman Lucas, Rose Villa, Byfleet, Surrey.

25240. Improvements in electrical instrument for signalling on railways. Edward Tyer, Frederick Thomas Hollins, and Frederick William Leake, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

Nov. 18.

25263. Improvements in and relating to electrical fuses. Harry William Cox, Brougham-chambers, Nottingham.

25273. An electric tramcar or like trolley pulley guide. William Moorehead and Abraham Taylor, jun., 55, Market-street, Manchester.

25287. Improvements in telephone system. Wayne C. Wright and John William Pierson, 62, St. Vincent-street, Glasgow. (Complete specification.)

25288. An improved electric current indicator. Archibald Denny, James Archibald Robertson, and Charles H. Johnson, 121, West George-street, Glasgow. (Complete specification.)

25327. Improvements in systems of regulating alternating-current electric motors. The British Thomson-Houston Company, Limited, David Peter Thomson, and Reginald Charles Clinker, 83, Cannon-street, London.

25330. Improvements in systems of electrical distribution John Sedgwick Peck, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, March 21, 1902, being date of application in United States). (Complete specification.)

25342. Improvements in trolley poles. Theodore Charles Buder, 6, Lord-street, Liverpool. (Complete specification.)

25368. The electric arm and trolley-wheel controller. Thomas Wilson, 90, James-street, Devonport.

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25354. Improvements in the electrolytic treatment of liquids of all kinds. Arzano Corrado, 36, Chancery-lane, London. (Complete specification.)

Nov. 19.

25371. Apparatus for working portable fire-engines, pumps, and the like, by means of an electrical current. William Robert Burns Lockie, 17A, South Castle-street, Liverpool. (Robert Lefebvre and the firm of La Société A. Thirion et Fils, France).

25377. Improvements in arc lamps for electric lighting. Joseph Wilfred Bowley and Austin Walters, 67, Yarburgh-street, Alexandra Park, Manchester.

25427. Improvements in or connected with electric signalling lamps for naval and other purposes. Alfred Graham, 4, South-street, Finsbury, London. (Martino Casabona, Italy.)

25435. Improvements in and relating to electric telegraphy. Philip O'Neil, 323, High Holborn, London.

25436. Improvements in and relating to interrupters for induction coils and the like. Francis Lauder Muirhead and John Parr, 323, High Holborn, London.

25441. Improvements in electricity meters. Charles William Godson Little, 47, Lincoln's-inn-fields, London. (Complete specification.)

25442. Improvements in secondary electrodes for electrolytic apparatus, more especially intended for use in the manufacture of chlorates. Paul Imhoff and the United Alkali, Company, Limited, 47, Lincoln's-inn-fields, London.

25444. Improvements in clocks and electrical winding devices therefor. Heinrich Cohen, 18, Buckingham-street, London.

Nov. 20.

25454. A novel construction for the covering and protection of tramcar passengers (outside) from rain or falling wires. David Agnew, 179, Brighton-street, Egremont, Cheshire.

25457. New or improved recording apparatus for use in connection with ships' telegraphs, tell-tales, and the like. Joseph Fuller and Alfred Charles Leicester, 9, Tempest Hey, Liverpool.

25482. Improved rotary reversing gear for electric motors, dynamos, and the like. William Ellerton, 5, John Dalton-street, Manchester.

25500. Improvements in electric incandescent lamps. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

25511. Improvements in carbon or brush holders for dynamo-electric machines and the like. Charles Zabel, Bruno Zabel, and Willy Zabel, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25519. Improved telephonic apparatus. Dino Corsi, 52, Chancery-lane, London.

25522. Improvements in boosters for charging and discharging storage batteries, and regulating the pressure of the 'bus bars. Crompton and Co., Limited, and James Rae MacIntosh, Salisbury House, London-wall, London.

25524. Improvements in arc lamps and electrodes therefor. La Société G. et P. de Mestral, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 28, 1902, being date of application in France). (Complete specification.)

25546. Improvements in or relating to incandescent electric lamps. George Edward Battye, 46, Lincoln's-inn-fields, London.

25554. Improvements in and relating to electric contacts. Coloman de Kandó, 27, Chancery-lane, London. (Complete specification.)

Nov. 21.

25558. Windings for compensated asynchronous machines. Ole Sivert Bragstad and Tens Lassen la Cour, Karlsruhe, Baden, Germany.

25570. Improvements in tower wagons for trimming arc lamps or for repairing the conductors of the overhead system of electric traction. Samuel Rawlinson, William Rawlinson, and John Rawlinson, Penny Bank-chambers, Halifax.

25576. Improvements in electric current meters. H. V. Cramer and Co., Ernst Hermann Horstmann, and A. Horstmann, 25, Avondale-road, Lower Weston, Bath.

25578. Improvements in electrical measuring instruments. Arthur Cecil Heap, Century Works, Lewisham, Kent.

25586. Improvements in or in connection with electric tramcars and the like. Gideon Dickinson, Harry Dickinson, and Walter Dickinson, 7A, Market-place, Huddersfield.

25606. New carbon-holder for arc lamps or the like. William Cecil Jeapes, 12, Charing Cross-road, London.

25625. A new or improved electric pianoforte player. Andrew Gibson Douglass, 9, Regent-street, London.

25658. Improvements in apparatus used for wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, and Charles Samuel Franklin, 24, Southampton-buildings, Chancery-lane, London.

25682. Improvements in or relating to prepayment electricity meters. Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25668. Improvements in gas or electric light brackets applicable for bakers' ovens. Thomas Gillard, 6, Lord-street, Liverpool.

Nov. 22.

25699. An electrical cure. John Frederick Burger, 115, St. Vincent-street, Glasgow.

25711. Alternating-current machine, applicable as converter, motor, and generator. Ole Sivert Bragstad and Tens Lassen la Cour, 14, Lachnerstrasse, Karlsruhe, Baden, Germany.

25731. Improvements in or relating to electro-mechanical regulators. Joseph Louis Routin, 111, Hatton-garden, London.

25738. Improvements in or additions to insulators for telegraph, telephone, and electric light cables or conductors. Edward John Chambers, 7, Staple-inn, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 11.

1901.

16653. Manufacture of filaments for incandescing electric lamps and apparatus for use in such manufacture. Voelker.

23382. End-play devices for rotary machines. British Thomson-Houston Company, Limited. (Hewlett and Potter.)

23456. Electrical resistances. Mavor, Mavor, and Coulson, Limited.

23729. Brakes for electrically-operated cranes and similar hoisting apparatus. Jordan.

23845. Dynamo-electric machinery. Mavor, Mavor, and Coulson, Limited.

24512. Means for electrically controlling fluid compressors. Boult. (Richards.)

24806. Electromagnetic switches for electric railways. British Thomson-Houston Company, Limited. (Stewart.)

25064. Printing telegraphs. Moore and Steljes.

25613. Means for lighting gas lamps at a distance by means of an electric current. Stoltenhoff.

25125. Means for electrically signalling railway trains, tramcars, and the like. Butt.

25215. Telephone receivers. Orr.

26590. Winding for electrical machines. Lamme. (Date applied for under International Convention, June 26, 1901.)

26759. Means for supplying current to electrical vehicles. Wise (Maschinenfabrik Oerlikon.)

1902.

561. Electrical heating apparatus. British Westinghouse Electric Manufacturing Company, Limited. (Peck and Randall.)

918. Electrical measuring instruments. Whipple.

1232. Cutting cards for Jacquard apparatus permitting electrical reading of the same. Harleaux and Harleaux.

1528. Manufacture of incandescent electric lamps. Scharf.

3165. Multipolar electrical dynamos or motors. Bergman.

17127. Underground conduits for electric tramways and railways. Cope.

17380. Electromagnetic treatment of ores, slimes, and the like for separating their constituents. Leuschner.

19225. Storage batteries. Fairweather. (International Battery Company.)

19713. Composition of electrolytes for the formation of accumulator plates. Sandhagen and Lürgen.

20461. Detachable connections for use in electric lighting and heating. Lundberg and Lundberg.

21748. Arc electric lamps. Worsley.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated and Helsby Cables, Ord., 1-70,000	5 ..	7½-8
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	5½-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
British Westinghouse Elec. and Manuf., 5 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	101-103
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¼-1¼
—— Non. Cum., 5 per cent. Pref.	2 ..	1-1½
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	2¾-3
—— 5 per cent. Debentures	100 ..	101-106 p c
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼-½
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78

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Name.	Amount paid.	Last price.
	£	£
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17½
—— 4½ per cent. Preference	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	109-113
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20¼-21½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15¼
Telegraph Construction and Maintenance	12 ..	37-40
—— 5 per cent. Bonds	100 ..	102-105

Electric Lighting and Supply.—

Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	½-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	110-113
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	103-106
Brompton and Kensington, Ordinary	5	..	10¼-10⅜
—— 7 per cent. Preference	5	..	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	7-8 xd
—— Nos. 20,001-30,000	5	..	7-8 xd
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	16½
—— ,, ,, ,, £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	107-110
Charing Cross and Strand	5	..	9-9½
—— Nos. 50,001-70,000	5	..	8-9
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	105-107
Chelsea Electricity Supply	5	..	5¼-6
—— 4½ per cent. Debentures	100	..	109-112
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	124-129
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	104-107
County of London and Brush Provincial, Ordinary	10	..	8¼-9¼
—— 6 per cent. Cum. Pref.	10	..	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	6-6½
—— 6 per cent. Cum. Pref.	5	..	6-6½
—— 4½ per cent. First Mort. Deb.	100	..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6½
—— 4½ per cent. First Deb. Stock, Red.	100	..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7¼-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10-11
—— 4 per cent. Debenture Stock, Red.	100	..	101-104
Kensington and Knightsbridge and Notting Hill	100	..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10½
London Electric, Ordinary	3	..	1¾-2¼
—— 6 per cent. Pref.	5	..	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	96-99
Metropolitan, Ordinary	10	..	15¼-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 3½ per cent. Mortgage Debenture, Red.	100	..	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	9-9¼
—— Preference	4	..	6¼-6½
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	..	101-104
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5-6
—— 4 per cent. Debenture Stock	100	..	99-102
River Plate Electric Light and Traction, Deb.	100	..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	1¾-2¼
—— 4 per cent. Debenture Stock	100	..	80-90
South London, Ordinary	5	..	3-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14-15
—— 7 per cent. Pref.	5	..	8¼-9¼
—— 3½ per cent. Deb.	100	..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	..	3¼-4⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	..	3¼-4⅛
Westminster, Ordinary	5	..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	5	..	6-6½

Name.	Amount paid.	Last price.
	£	£
Electric Railways.—		
Central London, Ordinary	100 ..	106-109
—— 4 per cent. Pref.	100 ..	106-109
—— ,, ,, deferred	100 ..	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	75¼-76½
—— 4 per cent. Debenture Stock	100 ..	114-117
—— 5 per cent. Pref. Stock '91	100 ..	128-131
—— ,, ,, ,, '96	100 ..	126-129
—— ,, ,, ,, '01	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 —	93-96
Electric Tramways.—		
Anglo-Argentine, 1-250,007	5 ..	4¼-4½
—— Permanent 5 per cent. Debenture Stock, 1888	100 ..	127-132
Blackpool and Fleetwood Tramroad	10 ..	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3½-3⅝
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	12-12½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	123-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	98-101
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2⅜ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	4¾-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	95-98
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-4⅜
—— 4 per cent. Debenture Stock	100 ..	96-99
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	11½-12
—— ,, ,, ,, ,,	10 ..	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	106-108
—— ,, Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅜
—— 5 per cent. Cum. Pref.	10 ..	11¼-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	8¼-9⅛
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109 xd
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	16s. ..	13/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c. ..	80 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	92-94
—— Deferred Stock	100 ..	62-64
—— 6 per cent. Cum. First Pref.	10 ..	12¼-13¼
—— 6 per cent. Cum. Second Pref.	10 ..	11¼-12⅛
—— 5 per cent. Non-Cum. Third Pref.	5 ..	4¾-5⅛
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
—— 4 per cent. Deb. Stock, Red.	100 —	101-105
Oriental Telephone and Electric Company	1 —	¼-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 15	834	605	+ 229	+ 6,216	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	,, 22	4,635	4,495	+ 140	+16,406	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	,, 21	718	643	+ 75	+ 3,836	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	,, 21	285	224	+ 61	+ 279	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	,, 22	185	187	− 2	− 203	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	,, 23	1,462	1,235	+ 166	+ 4,152	32	—		77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	Oct. 26	3,208	1,090	+2,118	+82,937	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57[a]
Bristol Tramways Company	Nov. 21	4,037	3,625	+ 412	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	8,675	2,010,873	323,044[h]	1·03	6·46	—	4·65
Central London Railway	,, 22	7,233	6,650	+ 583	+11,341[h]	12	12	,, 31	335,086	41,188,389	1,243,730[a]	1·88	64·23[a]	27,923	34·89[a]
City and South London Railway	,, 23	3,491	3,029	+ 462	+20,674	12½	9½	,, 31	62,601[a]	7,008,842[a]	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	,, 20	353	343	+ 10	+ 5,895	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,970	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—			,, 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dover Corporation	,, 22	151	173	− 22	+ 50	4½	—	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin & Lucan Electric Railway	,, 23	80	71	− 9	+ 77[h]	6½	6½								
Dublin U. T., electric cars	,, 21	3,413	3,258	+ 155	} +2,442	46	46	,, 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	,, 21	682	680	+ 2											
Dundee City Tramways	,, 5	768	625	+ 143	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	,, 22	12,048	10,322	+1,776	− 9,669	104	95	,, 31	582,146[c]	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	Oct. 22	1,139	1,028	+ 111	+ 2,225	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	Nov. 22	971	896	+ 75	—	48	48	Sept. 30	29,061[h]	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	,, 22	1,614	1,596	+ 18	+ 2,651	19	9½	,, 30	72,331[h]	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	,, 15	9,908	8,543	+1,165	+35,509	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	,, 23	1,433	1,434	+ 34	− 677	15½	15½	June 30	69,152	8,426,976	787,010[a]	1·97	21·07[a]	4,450	15·94[a]
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 23	3,839	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82[f]
Southampton Corporation	,, 21	841	685	+ 156	—	11	—	,, 31	28,973	4,761,149	696,159	1·45	9·96	2,630	—
Sunderland Corporation	,, 23	974	931	− 7	+ 2,760	19	17	,, 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. [a] Train mile.
[h] Half-year's figures. [c] Include rail and tram. [d] Total receipts. [e] Electric traction only. [f] Including one section of horse traction.

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NOTES.

Wireless Telegraphy at Sea.—The Johnston liner "Vedamore," which arrived at Baltimore on Monday, is reported from New York to have received messages by the Muirhead system of wireless telegraphy over a distance of 1,000 miles, and to have dispatched messages over a distance of 300 miles.

Tunbridge Wells Telephones.—The Postmaster-General, in the House of Commons on Monday afternoon, stated that he had been unable up the present to come to a decision with regard to the proposed sale of the Tunbridge Wells municipal telephone system to the National Telephone Company, to the agreement between whom his sanction has been asked.

Electrolytic Oxidation of Naphthalene.—When a cold solution of naphthalene in a mixture of acetone and sulphuric acid is electrolysed some α-naphthaquinone is formed at the anode, and a considerable quantity of brown non-crystalline substance. Mr. A. P. de Bottens has found that naphthalene-α-sulphonic acid or its sodium salt and 1-animo-β-naphthol-4-sulphonic acid, dissolved in water or a mixture of acetone and sulphuric acid, gives small quantities of phthalic acid.

American Submarines.—The new submarine boats which are the most recent acquisition to the United States navy are reported to have given excellent results under test. The contract stipulated that they should have a speed of seven knots submerged, and the official figures show that the "Mocassin" made a maximum speed of $7\frac{28}{100}$ knots on her submerged trials. The electric batteries and motor provided this record speed without any assistance from the gas-engine, which is only used when the boat is at the surface.

Royal Institution.—A general monthly meeting of the members of this institution was held on Monday afternoon, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The following were elected members: Edward Divers, M.D., Miss Amy French, Winefred, Lady Howard of Glossop, and Mr. J. H. Whitehorn. The special thanks of the members were returned to Mrs. Hickman for her donation of £21 and to Dr. Frank McClean, F.R.S, for his donation of £40 to the fund for the promotion of experimental research at low temperatures.

Alternative All-British Cable to India.—In the House of Commons on Tuesday, Sir Charles Dilke asked the Prime Minister whether the attention of the Government had been directed to the recommendation of the Committee on Cable Communications in favour of a cable connecting the Cocos and Ceylon, or the Cocos and Singapore, and thus giving an alternative and an all-British line to India. Mr. Balfour replied that the matter had engaged the attention of the Government, but at present they were awaiting a report from the Government of India, to whom they had made a communication on the subject.

Electricity in Lighthouses.—In an article on the new American lighthouse system, Mr. George E. Walsh states that a modern American lighthouse frequently costs £25,000, and often one-third of this is spent in the electric light and apparatus alone. In the old system the lights represented a comparatively small proportion of the expense. The finest French mirrors and lenses used were considered costly, but not in comparison to the electric lights and equipments. The gain obtained in the power of the light more than counterbalances the extra cost. There are a score or two of lighthouses in existence whose lights throw a beam of 100,000 c.p. The tendency, he remarks, is to increase the power of the light, for by so doing the great link of lighthouses round the coast is made more secure and more trustworthy.

Electrical Steering Gear.—Successful experiments are reported to have been made with an electrical steering gear during the past week on board the Earl of Crawford's yacht "Valhalla," in the presence of the owner of the boat, a representative of Messrs. Siemens Bros., who supplied the apparatus, and a representative of the Admiralty. After a five months' cruise the yacht has returned to British waters, and the gear has been overhauled and several improvements made on the side of simplicity. In conjunction with Messrs. Siemens, Mr. Brougham, the inventor, has devised a method of controlling the steering gear from any part of the yacht, and the results of the test are said to have proved satisfactory. We hope to be able to give further details of this electrical steering gear in a later issue.

Electric Heating.—An extensive scheme of electrical heating is, we understand, to be put in hand in the Davos-Platz region in Switzerland, which is famous as a winter resort for consumptives. The remedial value of pure cold air is now well recognised in such cases, and in this instance the primary reason for adopting electric heating is the preservation of the air free from impurities such as accumulate from coal and wood fires. The total population of the district is put at about 5,000, and the scheme provides for a complete electric heating system for the whole community. Water power abounds in the neighbourhood, and the proposal is to instal a polyphase plant of about 15,000 h.p. to do the work. It is estimated that the total cost of the energy delivered, including all items of fixed charges and depreciation, will amount to just over $\frac{1}{3}$d. per kilowatt-hour. Presumably, with the completion of the scheme electricity would be generally used for lighting in the neighbourhood, and later on it might be conveniently employed to operate a small electric railway connecting up the surrounding districts.

St. Louis Exposition.—With the formal acceptance by the British Government of the invitation to take part in the Universal Exposition at St. Louis in 1904, the organising body has prepared some special information for the guidance of intending exhibitors and visitors from the United Kingdom. It is published in the form of a pamphlet, and may be had from Mr. Geo. F. Parker, the commissioner for the exposition in the United Kingdom, at Sanctuary House, Tothill-street, Westminster. Intending exhibitors will find in this pamphlet full particulars as to the scope and plan of the exposition, illustrated descriptions of the grounds and buildings, etc. Of special interest to engineers is the statement that the electrical industry will be well represented at St. Louis. The electricity building has cost more than £80,000 to erect, and it will be an average of 600ft. long by 525ft. wide, with a floor space of 315,000 square feet. In the schedule of exhibits all kinds of apparatus and machinery for generating and using electricity are included, embracing power, lighting, telegraphs, telephones, electrical signalling, and last, but not least, electric traction.

Books Received.—We have received a copy of the "'Via Eastern' Telegraphic Social Code," compiled by Mr. R. T. Atkinson, and issued under the authority of the Eastern Telegraph Company and associated companies. By the use of this code, senders of social cable messages will be able to communicate with friends across the seas at considerably cheaper rates than heretofore. The code is arranged in alphabetical order, and there is to be one at each of the telegraph stations of the cable companies

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for reference purposes. Information is also given in this book as to the registration of addresses, list of telegraph stations where the code is obtainable, and a table showing possible transformations of telegraphic signals, which should come in very useful where secrecy is an important consideration. The price of the code is 5s. We have also to acknowledge from Messrs. McMillan and Co. a copy of "Light for Students," by Mr. Edwin Edser. The published price is 6s.

Wireless Telegraphy in the States.—It is reported that the United States naval authorities have been unable to come to an agreement with the Marconi Wireless Telegraph Company in regard to the adoption of wireless telegraphy in the navy. The company, it appears, require the payment of a given sum for each set upon delivery and a royalty for each year during the life of the patents. The aggregate cost of a set under these conditions would, in the estimate of the authorities, be very great, and they have refused to come to an agreement on such a basis, especially as it is illegal in the United States to obligate the payment of money beyond a single fiscal year. If the Marconi system is not to be taken up by the navy, however, it is to be given further tests on shore. Several naval stations are to be provided with wireless telegraph stations, and in order to ascertain the effect of heat, which is said to be injurious to the successful working of wireless apparatus, a station will be established at Key West. At the present time the United States is far behind other naval powers in the adoption of wireless telegraphy on board of warships.

Delivery of Telephonic Messages.—It may not be generally known that the Post Office has made arrangements in those districts served by its telephone system for delivering telephonic messages at their destinations in the same way as a telegram, and at half the telegraphic rate. Only those having a private telephone, however, can avail themselves of this facility, and 30 words seem to be the maximum for an ordinary message, which can be delivered by express within a radius of one mile of the receiving office for a charge of 3d. over and above the usual charge for a call. The Post Office telephone scheme contemplates the establishment of a call office at practically every branch post office in London within a few months, and there is little doubt but that the above arrangement will readily be taken advantage of by the subscribers to the system. In the same way the trunk lines can be used for this purpose, the only additional charge being 3d. a mile for the delivery of the message. When the Post Office have completed their metropolitan system, it is conceivable that in some cases it will be found more expeditious to telephone messages to non-subscribers than to use the telegraph, and owing to the limits placed on the length of a telegraphic message, it should certainly prove more economical.

Electrolysis.—In a paper abstracted in the current number of the *Journal* of the Chemical Society, Mr. M. P. E. Berthelot describes a research he has made into the relation between current intensity and manifestation of electrolysis. In this research previous experiments were extended to cases in which the E.M.F. only slightly exceeds that necessary for the electrolysis of water. The element employed contained solutions of sodium hydroxide with the addition of a small quantity of pyrogallol, and of sodium chloride with the addition of a little hydrogen peroxide, and the E.M.F. was about 0·86 volt. With two such elements in a voltameter containing sulphurous acid, no electrolysis was observed under 760mm. pressure, but the action was evident under 8mm. On the addition of pyrogallol, the action was evident under the ordinary pressure. This is in accord with previous observation, as it had been found that in the first case the quantity of hydrogen which could be liberated, about 0·00001 mgm. per minute, would only be visible under reduced pressure. Electrolysis was apparent with one element under reduced pressure and on the addition of pyrogallol, and the rate of evolution is calculated to be 0·000003 mgm. per minute, a quantity only just on the limits of possible observation.

Telephones in Paris.—For the moment we may transfer the attention of those interested in the telephone question in England to the state of things that exists in Paris. The Parisian telephones are in the hands of the Government, and we understand that at the present time there is a complaint of the shortcomings of the system. The principal reason for this outcry is that both the staff and the number of lines are altogether inadequate for the work required of them, and the natural result is an inefficient service. The plea put forward by the French Post Office is that it has not the funds at its disposal to remedy the grievances or to extend the service. Considered in the light of the fact that the charge for unlimited user in Paris is as high as £16 per annum—probably not exceeded in any other large city—this is surprising, and tends to the suspicion of bad management. It is asserted in certain Parisian circles that if a private company had the monopoly instead of the Government, it would not only pay its shareholders big profits, but also find without difficulty the wherewithal to modernise and develop the system. This, at any rate, has not been the experience of this country, where the National Company insisted on maintaining its high charges until driven to reduce them by the competition of the municipalities in the provinces and of the Post Office in the Metropolis.

The Carbon Spectrum.—From an abstract of a paper by Mr. A. M. Herbert on the effect of the presence of hydrogen on the intensity of the lines of the carbon spectrum, we gather that when an induction spark is passed through mixtures of carbon dioxide and hydrogen under atmospheric pressure, it is found that the intensity of the strong red line of the carbon spectrum rapidly diminishes with increasing percentage of hydrogen, far more rapidly than the strong violet line of the carbon spectrum under the same conditions. In a mixture with 5 per cent. of hydrogen, the red lines of the carbon and hydrogen spectra are about equally strong; in a mixture with 50 per cent. of hydrogen, the red carbon line is scarcely visible. The violet carbon line, on the other hand, is quite distinct in a mixture with 90 per cent. of hydrogen. Similar results are obtained when carbon monoxide or coal gas is substituted for carbon dioxide. When, on the other hand, the carbon compounds are diluted with air, the intensities of the two carbon lines diminish more or less equally. Special experiments show that the rapid extinction of the red carbon line in presence of hydrogen is not an apparent effect due to the glare of the neighbouring red hydrogen line. It is suggested that the red and violet lines belong to different carbon spectra, and that the molecular combination which gives rise to the red line is destroyed by hydrogen.

Goods Traffic on Tramways.—The scheme which was recently described in this journal for the carriage of merchandise from the Liverpool Docks to the numerous manufacturing districts in South Lancashire is approaching fulfilment. Practically, it will mark an entirely new departure in tramway working, at least in this country, although there are a few cases in the provinces where goods are carried by the electric tramways, and, as noted last week, Huddersfield is moving in the same direction. The

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scheme in South Lancashire is being developed by the Mersey Docks and Harbour Board and the Liverpool Corporation, which authorities have just come to an agreement to co-operate in the matter. Later on it will be necessary for arrangements to be made with the various traction authorities in South Lancashire over whose lines the traffic must pass, notably the South Lancashire Tramways Company, which is at present engaged in carrying out an extensive network of electric tramways in that district. The Liverpool Corporation tramway system ends at Knotty Ash, and at this point the goods traffic will have to be taken over by this company, by whose lines Prescot and St. Helens will be reached. From these points it will be possible to distribute goods to any of the large manufacturing towns which lie westwards of Manchester. The consummation of the scheme will be watched with keen interest by tramway authorities and by the trading public, and the experiment is likely to furnish an additional stimulus in the development of electric traction all over the country.

Ether from Acetylene.—There are a variety of chemical methods for the synthesis of ether from acetylene, but they are in general indirect, alcohol being formed as an intermediate product. In a method proposed by Joseph W. Harris, and described by Mr. C. P. Townsend in the *Electrical World*, the transformation, for all practical purposes, is direct. From this description it seems that acetylene is introduced into strong sulphuric acid solution in the cathode compartment of an electrolytic cell, the anode of which is enclosed in a porous cup. The gas reacts with the liberated hydrogen, yielding a mixture of ethylene and ethane, the conditions of the reaction being such as to restrict as far as possible the production of the latter gas. This ethylene, formed in strong sulphuric solution, passes at once into ether, the controlling feature of the reaction being the presence of relatively small percentages of water—not to exceed 35 per cent.—in the acid. At lower acid concentrations the formation of alcohol is noted. The author states that the reactions considered most probable by Mr. Harris are as follows: first, acetylene by union with hydrogen passes into ethylene; second, ethylene unites with sulphuric acid to form ethyl-sulphuric acid; and third, ethyl-sulphuric acid in the presence of water breaks up with formation of ether and regeneration of the acid electrolyte. Inasmuch as certain of the known carbides and carbide mixtures react with water with formation of ethylene, it would be interesting to determine whether they would yield some ether by decomposition with strong sulphuric acid.

Purification of Sugar Juices by Electricity.—Mr. C. P. Townsend describes in the *Electrical World* the latest electrolytic method for the purification of sugar juices, the inventor being Albert Baudry, of Kiew, Russia. Chemically considered, the process is substantially that known abroad as Urbain's, with the addition of certain dialytic features, adapted from still earlier art. The cell employed in the first treatment is divided into three compartments, of which the central one contains the juice and anodes. The external compartments containing the cathodes are filled with water, and are separated from the anode compartments by diaphragms of parchment. The anodes are of soluble metals, such as zinc, aluminium, and lead. Upon passage of the current the bases of such salts as the juice may contain are transferred to the water around the cathodes. Before this operation the juice has received the usual treatment with sulphurous acid. After concentration the juice resulting from this preliminary treatment is again electrolysed in a similarly constructed apparatus, the polarity of the electrodes being now reversed so that the water surrounds the anodes. The acid radicals of the salts are now removed from the juice, and the sulphuric acid which is injected during the second treatment is reduced by the hydrogen to hyposulphurous acid, the great decolorising power of which is exerted under favourable conditions. The syrup may undergo a still further treatment in a third electrolytic vat, wherein both anodes and cathodes are immersed in water, the solution passing through intermediate compartments. This supplemental dialytic treatment seems to be precisely the method proposed many years ago by Despeisses. The claim that the conjoint use of the methods of Despeisses and Urbain yields excellent results as regards increase in the coefficient of purity, and particularly the elimination of extractives and colours, would seem to be well founded.

Royal Society.—The anniversary meeting of this society was held at Burlington House on Monday evening, when the president, Sir Wm. Huggins, delivered his address. In the course of his remarks, the president referred to the work of the Physikalisch-technische Reichsanstalt, of Berlin, and hailed with high satisfaction the opening in March last of a similar national institution in this country. He pointed out, however, that for the maintenance of the National Physical Laboratory at Bushy Park we must look to the liberality of the public, not only for sums of money, but also for presents of machinery and other appliances. Referring more particularly to the subject of education, he observed that the evidence seemed clear that the present inappreciative attitude of our public men, and of the influential classes of society generally, towards scientific knowledge and methods of thought must be attributed to the too close adherence of our older universities, and through them of our public schools, and all other schools in the country downwards, to the traditional methods of teaching of mediæval times. With the experience of Germany and the United States before us, the direction in which we should look for a remedy for this state of things would seem to be for both the teacher and the student to be less shackled by the hampering fetters of examinational restrictions, and so for the professor to have greater freedom as to what he should teach, and the student greater freedom as to what line of study and research he might select as being best suited to his tastes and powers. One way of bringing about reform in this direction would be to make individual research an indispensable condition of proceeding to degrees higher than the B.A. The first steps in the direction of true reform, however, must be taken by the universities in the relaxation to some extent of the established methods and subjects of their examinations, which had been carried down with but little change from the Middle Ages.

Remarkable Phenomenon in Gases.—Dr. John Trowbridge, in the current number of the *Electrical Review* of New York, has a short article on what he describes as a remarkable phenomenon in gases submitted to very high temperatures. For several years Dr. Trowbridge has been studying the spectra of gases produced by powerful discharges from condensers charged by a storage battery of from 10,000 to 20,000 cells. A year ago he reached the limit in this study with glass vessels, but was fortunate last summer to obtain in London suitable vessels made of quartz, which can be heated to a white heat without cracking. They are made by a process invented by Prof. W. A. Shenstone, of Clifton College, in this country, which consists essentially in heating the quartz for some time in a platinum crucible in a muffle furnace, and afterwards heating the fragments in the oxyhydrogen flame. From the fragments sticks of limpid quartz are thus prepared, from which glass

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vessels even of large size can be made. In his experiments Dr. Trowbridge used Geissler tubes, 4in. or 5in. long, with a capillary portion of 2in. in length. He states that in this capillary the electric discharges form the most intense light that has ever been studied in a laboratory. In its photographic effect it is at least four times that produced by the same amount of electrical energy discharged between magnesium terminals. His study of this light revealed the presence of both bright and dark lines in the ultra-violet portion of the spectrum of hydrogen or water vapour. The dark lines, he asserts, have never been seen before. They are due to a selective reversibility or selective polarisation of the photographic images of the lines of the gas. Dr. Trowbridge thinks that this result has an important bearing upon theories of the nature and constitution of the stars, and upon the character of the sun's spectrum. There are probably dark gaseous lines also in the visible portion of the sun's spectrum. To the eye this intense light of hydrogen appears to give a continuous spectrum with no bright lines. Photography, however, reveals many bright and dark lines in the ultra-violet. A new field in spectrum analysis thus appears to be opened.

Light Telephony.—A very interesting account of some experiments with "light telephony" is given by Ruhmer in a recent issue of *Elektrotechnische Zeitschrift*, in which the author claims to have succeeded in establishing good communication over a distance of nearly 4½ miles. The principle followed by the experimenter is this: At the transmitting end the sounds spoken into a microphone generate variations of the current, which are superposed on the direct current from a storage battery feeding an arc lamp. This gives the phenomenon of the sparking arc, and the light intensity of the arc lamp follows the vibrations. The vibrating light rays are made parallel by a parabolic searchlight reflector, and transmitted to the receiving station, where they fall upon a reflector in the optical axis of which there is a cylindrical selenium cell. This cell is connected in series with a battery and two telephones. If the selenium cell is sensitive enough, the transmitted sounds are reproduced. It is necessary to use such a current at the transmitting station for feeding the arc lamp that the illumination of the selenium cells is at the point of its maximum sensitiveness. The author uses 4 to 5 amperes for transmission over 1¼ miles, 8 to 10 amperes for 2½ miles, 12 to 16 amperes for 4¼ miles; the greater the distance, the more light is needed at the transmitting station, in order to keep the illumination of the selenium cell at the most favourable point. The author finds that the relatively short wave-lengths of the spectrum are the most active in the phenomenon of the "sparking light." The construction of the selenium cell is the principal matter, and the author claims that his cells are at least as good as the one used by Simon, which has a resistance of 533,000 ohms, and is reduced to 26,000 ohms with an illumination of 400 lux. In the author's cell, thin layers are used. After having been illuminated, the original resistance, which corresponds to darkness, is reproduced within a few minutes. The author, whose experiments were made on the Wannsee, and are said to have given satisfactory results, thinks that light telephony has a practical future in naval and military evolutions.

Ventilation of Tunnels.—At the Society of Arts on Wednesday, Nov. 26, Dr. Gustave Goegg read a paper on "The Construction of the Simplon Tunnel," which is to afford direct connection between England and Italy and other Eastern countries. The paper, as a whole, is well worthy the careful study of all engineers, but we propose here to refer to one particular part—*i.e.*, to the ventilation of these long tunnels. The problem is in a way an aggravation of that found in the ventilation of our tube railways. In the Mont Cenis tunnel with steam locomotion the air has been found to be extremely vitiated, and in consequence engine drivers have in some cases been overcome by fumes. In the new route the distinctive feature is that two trains will not be running in opposite directions through the same tunnel, but two independent tunnels have been constructed, each of which will have to deal with the traffic in one direction only. This reproduces the conditions of the tube railways in London, with, however, the important advantage that the ends of the tunnels are in the open air, and not in practically air-locked chambers underground. Another point is that it is proposed in the Simplon tunnel to drive the trains electrically in order to avoid the extreme vitiation of air otherwise experienced. During construction exceedingly high temperatures have been experienced, the rock frequently being found to be at 122deg. F. This heat, while exceedingly troublesome to the workmen engaged in the construction, is not likely to cause much inconvenience to passengers in the trains. It is also unlikely that while the rock will maintain itself at a high temperature, the air in the tunnel, in consequence of the ventilation caused by the trains passing through, will be at anything like such a high temperature. The construction of these tunnels is proceeding as rapidly as can be expected, but we believe that the contractors have found it quite impossible to complete their work in the contract time. With respect to the ventilation of tube railways in London, the problem resolves itself into removing the vitiated air by means of fans, so that the fresh air is drawn in through the various openings at the stations. No doubt a mistake was made in the earlier days in supposing that these tubes would ventilate themselves, as the above-mentioned railways in the Alps will do. Provided, however, that fans of sufficient capacity are used, there will be no difficulty in maintaining a good atmosphere both in the "Twopenny Tube" and in various other deep-level lines now in course of construction.

Electrical Insulating Porcelain.—Mr. Arthur S. Watts has made a series of exhaustive tests on electrical insulating porcelain, and recently submitted the results to the American Ceramic Society in the form of a paper, which is published in the *Transactions* of the society. The author first gives a brief sketch of the early use of porcelain articles for electrical purposes. The leading materials used in its manufacture are certain kinds of kaolin—which are very slightly plastic—quartz, and feldspar. The first step in the way of improving the plain bell porcelain insulator was made in 1857, but it did not result in the introduction of the double bell insulator until 1895. The author states that up to a tension of 3,000 volts the double bell, 75mm. wide and 100mm. high, suffices, but above this voltage the question of further improvement arises. The object of the investigations carried out by Mr. Watts was to prove, if possible, the proportions of the essential materials which go to make up the best insulating porcelains. In general, the tests showed that porcelains of equally good appearance may possess greatly varying values when subjected to various tests. The electrical resistance trials showed that every specimen standing a superior test had a high silica and moderately low alumina content. Unfortunately, in each series showing the variation in proportions of CaO and K_2O, the content of Al_2O_3 was so high that no exceptionally good porcelains were obtained, even with high K_2O content. A marked improvement was observed, however, upon increasing the K_2O and decreasing the CaO, except at the extreme of the series, where K_2O was used alone, and here the experiments showed weakness due to brittleness. This

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tends to indicate that had the K_2O been somewhat increased, and the CaO proportionately decreased, the result would have been much better. In the series of tests showing the effect of Al_2O_3 content, no great difference was noticed in the ability of the specimens to resist abrasion. Much the same statement applies to the series showing the results of varying of SiO_2. However, the medium high SiO_2 specimens seemed to clip worse than the extremely high SiO_2 specimens, while the low SiO_2 specimens showed a lack of ability to resist abrasion. The shrinkage tests tended to show that there are three factors that may cause a variation: first, the amount of clay substance introduced; second, the variation in the kind of flux used; and third, the amount of silica present. Hence the shrinkage may be varied to suit almost any case. At the end of the paper the author mentions an ideal porcelain for electrical purposes, the limits of composition of which may be expressed thus:

$$\left.\begin{matrix}0{\cdot}5 \text{ to } 0\,8\ K_2O \\ 0{\cdot}5 \text{ to } 0{\cdot}2\ CaO\end{matrix}\right\} 0{\cdot}8 \text{ to } 1\,0\ Al_2O_3 \left\{4{\cdot}2 \text{ to } 6{\cdot}2\ SiO_2.\right.$$

Closer limits than these would be largely a matter of fancy for more translucency or more stoniness as might be required. Any porcelain, however, within the above limits would probably be superior to the average electrical insulator now in everyday use.

Experimental Research in Workshops. — The great value of experimental research was the text of an interesting lecture delivered to the Dundee Institute of Engineers in University College on the 27th ult. by Prof. J. T. Nicolson, professor of engineering at Manchester Municipal School of Technology. The lecturer's remarks were specially concerned with the importance of experimental research in our engineering workshops, and in this connection he unfavourably compared the position of this country with that of Germany and of America. For instance, while he stated that he knew of no firm in Great Britain possessing such an experimental laboratory, in the case of one German engineering establishment there was a Versuchsfeld, or experimental station, which was quite apart from the standardising laboratory, and in which the staff consisted of a chief engineer and 13 assistants, everyone holding his diploma from one of the universities or technical high schools. He affirmed that the engineering employers of this country should either be themselves constantly experimenting and trying new ideas, or they should maintain one scientifically-trained man at least on the premises constantly engaged in practical research work. There should be a laboratory attached to every large engineering works, in which a properly-trained staff should be employed in the endeavour to improve the design, both in principle and in detail, of the machines turned out. Those firms in England who had tried the system, and had given much time and expense to experimental research work, had found it to be a most lucrative investment. With regard to the position of engineering colleges, Prof. Nicolson observed that if work of the kind he desiderated were to be carried out in these institutions, the scope of their laboratory equipment must be extended to include not only the subjects in which instruction was now given, but also to provide facilities for experimental work by the actual leaders of industry, or certain properly trained deputies appointed by them, on the problems of engineering design which presented themselves in daily practice. He also considered that the endeavour would have to be made in such laboratories to ascertain and set up a standard of reference to which the specimens of every type and class of machine and instrument might be referred, and relatively to which the excellence or figure of merit might be impartially determined. Concluding, he again impressed the necessity of research, remarking that manufacturers, while endowed with the skill that was purely practical and acquired by observation in business, had frequently been lacking in the higher scientific skill which could produce the greatest effect with the least possible expenditure of material and labour.

Private Bill Procedure.—The Select Committee of the House of Commons, who commenced their sittings last June, on the question whether, in the interests of public economy, efficiency, and general convenience, it is not possible to effect reforms in the Standing Orders of Parliament relative to private Bills, have agreed upon a report recommending various alterations in the existing rules. The chief aim of the reforms proposed is to cheapen and simplify parliamentary procedure, which at the present time involves such heavy expense to promoters of private schemes. In the first place, the formality of reading the Bill a first time in the House of Commons is to be dispensed with, and another reform proposed relates to the question of costs. In their report the committee state that, after investigating the total costs incurred by bringing opposed Bills before Parliament, they think that a Joint Committee of the two Houses should be appointed with a view to a general revision of the scale of fees, and their being identical in the two Houses. A heavy item of expense is the cost of the parliamentary notices at present required by the Standing Orders, and it is proposed now to considerably reduce this item by adopting the more summary form of notices required by the Light Railway Commissioners, and in the case of a provisional order the committee believe that the public and all parties interested would be sufficiently safeguarded and at least equally well informed by a shorter form of notice. It is also thought that economy would be gained by the amalgamation into one office of the Private Bill Offices of the two Houses, and the suggestion is recommended for consideration The committee recommend that a Board of Trade report should be made on all proposals concerning the supply of electrical energy, and that it would be desirable that the General Committee on Railway and Canal Bills, as well as the chairmen considering other groups of private Bills, should from time to time confer together so as to secure uniformity of decision as far as possible, especially with regard to any new question that may arise. A further recommendation proposes that a careful and thorough examination be made in the public interest of the powers sought in unopposed Bills, as such Bills often contain large and far-reaching proposals which it may be contrary to public advantage to sanction, although it may not be to the interest of any individual to oppose them. A sore point with promoters of private Bills at the present time is that they are often subjected to unreasonable and unnecessary expense by the withdrawal at the last moment of the petitions against the Bills, when all the expenses necessary for the hearing have been incurred. On the other hand, the opposing parties are often subjected to the same inconvenience and pecuniary loss by the withdrawal without due notice of a Bill. Neither of these contingencies is provided for under the Standing Orders or the Costs Acts as they stand at present, and the committee recommend that the Standing Orders should be so amended as to cover such cases. Finally, it is recommended that facility be given to petitioners to amend their petitions, so that their objections to any proposals may have fuller and earlier consideration. We think that, generally speaking, the above recommendations will find favour with promoters of private schemes, as they should certainly tend to make the promotion of a private Bill in Parliament a less burdensome undertaking than has hitherto been the case.

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ELECTRICAL TRANSMISSION PLANT FOR THE OCEAN COAL COMPANY, TREORCHY.

The following is a brief description of an interesting transmission scheme for pumping the water from the Treorchy pit of the Ocean Coal Company. The complete plant has been manufactured by Messrs. Ernest Scott and Mountain, of Newcastle-on-Tyne, and the various parts were recently on view at their works. A large number of mining engineers from the Northumberland and Durham districts took the opportunity offered them of inspecting the dynamo, motor, and pump before the same were dispatched. The generating plant consists of a single engine and dynamo with provision for rope driving. The dynamo is used to supply a motor in the mine, which drives also by ropes a large three-throw pump. The plant now being installed is considered as only one half of what will be ultimately required, and in duplicating it exactly similar machines will be used. Coming now to the details of the plant, the engine is of the horizontal long-stroke compound type with the following dimensions: diameter of high-pressure cylinder, 16¾in.; diameter of low-pressure cylinder, 26½in.; length of stroke, 36in.; revolutions per minute (approximately), 100; steam pressure per square inch, 100lb. The engine is fitted with automatic trip expansion gear to both cylinders, and a heavy rope flywheel, 16ft. in diameter, grooved for 14 1½in. diameter ropes.

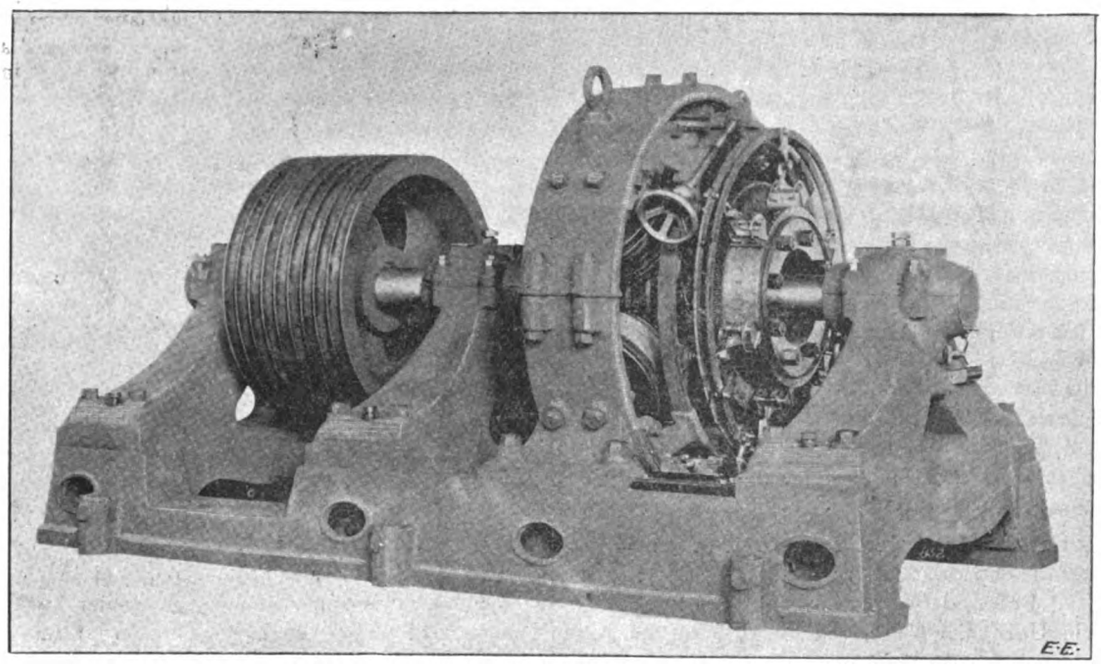

FIG. 1.—View of Ernest Scott and Mountain's 170-kw. Generator for the Ocean Coal Company.

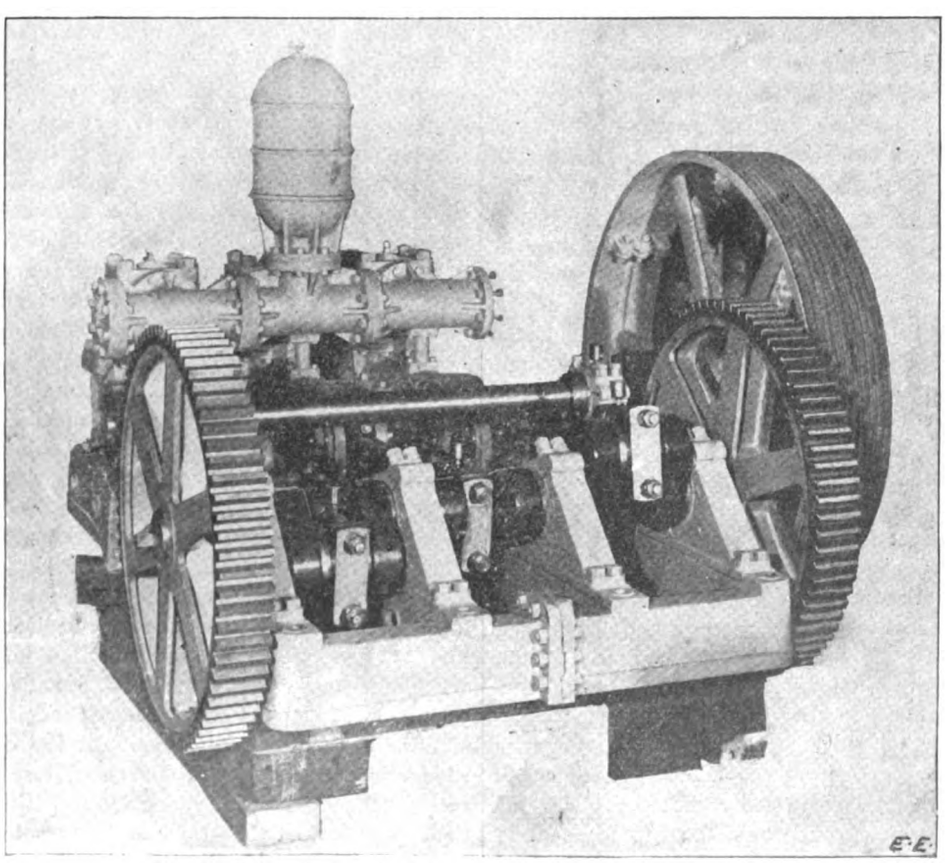

FIG. 2.—Pump to deliver 250 gallons against a 1,560ft. head.

The dynamo is of Scott and Mountain's six-pole type, as

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shown in Fig. 1, and is constructed to give an output of 170 kw. at 500 volts, with an approximate speed of 400 revolutions per minute. The dynamo has three bearings of the self-oiling and self-aligning type, carried on a girder

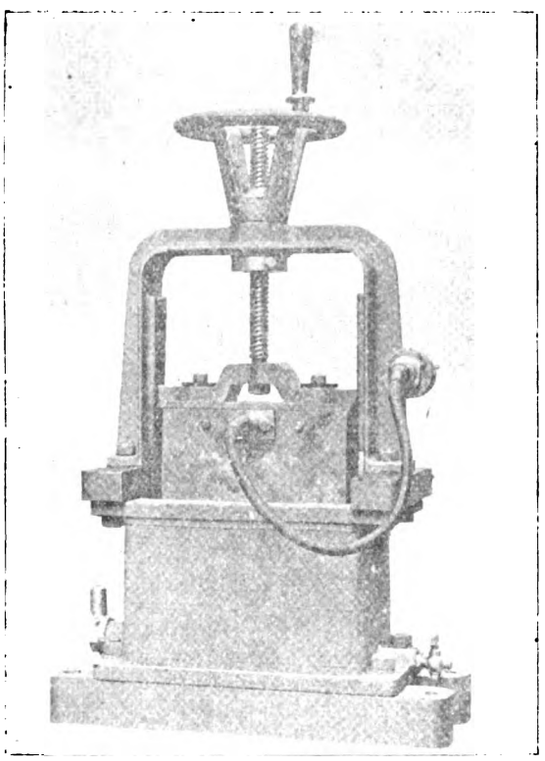

FIG. 3.—Liquid Switch.

type bedplate, the driving pulley being mounted upon an independent shaft, secured by half coupling to the dynamo spindle. The brush gear is of the reaction type, carbon block brushes being fitted in specially designed brush-holders, these being supported from a large diameter ring, supported by brackets from the magnets, as is clearly shown in Fig. 1. The dynamo is mounted upon a cast-iron sliding bedplate, with tightening screws and brackets for taking up the slack of the ropes whilst the machine is running The switchboard in the engine-room consists of a marble panel in an oak frame, and carries the usual instruments for controlling the output from the dynamo. These include overload and no-voltage automatic circuit breakers, and a recording ampere-meter to register the current output.

The distance between the dynamo and motor is 650 yards. The main cables used have cores of 37 No. 12 S.W.G. wires stranded together and insulated with vulcanised bitumen, with a double layer of galvanised iron wires, and then braided and compounded over all. These cables are arranged to carry their own weight in the shaft, and each cable has a sectional area of copper of ·322 square inch The motor used to drive the pump is an exact duplicate of the dynamo. This gives it a good margin of power, and it is somewhat large for its work. The obvious advantage of this uniformity is the interchangeability of the spare parts required. It is wound to give 170 b.h.p. at 470 revolutions with 470 volts at the terminals, so that a 30-volt drop is allowed for in the line at full load. This motor drives by ropes the main pump, which is of Scott and Mountain's three-throw ram type, as shown in Fig. 2, all the parts being specially strengthened for the exceptional head against which the pump is to work. The pump is constructed to deliver 250 gallons per minute against a total head of 1,500ft. The diameter of the pump rams is 9in., the length of stroke 18in., and the approximate revolutions per minute 21. The pump is fitted with independent and interchangeable pump barrels, suction and delivery branch pipes, and suction and delivery valve boxes. The rams are of solid gunmetal, attached to substantial cross-heads working in slipper guides on the bedplate. The pump barrels are fitted with glands and stuffing boxes bushed with gunmetal, and an independent air-vessel is mounted on the delivery side, and fitted with air relief valve. The crankshaft is of steel of the built type, running in four bearings on the bedplate, the crank webs being of cast steel, shrunk on to forged-steel centres. The power is transmitted from the motor through a double set of machine-cut spur gearing, the countershaft carrying pinions being mounted on pump bedplate and fitted with large driving pulley, grooved for 10 driving ropes, each 1¼in. diameter.

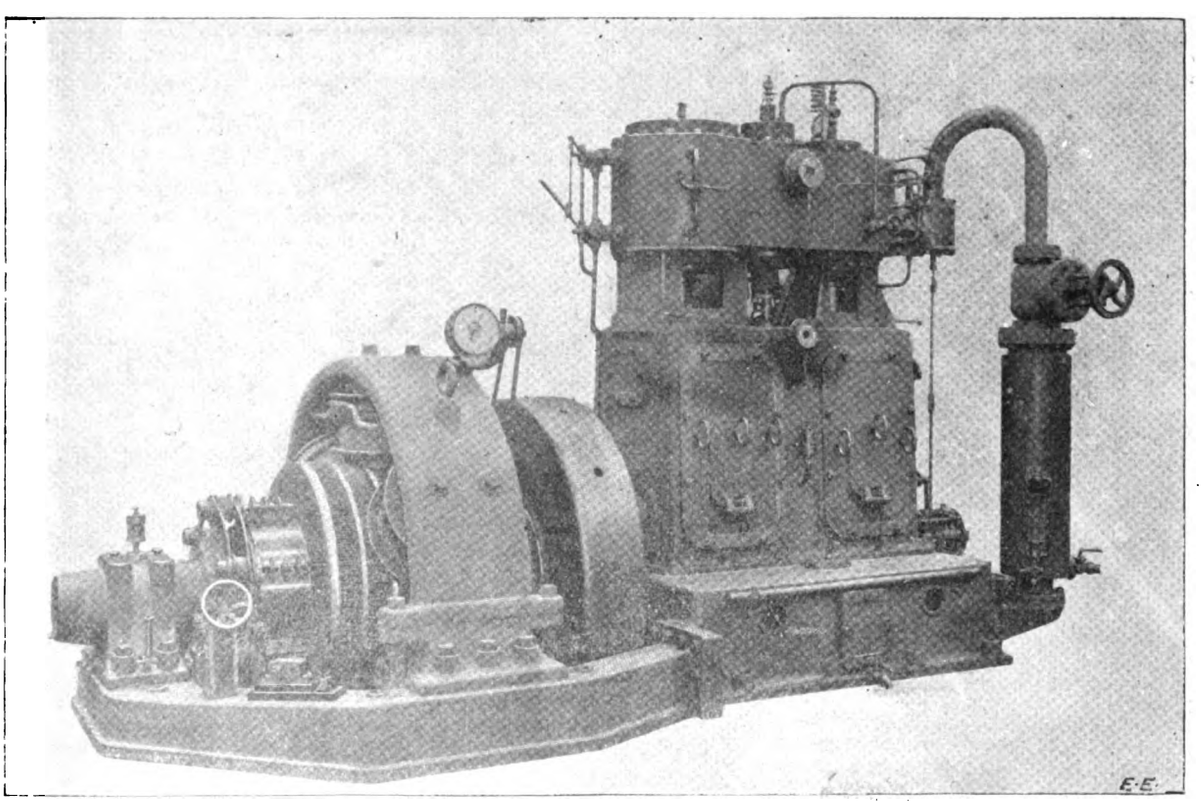

FIG. 4.—Direct-Coupled Set, both Engine and Dynamo being manufactured by Messrs. Ernest Scott and Mountain.

The switchgear in the motor-room allows of the motor being readily stopped and started. Besides the usual current and voltage meters, there is a no-voltage circuit breaker and a shunt regulating switch and resistance. The motor is started and stopped by means of one of Scott and

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Mountain's single-pole liquid type of mining switches, shown in Fig. 3. The arrangement of this switch is such that when the machine is fully at work it is short-circuited, so that the liquid is not in use for carrying current except while starting or stopping the motor.

The two remaining illustrations show respectively one of the firm's high-speed engines direct-coupled to a dynamo, and their erecting shop as it appeared a week ago. In this latter (Fig. 5) one of the dynamos such as is to be used at Treorchy is shown in the foreground. In the shop beyond will be seen one of the electrical coal-cutters made by the firm and numerous other machines in course of completion.

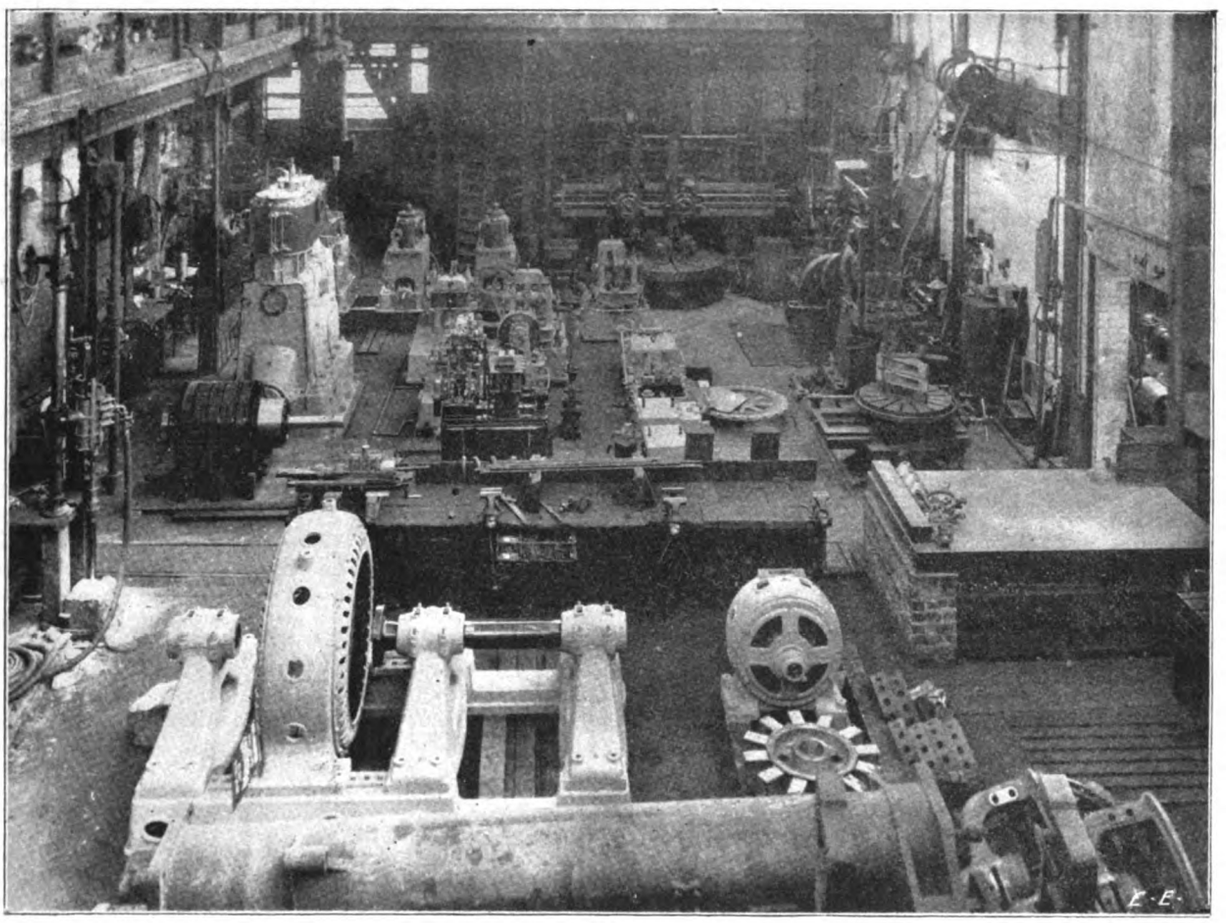

FIG. 5.—View of Erecting Shop, showing Mining Plant in progress.

ROSS ELECTRICITY WORKS.

The town of Ross is situated on a rocky eminence overlooking the River Wye, and is 12 miles distant from the city of Hereford. In early times it was a free borough, returning members to Parliament, but in the reign of Edward the First the privilege was withdrawn by desire of the inhabitants, and the management of local affairs is now in the hands of the Urban District Council. The town has been immortalised by Pope in his well-known eulogy, "The Man of Ross," the subject being John Kyrle (1637 to 1734), who was famed for

MR. JOHN PARKER, CONSULTING ENGINEER.

MR. JOHN MACKAY, J.P., CHAIRMAN.

MR. MONTGOMERY, ELECTRICAL ENGINEER.

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his benevolence and has left many mementoes, including his residence and a public walk which bears his name. The present population is about 5,000, but the increasing favour of the "Wye Valley tour" brings numerous visitors in the summer months, for, with a charming river, excellent roads, and convenient railway facilities, Ross forms an ideal centre for visiting such well-known places as Symond's Yat, Raglan, Tintern, Goodrich, or the Forest of Dean. For a town of its size Ross is well provided with public buildings and institutions, and the principal streets give ample signs of business enterprise.

EXTERIOR VIEW OF ROSS ELECTRICITY WORKS.

In 1899, the Urban District Council, recognising the necessity of improved lighting, obtained a report with plans and particulars of a scheme which was to cost £13,000, and involve an annual outlay of £1,463, against a revenue of £1,573; but at a town meeting this scheme was thrown out by a large majority of the ratepayers, chiefly on the ground of the high cost of the installation, it being considered that many years would elapse before such a revenue as £1,573 per annum could be obtained for electric light in Ross.

In the following year the late Mr. Alderman Blake, in conjunction with Mr. John Parker, A.M.I.C.E., and a few others held an informal meeting, and it was considered desirable (there being no probability of the District Council taking up the scheme) that a company should be formed for the purpose of acquiring a provisional order to carry out a more modest scheme at a cost not exceeding £8,000. A company was thereupon formed, with Mr. John Mackay, J.P., A.I.C.E., as chairman, Mr. John Parker being retained as consulting engineer.

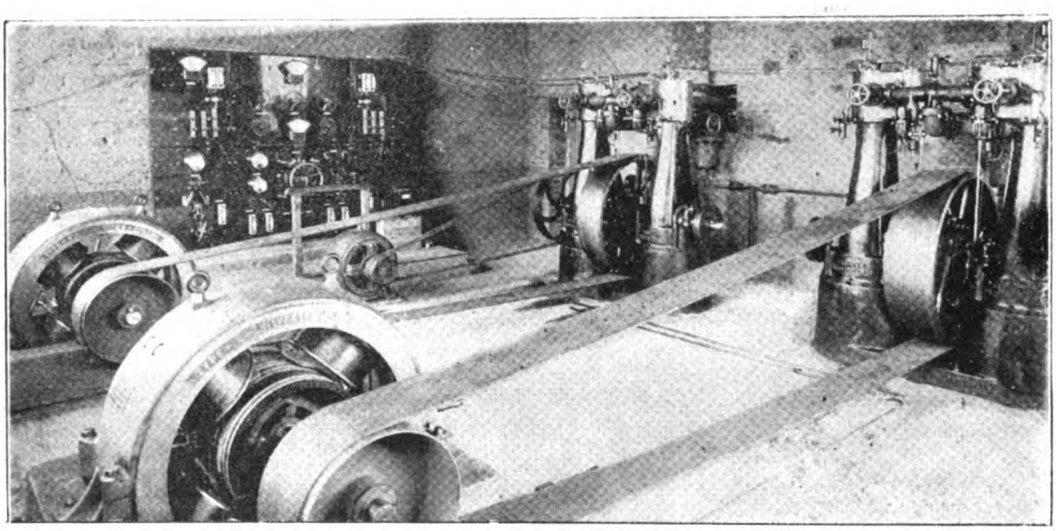
A provisional order was obtained under the Electric Lighting Acts, and the Confirmation (No. 7) Act, 1901, received the Royal assent on Aug. 9, 1901, whereupon the scheme was proceeded with.

Description of Works.

In order to ensure a reasonable dividend, the scheme is of modest dimensions, and designed on the two-wire system. It is, however, readily capable of expansion whenever and wherever the demand for extra current may arise, the estimated cost of the entire scheme when complete being only £7,500, of which £3,500 has been expended up to the present. The company were fortunate in acquiring central and extensive premises in Brookend-street, Ross, known as the Millbrook estate, upon a 99 years' lease, with the option of purchase, and upon this site they have erected buildings as follows: boiler-house, 30ft. by 32ft.; engine-room, 30ft. by 26ft.; battery-room, 36ft. by 17ft.; with convenient offices, storerooms, etc.

The boiler-house, which is situated at the back of the building, is provided with space sufficient for three boilers, one only of which is included in the present installation. This boiler was supplied and erected by Messrs. Marshall and Sons, of Gainsborough, and is of the locomotive type, having 70 tubes 1¾in. diameter and 9ft. long. The working pressure is 110lb. per square inch. The feed water is obtained from two sources—(1) from the town main river supply; (2) from a local brook, which runs into the river close by. In this latter case the water is conducted from the brook through an old existing culvert into one side of a large tank in the ground, thence through a filter and into the hot-well situated close to the boiler. From here the water from either supply is forced into the boiler either by a Worthington steam pump or a Sirius injector.

The main steam-piping is of lap-welded steel, 5in.



INTERIOR OF ENGINE HOUSE, ROSS ELECTRICITY WORKS.

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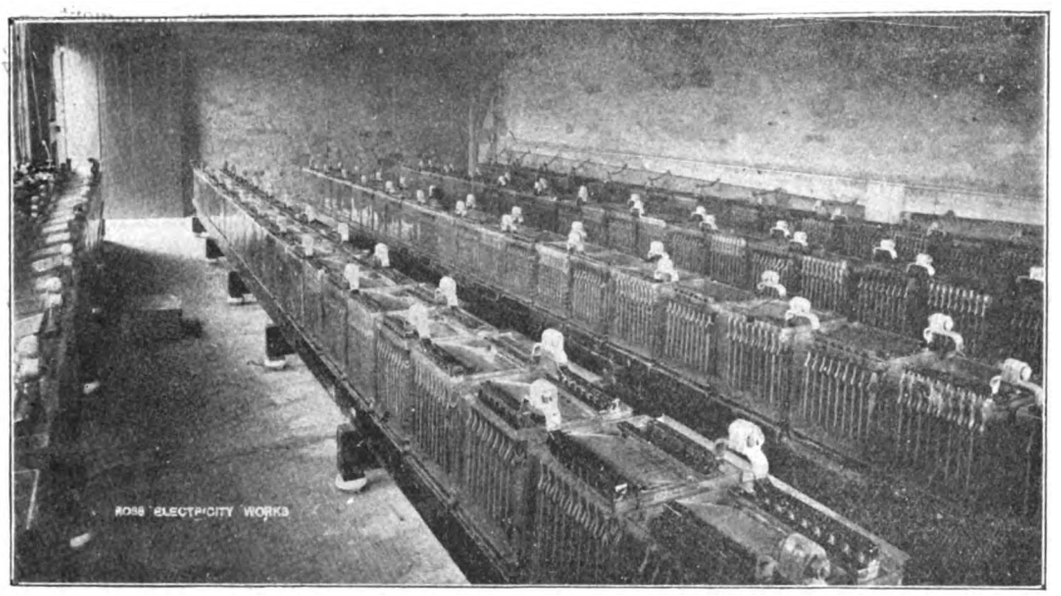
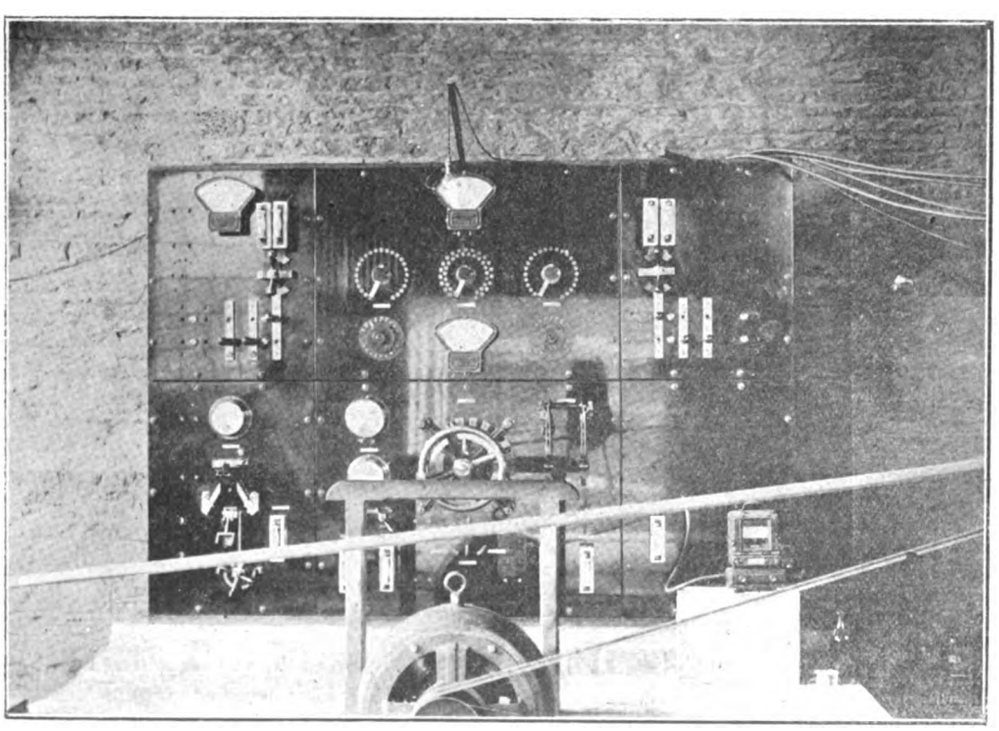
diameter, with steel screwed flanges, the subsidiary steam-piping being of wrought iron, and the last bend to the main range being of solid-drawn copper, 5in. diameter. The steam separators on the main range, two in number, are provided with a Holden and Brooke's patent steam-trap. The main exhaust is taken up through the smoke chamber of the boiler, and is utilised for obtaining forced draught. All steam, hot-feed, and exhaust pipes in the engine and boiler rooms are covered with Fergusson's patent pipe covering.



INTERIOR OF BATTERY ROOM ROSS ELECTRICITY WORKS.

The engine-room contains two belt-driven lighting sets of 40 kw. each, with booster and switchboard. The two engines were supplied by Messrs. Tangyes, Limited. They are of the firm's two-crank vertical type, with cylinders of 9in. diameter by 9in. stroke, and each is capable of developing 66 b.h.p., at 275 revolutions per minute, when working non-condensing, with a steam pressure of 100lb. at the engine stop valve. Each engine is fitted with a governor, which allows of a variation in speed not exceeding 2 per cent when the load is suddenly thrown off or on. Each engine is coupled by means of a Hendry's patent laminated belt to a Silvertown type K. four-pole shunt-wound dynamo, with slotted core armature, giving an output of 160 amperes at 230-250 volts at a speed of 600 revolutions per minute. When tested, these dynamos, after six hours' run at full load, showed no signs of sparking at the brushes, which are of carbon, and the maximum increase of temperature was found to be considerably under the specified rise of 70deg. F. Each engine and dynamo is capable of supplying current for 2,000 8-c.p. lamps at 230 volts. The booster is of the Silvertown Company's open protected F.E. type, wound to give 50 amperes at any pressure up to 110 volts when running at a speed of 900 revolutions per minute.

The switchboard, which was also supplied and manufactured by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, of Silvertown, is arranged for a two-wire supply at a pressure of 230 volts



FRONT VIEW OF SWITCHBOARD, ROSS ELECTRICITY WORKS.

between the bus bars, and consists of three enamelled slate double panels carried by a wrought-iron frame measuring 9ft. 6in. by 7ft. On the outer panels are mounted the dynamo automatic cut-outs with double-pole fuses and ammeter, omnibus bars, feeder ammeters, and duplex switch fuses. On the middle panel are mounted the battery regulating and emergency switches, shunt resistances, ammeters and voltmeters, with multi-way

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switches. Provision is made for two feeders, one only of which is included in the present installation.

The shunt circuit of each dynamo is so arranged as to be interlocked with the automatic cut out, so that the latter cannot be closed until the shunt circuit is made, and the shunt circuit cannot be opened before the main circuit is broken by the automatic cut-out.

The battery was supplied by the Hart Accumulator Company, and consists of 130 cells of their G. lighting type, and is capable of discharging 390 ampere-hours at a normal discharge rate of about 40 amperes, with an emergency discharge capacity of 160 amperes for one hour. It is fixed in one tier in a spacious accumulator room, well ventilated. Twenty-six cells on the positive end of the battery are connected to a 14-way regulating switch on the main board, so that the cells are cut in or out in pairs. The floor of the battery room is of cement, and is drained to the centre for cleaning purposes.

The main feeders, as well as the distributors, are of Silvertown manufacture, insulated with vulcanised india-rubber, and are laid on the solid system in wooden troughing filled in with bitumen.

The compulsory area of supply embraces Edde-Cross-street, High-street, Broad-street, St. Mary's-street, Copse Cross-street, Gloucester-road, and Wye-street, in which streets cables are or will be laid down It is intended at a future date to give a supply to every part of the district in which there is a sufficient demand for electric current to justify the expense of laying down the main cables. The applications for current have been fully up to expectation, and it will soon become necessary to extend the service cables, there being many applicants for current outside the compulsory area. The directors have under their consideration estimates for these extensions.

The contracts for the whole of the machinery and cables have been carried out by the India Rubber, Gutta Percha, and Telegraph Works Company, whose representative (Mr. Fourd Ely) has most successfully and expeditiously completed the work within the stipulated time to the complete satisfaction of the directors. The local contractors were: Messrs. Blake Bros, Ross, for constructional iron-work; Messrs Kemp and Sons, Ross, for buildings; and Mr Hilo Davies, of Hereford, for street work, and these have also given entire satisfaction.

LAYING MAINS IN HIGH STREET, ROSS.

Opening Ceremony.

The formal opening of the above-described works took place on Tuesday afternoon last, when, in the presence of a large gathering of shareholders, customers, and their friends, Mr. John Mackay, J.P. (chairman of directors), called upon his daughter to switch on the supply of electricity throughout the town. A vote of thanks having been accorded to Miss Mackay, Mr. W. E. Gray, on behalf of the Silvertown Company, then presented her with a memento of the occasion in the form of a curb chain bracelet, with medallion attached descriptive of the event. The ceremony was a pleasant one throughout.

Subsequently a banquet was held at the King's Head Hotel, some 50 guests enjoying the hospitality offered jointly by the chairman of the Ross Electric Light and Power Company and the Silvertown Company.

NOTES ON POLYPHASE MOTORS.

(Continued from page 773.)

Now, if the E.M.F. varies as the sine of the angle, the current in which it gives birth must also vary as a sine curve; if there be no induction, the current will be in phase with the E.M.F.—that is, will vary with and at the same instant as the E.M.F.—but if there is any induction we have seen that the result of this will be to oppose an increasing current and to tend to maintain a dying current. The effect of this will be that, as shown in Fig. 2, the current will lag behind the E.M.F.; this is shown in the clock diagram, where Q, which represents the instantaneous value of the current, is shown lagging behind P, the instantaneous value of the E.M.F., attaining its maximum and minimum values later than does the E.M.F. The

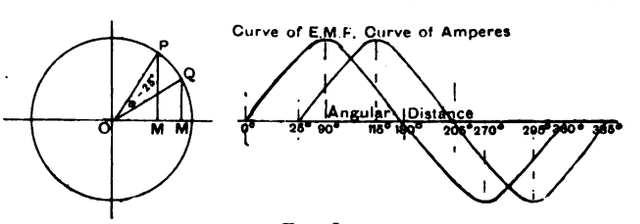

FIG. 2.

angle P O Q between the two lines joining P and Q to the centre is called the angle of lag, and is the angular distance by which the current lags behind the E.M.F.; this angle is usually represented by ϕ. As we have seen, the strength of the magnetic field due to induction depends solely on the value of the current, but the amount by which this induction affects the circuit depends upon the arrangement

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of the circuit. The induction gives rise to a counter E.M.F., and the more portions of a circuit which are cut by the induced field, the higher will be the value of the counter E.M.F. If, then, the circuit is arranged in coils so that the same lines of force cut more than one length of the conductor, the counter E.M.F. will be higher than it would were the circuit arranged so that only one portion of a conductor is cut by the same lines. In each circuit there is a constant quantity which determines the induction effects—this quality is called the inductance, and is generally represented by L; the unit of inductance is called the henry. The henry is defined as the inductance of a circuit in which the making or breaking of a current of one ampere will create a counter E.M.F. of one volt; in other words, since from our general formula we know that one volt is generated when 10^8 lines of force are cut per second, if a circuit has an inductance of one henry the passage of one ampere through it must create a magnetic field which is equivalent to the interlinking of 10^8 magnetic lines with the circuit.

From direct-current work we know that if a current passes through a wire wound in a spiral that the magneto-motive force due to this spiral will be

$$H = \frac{4\pi}{10} S i \div l,$$

where H is the intensity of the magnetic field, S the number of spirals, l the mean circumference of the ring in centimetres, and i the value of the current in amperes. We further know that if in place of encircling a non-magnetic medium, such as air, an iron core is inserted, the number of lines of force will be greatly increased and will be represented per unit area by B, which is called the induction, and which is equal to μ H, where μ is the coefficient of permeability. The value of μ we also are aware depends not only on the material, but also on the degree of saturation. The same rules apply to alternating currents, so that the value of the inductance of a circuit will not only depend upon whether the circuit is wound in a coil, but also upon whether the coil encloses a magnetic core, and, if so, on the degree of saturation of that core If a circuit wound in a single spiral has an inductance of one henry, it will create a magnetic field of 10^8 lines of force which will cut the coil when created and when dying away. If now the circuit is wound in two spirals, each spiral will give rise to 10^8 lines of force, and these lines will cut each spiral, so that each coil will be cut by 2×10^8 lines of force, and will consequently have generated in it two volts of counter E.M.F., but as the two coils are in series these E.M.F.'s will be added, and the total E.M.F generated will be four. We may then state that the self-induction of a circuit is proportional to the square of the number of times it is wound on itself.

It is evident that in an alternating circuit not only has the E.M.F. in driving the current through the circuit to overcome the ohmic resistance of the circuit, but it has also to overcome the counter E.M.F. due to self-induction. The total E.M.F. is called the impressed E.M.F., and it may be resolved into two components at right angles to each other; one component is that which is required to overcome the ohmic resistance, and the other is that which is required to balance the back E.M.F. due to induction of the circuit. It is quite correct to assume that these two components will be at right angles to each other. If there were no self-induction, the current would be in phase with the E.M.F.—that is, the E.M.F. which is required to overcome the ohmic resistance of the circuit attains its maximum and minimum values at the same time as the current; the E.M.F., however, which is required to counter-balance the back E.M.F. due to the induction of the circuit is 90deg. in front of the current, and is then said to be "in quadrature" with the current. That this is the case is at once apparent when we remember that the induction effects are the greatest at the moments when the value of the lines of force due to the current in the circuit is changing most rapidly. This must be at the instants when the current changes its direction of flow; this is when the current, together with the E.M.F. in phase with it, is at its minimum value, or 90deg. after attaining its maximum value. The component of the E.M.F. in quadrature gives rise to a wattless current. This does no work, but adds greatly to the heating of the circuit. If we trace out the sinusoidal curve, A B C, required to overcome the ohmic resistance of the circuit, in order to obtain the curve of the impressed E.M F. it will be necessary to draw to the same scale the curve of the back E.M.F. Since we have assumed that the current follows a sine law, the back E.M.F. will also follow a sine law, as it is dependent on the changes of value of the current (Fig. 3). The instantaneous value of the back E.M.F. will be $2\pi n$ L C; where n is the number of complete cycles per second, C the virtual value of the current in amperes, and L the inductance of the circuit in henries. If the values of this equation be found for various values of C, and corresponding points marked on the diagram, then by drawing a sine curve through these points we obtain the curve, D E F, of the back E.M.F., and adding the ordinates of the two curves we get a third curve, G H J, of the impressed volts.

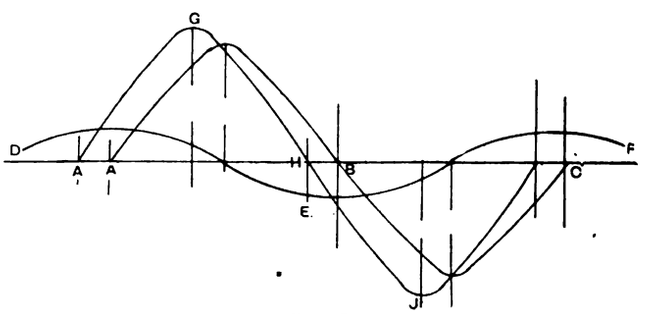

FIG. 3.

We have used the term "virtual." By this is meant the effective as against the true amperes. If a voltmeter or amperemeter which has been calibrated with a direct current is placed in an alternating circuit, it will not read the limits to which the volts or amperes attain, but it will read to a number less than these limits. The values which will be obtained are the maximum values divided by the square root of 2. These latter values are called the virtual values, because not only are they the values which the instruments indicate, but because they are also the values of the direct current which would have to be supplied to give the same results. For instance, if the E.M.F. of a circuit fluctuates between + 100 and – 100, a voltmeter in circuit will indicate $100 \times \sqrt{2}$ only, and to do the work in the circuit with a direct current this latter current would have to be at a tension of $100 \times \sqrt{2} = 70{\cdot}7$ volts. The same remarks apply equally to the amperes. The reason why the instruments give results which are equal to the maximum values divided by the square root of 2 is apparent when we remember that the volts and amperes vary as the sine curve, and that the mean of the sines taken over any quadrant is $\frac{1}{2}$. The limits between which the E.M.F. or current really fluctuates are called the maximum volts or amperes, while the values given by the instruments are called the virtual or effective volts or amperes.

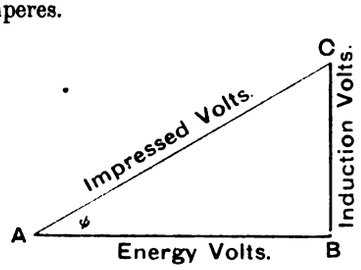

FIG. 4.

It has been stated that we may resolve the E.M.F. and the current in each instance into two components at right angles to each other. This is perfectly correct for the purpose of investigation, but it must be remembered that there are not two E.M.F.'s or two currents, and that the current as a whole will lag behind the impressed volts if there be any inductance in the circuit. The amount by which the current lags behind is called the angle of lag, and is represented by ϕ. The simplest method of considering the impressed E.M.F. and the components into which we may theoretically resolve it, is by representing these various values in the form of a triangle, as in Fig. 4

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Here the hypotenuse of the triangle represents in length and direction the impressed volts. The E.M.F. which would drive the same current through the circuit without induction is necessarily in phase with the current, and lags behind the impressed volts by the angle ϕ. At right angles to this is the E M.F. required to overcome the counter E.M.F. due to the induction of the circuit. Let A B represent the E.M.F. in phase with the current, both in direction and value, and B C represent the E M.F. in phase with the wattless current both in direction and value, then A C will represent the impressed E.M.F. in both direction and value.

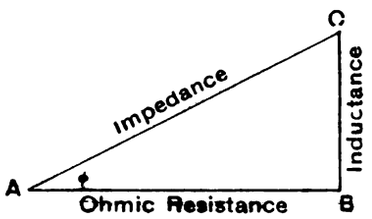

FIG. 5.

In dealing with an alternating current we are not able to use the formula $C = E \div R$ in its simplest form, as besides the ohmic resistance to the flow of the current, the resistance caused by the induction has to be taken into consideration. The name "impedance" has been given to the total opposition in any circuit to the flow of a current. This is with respect to resistance analogous to impressed volts in the case of the tension, and can conveniently be resolved into two components in the same manner. The method of doing this is shown in Fig. 5. Let the line A B represent to any scale the value of the ohmic resistance, R, at right angles to this line draw to the same scale the line B C to represent the effect of the induction expressed in

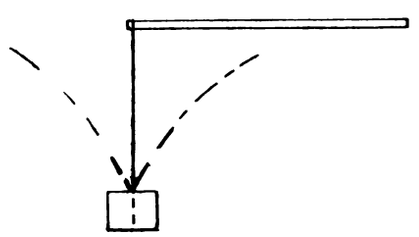

FIG. 6.

ohms (the name reactance has been given to this expression). It is evident that these two lines must be at right angles to each other, since we are only doing what we have done before—viz., resolving the system into its energy portion and its ineffective portion—which we have seen are at right angles to each other. If, now, we join A C, this line will represent to the same scale the total opposition to the flow of current, which we call the impedance. The angle ϕ, formed by the two lines A B and B C, is the angle of lag, and we see at once that the tangent of this angle is A C $\div$ A B, or tan ϕ = reactance divided by resistance. Expressed in symbols, this becomes

$$\tan \phi = 2 n \pi L C \div R C = 2 \pi n L \div R.$$

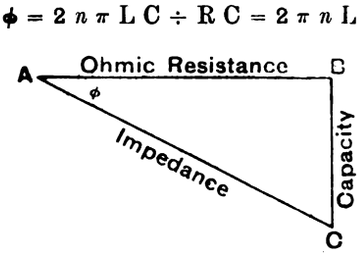

FIG. 7.

Besides, however, possessing inductance a circuit may also possess capacity. The effect of capacity is exactly the opposite to that of inductance, and is to cause the current to lead in phase. If a condenser is connected in series with an alternating circuit the condenser becomes charged, and there is set up an opposing E.M.F. Prof. Silvanus Thompson has compared the action of a condenser to the bending of a spring. If a rod were attached to a piece of spring metal, as shown in Fig. 6, and the spring were moved by the rod between the limits a and b, it is easy to see that the recoil of the spring when it began its return movements from the limiting positions would do work on the rod which would tend to move the rod faster; in other words, cause it to lead in front of the force which was the original cause of the motion. The shorter the spring the more force it would exercise on the rod; similarly, the smaller the capacity of the condenser the more the current will lead in phase.

The capacity is measured in farads, and is usually represented by K. The reactance due to capacity is inversely proportional to the capacity, K, and as it causes the current to lead in phase it is negative, and consequently may be written as $-\frac{1}{2 \pi n K}$, for similarly to the inductance it depends upon the number of cycles per second. The total impedance of a circuit possessing capacity may be shown, as in Fig. 7, by means of a triangular diagram. To draw this we proceed in the same manner by setting out A B to represent to any scale the value of the ohmic resistance, and then drawing B C at right angles to represent to the same scale the reactance due to the capacity, but as this is negative it must be drawn below, and not above the line, A B. Upon joining A C, this line represents to scale the total impedance. As before, we see if ϕ is the angle, B A C, then the tangent of the angle of lag (or lead) is equal to the capacity effect divided by the ohmic resistance, or in symbols,

$$\tan \phi = -\frac{1}{2 \pi n K R}.$$

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

539. The governor of a 12-h.p. water turbine (fall 20ft.) driving a 10-kw. compound dynamo (220 volts), is not sufficiently sensitive to maintain a constant speed and resultant steady voltage when load on dynamo is of a fluctuating nature. Would it be possible to secure a fairly constant E.M.F. by means of a solenoid connected across the mains, with its armature actuating a liquid resistance in series with the shunt winding of the dynamo? Supply sketch with dimensions and particulars of this, or alternative suitable arrangement.—R. V. M.

540. What is the most dangerous impurities to be guarded against in water for battery work—*i.e.*, iron, lime, etc. Describe the effect of these impurities upon the battery.—H. H. R.

ANSWERS.

Question No. 533.—Is there an installation working at the present time in the British Isles where wind power is utilised for generating electric energy? If so, describe working details.

Best Answer to No. 533 (*awarded* 10*s.*).—This question revives a subject which was in a quiet way very considerably discussed some years ago, and was the origin of experiments in this and other countries to determine the type of windmill best adapted for taking advantage of the vary variable winds, and of utilising the force of even the most violent hurricane efficiently. Obviously the problem is a difficult one, and until the advent of a commercial accumulator the adaptation of the windmill for electric lighting purposes was quite out of the question. Lord Kelvin appears to have first suggested the utility of the windmill in conjunction with accumulators for the generation of electricity for lighting purposes at the York meet-

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ing of the British Association; but, in this country at any rate, Prof. Blythe, of the Glasgow and West of Scotland Technical College, Glasgow, seems to have been the first to attempt a solution of the problem in a really practical manner. In 1887 Prof. Blythe erected an old English type of windmill at Marykirk, in the North of Scotland, to drive a small dynamo charging a few accumulators, but found this type unsuitable, as it could not be worked in anything beyond a moderate breeze. This windmill was therefore replaced by one of the American type with a smaller wind-wheel—having numerous cast-iron blades—but even so there were difficulties and deficiencies, so that it was decided that the proper type would be found in some departure from the old ideas. Eventually the wheel of the Robinson anemometer was taken as most likely to fulfil the conditions, and accordingly in 1891 Prof. Blythe had a wheel, modelled on the lines of this wheel with its cups, erected and tested. The particulars as given by himself are as follows: "The cups are replaced by semi-cylindrical boxes attached to four strong horizontal arms, each about 26ft. long. The opening of each box is 10ft. by 6ft., and the vertical shaft is a long rod of iron 5in. in diameter. At the lower end it carries a massive pit wheel, which actuates a train of gearing, and drives a flywheel 6ft. in diameter with the requisite speed for driving a dynamo connected to it by a belt in the ordinary way. This machine works most satisfactorily, and with a fair wind speed will give about 4 e.h.p."

Tests of the machine on no load in a strong gale gave perfectly satisfactory results, as a certain definite terminal speed was attained and all racing avoided. From these results it would seem that the best form of wind-wheel is one whose design follows somewhat on the lines of the Pelton water-wheel, fixed horizontally on a vertical shaft. The rate of travel of the boxes or cups will attain a certain definite and constant terminal speed for each speed of wind, which is about one-third that of the velocity of the wind. Such a machine fulfils at least three important conditions—viz.: it is always ready to work without any adjustment of its sails; it will work for long periods without attention; and it will work during, and take full advantage of, the strongest gale.

There remains, then, only the electrical arrangements to be considered, and these are simple. Prof. Blythe used 12 small E.P.S. accumulators, which were charged from a small dynamo. To disconnect the generator from the cells when the voltage fell below the charging point he used a centrifugal governor attached to the shaft of the generator, which made circuit at the correct voltage by means of contacts dipping into a mercury bath. He also used such a governor, which cut out one or more cells from the circuit as the voltage fell, and thus enabled the windmill to be always doing work so long as it was revolving; but this latter arrangement would not be beneficial for the cells. With this plant it was found that one good breezy day gave a charge to the cells sufficient to light 10 8-c.p. lamps for 12-16 hours—that is, an output of about 4·2 kw. to 5·6 kw. Thus it is seen that the capital expenditure per kilowatt output is likely to be very great, and results tend to show that the cost of maintenance is greater than for a steam or oil plant of equal size. The records are not very easily analysed, but they seem to vary from about 1½d. to 3s. per kilowatt output. Most of the wind-power schemes hitherto attempted have been abandoned owing to the intermittent nature of the source of power and the occurrence of long periods of calm weather.—ALPHA.

Answer to No. 533 (*awarded* 5*s.*).—Several attempts have been made to utilise wind power for charging accumulators and obtaining an electric light, but apparently without any great success. General experience is that a windmill works only about one-third of its time, and that with no regularity. The force of the wind is very variable at the best, and, of course, sudden gusts and lulls have to be considered. Years ago almost every landscape had its windmill to grind its corn, but now they have nearly all vanished to give place to modern steam, gas, and oil engines. This is doubtless owing in a large degree to the requirements of the corn trade and to agricultural problems, for windmills, like many other things, have kept pace with the times, and now instead of the four great ponderous arms of Quixotic notoriety we see a neat-looking disc with its inclined vanes counterpoised by weights against the force of the wind, so that the vanes open and shut with variations of wind force and so keep a fairly constant speed. Some of these discs are 30ft. in diameter, and it is said that with accumulators capable of "storing" enough energy for three days' supply they will give very good results up to 2½ h.p. or thereabouts. These windmills turn with the least breeze, and one was put on board the "Discovery" when it started on its celebrated antarctic voyage.

Disc windmills are made by Messrs. Alfred Williams and Co., 814, Old Ford-road, London, E., to whom "H. H. R." would do well to apply for particulars, as they have a good deal of experience in this line, and have introduced some special switches, regulators, etc., to meet the requirements of the case, such as varying speed from gusts, lulls, etc.; and it would be far better to avail oneself of their experience in such an exacting affair as charging accumulators by the fitful wind than to attempt to put up any rough apparatus. In fact, it would probably make all the difference between success and failure, as charging accumulators requires a fairly constant E.M.F. from the dynamo; and also they must be properly filled, or they will soon deteriorate, and then, of course, they would be very expensive. Often a breeze may be found on a hill or at the top of a tower while a calm exists at the bottom. I have looked through most of the "Central-Station Directory," but can find no mention of a wind-driven plant. I have also looked in "Whitaker's Almanac" at the Greenwich wind record for last year, and find that although in January the record for two days was no force of wind at all, yet, taking all the year through, we do not find three consecutive days with a dead calm. The maximum force in pounds per square foot for each month was: January, 34lb.; February, 12lb.; March, 27lb.; April, 20lb.; May, 5·8lb.; June, 12·5lb.; July, 4·8lb.: August, 11·5lb.; September, 14·2lb.; October, 26lb.; November 10lb.; and December, 27lb. Only on six days of the whole year was it recorded as nil. I have heard that more is done abroad than here with regard to driving dynamos by wind power, but disc windmills are used in many places in England for pumping quite successfully, but it is found that if more than 2½ h.p. or 3 h.p. is required, then oil or gas engines are more economical.—F. G. A.

Answer to No. 533 (*awarded* 5*s.*).—I have often wondered why wind power was not much utilised for generating electricity, but when the question is gone into thoroughly, it is easy to see why it does not find much favour. Let us first consider the case where it is proposed to use an existing windmill. The main shaft revolves much too slowly for driving the dynamo directly from it, and it will be necessary to have a countershaft. This countershaft must, of necessity, be fixed almost vertically below the main shaft because of the shape of the mill. Now, a vertical drive is a very bad mechanical device. If the belt or ropes are too tight, then hot bearings result, and if they are too slack, then the slackness just comes at the undesirable place—*i.e.*, the bottom of the driven pulley. The drive on the dynamo would also most probably be vertical, and be open to the same objections. Suppose that the main shaft drove a vertical shaft by means of bevel wheels, and this vertical shaft drove a horizontal countershaft at the base of the mill, from which the dynamo was driven. Two pairs of bevel wheels are used, and a long vertical shaft, both being things to be avoided, if possible, as very inefficient.

Now as to regulation of speed. The arms of a windmill are supplied with numbers of cross vanes. When the wind is very violent these vanes are all turned almost at right angles, thus allowing the wind to blow through the arms without having much turning effect. If the wind is very light, these vanes oppose the wind passage through the arm and make it glance off, thus getting as much power from the wind as possible. It is thus seen that the speed of the main shaft can be kept fairly constant under wide ranges of wind power. As a good wind is a very uncertain quantity, a battery must, of necessity, be installed, and the battery must be of sufficient size to take the maximum lighting load for some time. In ordinary installations one relies on the dynamos to take the heavy loads and the batteries to take the light loads, so as to avoid running a

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big machine for a few lights that may be wanted. In a wind-power installation, however, a heavy lighting load is very likely to come on just when there is no wind—for example, during a fog. Windmills are not very common in England, and it is thus unlikely that an old windmill could be utilised. In order to utilise the wind, it would be necessary to build a new windmill. Of course, it could be built specially adapted for driving the dynamo, but the first cost would be very high, far more than an oil-engine and engine-house, and far less reliable.

Below I give particulars of a wind-power installation near Vienna, installed by Wuste and Rupprecht, of Vienna, for private electric lighting. Owing to the unreliability of the driving power two large batteries were installed, and they are charged in parallel, being automatically switched out when the voltage per cell reaches 2·5 volts. When the dynamo speed falls, causing its voltage to drop too low for charging, it is cut out of circuit automatically. At night one of the batteries is connected in parallel with the dynamo to the lamp circuit to regulate the voltage, the other battery being so connected that it will be charging if there is any surplus power. The following night the functions of the two batteries are reversed. When the wind falls, the two batteries are placed in parallel across the lighting mains. There are no regulating cells used, small resistances being inserted in battery circuit as required. This last arrangement is inefficient, and the two batteries working in parallel is a bad arrangement. In fact, the utilisation of wind power cannot be recommended.—W. A. T.

Question No. 534.—Define the meaning of the terms "inductance" and "reactance," and explain clearly the application of these terms in determining the sparking limit of a continuous-current dynamo. Give a fully-worked-out example.

Answer to No. 534 (*awarded* 10s.).—*Definition of Inductance.*—Inductance is the name given to the magnetic flux which surrounds any conductor which is carrying current. Inductance is usually expressed as so many henrys.

$$\text{Inductance or} \left\{ \begin{matrix} \text{Number of lines} \\ \text{looping conductor.} \end{matrix} \right\} \times 10^{-8} = \text{henrys};$$

therefore a leakage of 10^{-1} C.G.S. lines corresponds to an inductance of 10^{-9} henrys.

$$10^{-1} \times 10^{-8} = 10^{-9} \text{ henrys.}$$

Reactance.— $\text{Reactance} = 2\pi . \sim . \text{L};$

$$\text{Reactance volts} = 2\pi . \sim . \text{L} . \text{C};$$

where $\sim$ = periods per second;
L = coefficient of self-induction;
C = current in amperes.

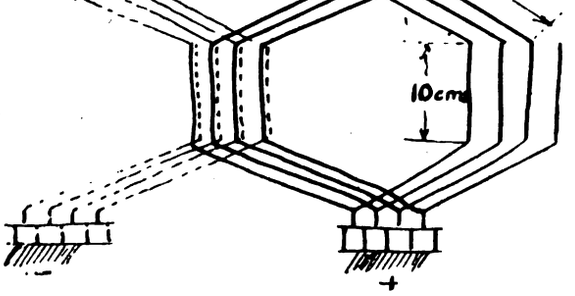
It is not proposed here to give the proofs for the above formulæ.

Reactance is an arbitrary term which has been given to the product of the above quantities in an alternating-current circuit in which the ohmic resistance of the circuit is negligible. The term reactance corresponds or is analogous to a resistance, and behaves in an alternating-current circuit in a similar manner to resistance in a continuous-current circuit.

Reactance volts for a similar reason expresses the product of reactance and current as following out the analogy to Ohm's law. These terms have been freely used by Parshall and Hobart in their work on electric generators, and are very useful terms to have for use in the above connection.

Influence of Reactance Volts and Inductance with Reference to Commutation in Continuous-Current Generators.—In order to produce sparkless commutation in continuous-current generators, the reactance volts of each armature section when undergoing commutation has to be overcome by an opposing E.M.F. or reversing voltage, such as to produce a reversal of the current in the section to an equal ampere value, but in an opposite direction. When this condition is arrived at there is no difference in potential between the commutator segments as they leave the tips of the brushes, and consequently we get sparkless running. The reversal of current in a section being commutated is produced partly by the reversing effect of the magnetic fringe under the leading polar tips, and partly by the varying current density in the contact of the carbon brushes, which produces a difference in potential between the leading and trailing tips of the carbon brushes. The difference of potential varies automatically with the value of the current in the short-circuited armature section, the difference of potential increasing with the increased values of the armature current. The above effect is clearly explained in this week's issue of the *Electrical Engineer*, Nov. 14, 1902, in a paper by Alexander Rothert. In modern generators the position of the brushes is fixed with a forward lead at light load, so that commutation is sparklessly effected, but that the short-circuited section develops its normal full-load current in the reverse direction on becoming short-circuited, this being due to the section being in too strong a reversing magnetic field—*i.e.*, the generator being on light load the field strength under the leading horns is at its strongest—the current in the short-circuited section is reduced to the light load current by the action of the carbon brushes in the manner referred to above. As the load increases on the generators, the field strength under the leading tip gets weaker, and, as will be readily understood, the reversal of current in the armature section is produced by the combined action of the reversing field and the action of the brushes. Accepting the above principle of working, it has been found by practical experience and experiment that for average conditions of working, if the reactance voltage per commutator section does not exceed three volts, satisfactory commutation is obtained.

We will now take an actual example and calculate the reactance volts; it will be noted that these calculations are based on experimental data, as such a calculation from first principles would be too complex to be of any practical value. Consider a case where three armature sections of one turn per section are short-circuited under the positive brush and three under the negative brush. The length of one armature turn = 100cm.; the effective length of armature laminations = 10cm.; length of end connections per



armature turn = 80cm.; let current in armature conductors = 100 amperes. Now, then, working from the following figures, which were given by Mr. Hobart in a paper read before the International Congress, Glasgow, in 1902:

1. Inductance per 1cm. length of armature conductor embedded in an armature slot = 4 C.G.S. lines for *one* ampere flowing.

2. Inductance per 1cm. length of armature conductor unembedded (*i.e.*, end connections) = 0·8 C.G.S. lines per one ampere flowing.

Therefore, from these figures, and referring to our example: inductance per ampere turn for the end connections = 80 × 0·8 = 64 C.G.S. lines; ditto for embedded conductor = 20 × 4 = 80 C.G.S. lines.

Now, since each embedded conductor is subject to the *mutual induction of all the conductors* being commutated both under the *positive brush* and also the *negative brush*; and also that the end connections of *one turn* are also subject to the *mutual induction* of the other, the *two turns* being commuted at the *same time* and under the *same brush*, we may write:

Inductance per one ampere flowing for the embedded portion of one armature turn (two armature conductors) = 6 × 80 = 480 C.G.S. lines.

Similarly, the inductance per one ampere flowing for the end connections of one armature turn = 3 × 64 = 192.

∴ Inductance for one armature section of one turn for one ampere flowing = 480 + 192 = 672 C.G.S. lines.

Therefore the self-induction of one armature section in henrys = 672×10^{-8} henrys.

The periodicity of commutation = $\frac{2}{T}$, where T = the time

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in seconds that a given armature section is short-circuited under the brushes.

If the periodicity of commutation = 500, then from the formula given above the reactance per turn = 2, π, 500, 672×10^{-8}; reactance = ·0212.

Now, as the current in the armature conductors = 100 amperes, then the reactance volts per turn = ·0212 × 100 = 2·12 volts, this value being a good working amount.

The above will now enable the questioner to work out any specific case.—H. P.

Answer to No. 534 (*awarded* 10*s.*).—The inductance of a circuit may be defined as the total flux set up in the circuit when unit current flows in it. When the circuit contains more than one turn, the inductance is the sum of the fluxes through the different turns. The practical unit of inductance is the henry, which is equal to 10^8 C.G.S. lines per ampere flowing in the circuit. The inductance of a circuit in henrys is

$$L = \left\{\begin{array}{l}\text{Change in the average number}\\ \text{of C.G.S. lines looped with}\\ \text{each turn of the circuit}\\ \text{when the current through}\\ \text{the circuit changes by one}\\ \text{ampere}\end{array}\right\} \times \left\{\begin{array}{l}\text{Number}\\ \text{of turns}\\ \text{in the}\\ \text{circuit}\end{array}\right\} \div 10^8$$

The name *reactance* is given to the value obtained by multiplying the inductance by 2 π times the periodicity of the current in the circuit, or

Reactance = 2 π n L, where n = the periodicity.

When a fluctuating or alternating current is sent round a circuit having inductance, the changes in the flux looped with the circuit cause a voltage to be induced in the winding, which is always (in accordance with Lenz's law) in such a direction as to oppose the change in current. This voltage is called the *reactance voltage*. Its value at any instant depends on two quantities—the inductance of the circuit, and the rate of change of the current at that instant—and is always equal to $L \frac{di}{dt}$, where L is the inductance of the circuit, and $\frac{di}{dt}$ is the rate of change of current. When the current changes according to a sine law, the corresponding reactance voltage is also a sine curve, and its effective or root mean square value is

$$2 \pi n C L \text{ volts};$$

where C = the effective or $\sqrt{\text{M. S.}}$ value of the current in amperes.

When the change of flux through a circuit is entirely due to changes of current in that circuit, the inductance is called the self-induction of the circuit. When part of the flux from which L is calculated is due to changes in current in neighbouring circuits, the reactance voltage in the circuit is said to be partly due to self-induction and partly to mutual induction between the different circuits. The actual reactance voltage induced in the circuit is, however, the same so long as L represents the actual change of flux through the circuit, from whatever cause produced, per ampere change of current in the circuit

The great importance of the reactance voltage of the armature coils in the design of continuous-current machines was first pointed out in a practical way by Messrs. Parshall and Hobart, and general experience during the last few years has confirmed the fact that machines of otherwise good design having a low reactance voltage work well as regards sparking, whilst those having a high reactance voltage almost invariably give trouble at the brushes. When a section of a continuous-current armature becomes short-circuited by the brush, the current through it commences to fall, and in falling sets up a reactance voltage, tending to maintain the current constant. In spite of the reactance voltage, however, the current continues to fall until it becomes zero, and it has then to be increased in the opposite direction, still in opposition to the reactance voltage, so that when the section finally passes from under the brush the current shall have reached full value in the opposite direction, and be thus fitted to take its place without sparking in the circuit on the other side of the brush. This stoppage, and subsequent reversal, of the current in the section is produced partly by shifting the brushes from the neutral position until a sufficient reversing voltage is induced in the section by the main field of the machine, and partly by the effect of the increasing current resistance between brush and segment as the latter leaves the brush. In the case of reversing motors or other machines intended to work at all loads with brushes fixed in the neutral position, the latter cause alone must be relied on, and in such cases the reactance voltage must be kept lower than in machines working with brush lead.

Many methods of calculating the reactance voltage of armatures have been suggested. None of them profess to give the actual value of the voltage, but they give a figure more or less proportional to the true reactance voltage, and which can, therefore, be employed for comparing the sparking properties of different armatures. One of the simplest methods is that given by Mr. Hobart in his Glasgow Congress paper last year. He has found by experiment that in the case of slotted drum armatures of the ordinary "barrel" type having slots of usual proportions—depth ÷ width, about 3 or 4—every centimetre of winding actually embedded in the slot becomes surrounded by a field of about four C.G.S. lines for every ampere flowing in the section, whilst the ends of the windings not being in slots have a field of about ·8 C.G.S. lines per centimetre per ampere. Reduced to inches instead of centimetres, these values become 10 and 2 respectively in round figures. When the brush covers more than one commutator plate, commutation takes place in two or more sections under each brush at the same time. This has the effect of multiplying the number of lines per ampere per centimetre of "embedded" length by the number of sections simultaneously short-circuited under two neighbouring sets of brushes. The parts of the section which are not embedded in slots have their field only multiplied by the number of sections simultaneously short-circuited under *one* brush, as the end connections of sections under neighbouring brushes do not lie close together (see Fig. 1). The total number

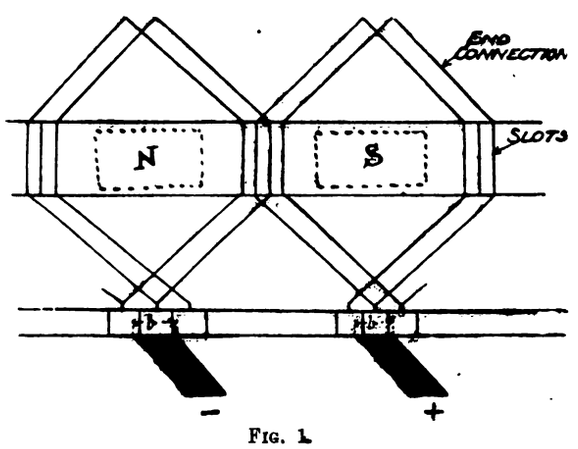

FIG. 1.

of magnetic lines looped with each turn of the section per ampere is therefore

$$= T (x \times 10 \times s \times 2 + y \times 2 \times s)$$
$$= 20 T s (x \times \cdot 1\ y),$$

where T = number of turns in one section;

s = maximum number of sections simultaneously short-circuited under one brush;

x = twice the length of armature core iron parallel to shaft, in inches;

y = length of one turn of armature winding less x, in inches.

This expression multiplied by T and divided by 10^8 is the figure corresponding to L in the formula for reactance voltage (= 2 π n L C) given above, or

$$L = 20 T^2 (x + \cdot 1\ y) \div 10^8.$$

The periodicity of commutation, n, is obtained by assuming that the time taken for a point on the commutator to pass under the brush is the time occupied by half a period, the current being charged from a positive maximum to a negative maximum whilst the short-circuit under the brush lasts.

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$$\therefore n = \frac{\pi R D}{120\, b} = \frac{\cdot 026\, R D}{b},$$

where R = number of revolutions of armature per minute;
D = diameter of commutator, in inches;
b = width of brush, in inches (see Fig. 1).

The reactance voltage is, therefore,

$$= C \times 2\pi \times \frac{\cdot 026\, R D}{b} \times 20\, T^2 s\,(x + \cdot 1\, y) \div 10^8$$

$$= \frac{R D T^2 s C (x + \cdot 1\, y)}{b} \times 3\cdot 3 \div 10^8;$$

where C is the current in each conductor, and the other symbols have the meanings given above.

Mr. Hobart limits the value of the reactance voltage calculated in this way to 3 or 4 for the best results, though many satisfactory machines have been built with higher values.

The above expression for reactance voltage applies to parallel-coupled armatures only, and must be multiplied by the number of pairs of poles in the machine if the armature is a series-coupled one.

Example.—A four-pole dynamo, with an armature 25in. in outside diameter, and having 8in. length of iron in the core, has a parallel-coupled winding with one turn per section (T = 1). The output of the machine is 220 volts 450 amperes at 500 revolutions, so that C = 450/4 = 112·5 amperes. The brush short-circuits a maximum of three sections simultaneously ($s = 3$). The diameter of the commutator is 20in. (D = 20); the width of each brush is $\frac{3}{4}$in. ($b = \cdot 75$); x is 16in., and y is about 47in. The reactance voltage is then

$$= \frac{500 \times 20 \times 1 \times 3 \times 112\cdot 5\,[16 + (47 \times \cdot 1)]}{\cdot 75} \times 3\cdot 3 \div 10^8$$

= 3·1 volts. —Q.

Answer to No. 534 (*awarded* 5*s.*).—The term "inductance" or "coefficient of self-induction," usually denoted by the symbol L, represents the amount of self-enclosing of magnetic lines in a given circuit, or part of a circuit, when the current has unit value. It is well known that any conductor carrying current has concentric rings of lines of force set up around it, and if the conductor is close to or surrounded by iron, the number of these lines of force is largely increased. The total number of lines so set up when the current has unit value is known as the inductance of the circuit. The number of lines is, for practical purposes, taken as proportional to the current, unless the circuit is large enough to bring the iron close to its point of saturation; but this is very rarely the case in ordinary dynamos and motors. The total number of lines set up—*i.e.*, L × C—is known as the self-induction. As explained in my answer to Question No. 459, which appeared in this journal for March 21, 1902, the current in the coil or coils undergoing commutation at any instant has to be completely reversed (as shown in Fig. 1) during the time which the coil is under

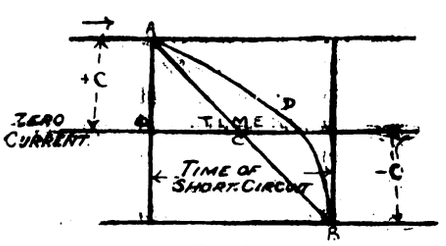

Fig. 1.

the action of the brush. Now, if there were no self-induction in the short-circuited coil, the currents flowing between any commutator segment and the brush covering it would be simply proportional to the area of the bar which the brush was covering. In other words, the contact resistance of the brush would act as a sluice gate, and the current leaving any commutator segment would vary exactly as the amount of opening of the sluice—*i.e.*, the proportion of the bar covered by the brush and the current in the short-circuited coil would follow a straight-line course between A and B, as shown in the line A C B. Unfortunately, however, we have the self-induction of the coil coming in, and this, of course, tends to resist the current changing, thus causing it to hang back and giving a curve similar to A D B. This means that the rate of change of the current during the last part of the time of short-circuit is greatly increased, and hence the current density and the voltage at the trailing tip of the brush between the brush and the commutator segment which is leaving it is also greatly increased. It is evident that if this voltage reaches a sufficiently high value it will start an arc, when the contact is broken, and so cause sparking. We thus see that an armature coil with a high self-induction tends to cause sparking. It is also evident that, since it is the rapid rate of change of current which tends to cause sparking, that the time of short-circuit should preferably be as long as possible.

The terms "reactance" and "reactance voltage" (the latter being simply the former multiplied by the current) were first introduced as a measure of the sparking tendency of a dynamo by Messrs. Hobart and Parshall. They assume that the current in going from A to B describes half a period of a sine wave, and assume that the voltage set up by an alternating current of this periodicity is a rough measure of the sparking tendency of the machines. This "sine wave" assumption is, of course, very far from the truth, but the method, although far from perfect, certainly does give a fair indication of the probable behaviour of the machine. The following is an example of the method:

$$\text{Reactance voltage} = 2\pi n \text{ L . C.}$$

where n = periodicity per second;
L = self-induction of armature coil, in henrys;
C = current in coil.

Now, Hobart has found that in order to calculate L we may take for ordinary open-slot machines four lines per centimetre length per ampere for coil in slot, and eight lines per centimetre length per ampere for coil in end connections. We must, therefore, first of all, calculate out the value of L for an armature coil. Take a four-pole machine 14in. in diameter and 6in. long. If the width of the slots is about the same as the width of the tooth, the total length of end connections at both ends for a barrel winding will be given by the formula:

$$\text{Length of end connections in inches} = 7 \times \frac{\text{diameter}}{\text{number of poles}}.$$

In this case, therefore, our end connections are

$$= \frac{7 \times 14}{4} = 24\tfrac{1}{2}\text{in. long.}$$

We have, therefore, lines per turn per ampere:

In slots = 4 × 12in. × 2·54 = 122
In end connections = ·8 × 24½ × 2·54 = 50
172

Or multiplying by 10^{-8} to bring it to henrys, L per turn = $1\cdot 72 \times 10^{-6}$. If there are four turns per coil, we have, owing to the mutual induction between the turns,

$$\text{L per coil} = \text{L per turn} \times (\text{number of turns per coil})^2$$
$$= 1\cdot 72 \times 16 \times 10^{-6} = 27\cdot 5 \times 10^{-6}.$$

If diameter of commutator = 10in. and width of brush = $\frac{5}{8}$in., we have:

Time of short-circuit = time of half period = time taken by any point on the commutator to pass under the brush

$$= \text{time of one revolution} \times \frac{\text{width of brush}}{\text{circumference of commutator}}.$$

Or taking a speed of 600 revolutions

$$= \frac{60}{600} \times \frac{\cdot 625}{31\cdot 4} = \cdot 002 \text{ second.}$$

$\therefore$ time of one period = ·004 second, or $n = \frac{1}{\cdot 004} = 250$.

If, then, we last of all assume that the current per circuit is 30 amperes, we have

$$\text{Reactance voltage} = 2\pi n \text{ L C}$$
$$= 2 \times \pi \times 250 \times 27\cdot 5 \times 10^{-6} \times 30$$
$$= 1\cdot 3 \text{ volts,}$$

which is quite safe, Hobart fixing the limit at from three to four volts, though for large slow-speed multipolars of about 1,000 kw. the reactance may in special cases go up to six volts, but these high figures should be avoided if at all possible. Commutation cannot be too good.—T. Square.

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CONTENTS.

Notes	793	Trade Notices and Novelties.	816
Electrical Transmission Plant for the Ocean Coal Company, Treorchy	798	Companies' Meetings and Reports	818
Ross Electricity Works	800	Legal Intelligence	818
Notes on Polyphase Motors	803	New Companies Registered	819
Questions and Answers	805	Appointments Vacant	819
Experimental Research	810	Contracts for Electrical Supplies	819
Correspondence	811	Traction Notes	820
Reviews	811	Lighting Notes	823
On Electrons	812	Provisional Patents, 1902	826
Forthcoming Events	813	Companies' Stock and Share List	827
Electricity as a Competitor of Gas	814	Traffic Returns	828
Northampton Institute	814	Supplement:	
Forthcoming Bills and Orders	815	Experiments on Synchronous Converters	1
New Committees	815		

TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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EXPERIMENTAL RESEARCH.

Investigations tending towards the advancement of any department of science may be commenced in one of two ways. In the first case the author of the investigation commences with a few known facts, and develops a theory which will more or less account for the observations already made. Having completed this theory, he proceeds to deduce other conclusions, which he applies to more advanced problems in the same direction. The other mode of procedure is to rely entirely upon experimental facts, and by extending the range of these to lay down with certainty exact conclusions as to the meaning of the observations. When the intricate subject of alternating machinery is under consideration the number of variables is so great that the second method is, as a rule, to be preferred to the first. For instance, in the earlier theories of alternate-current working it was practically always assumed that the E.M.F. and current curves had sine forms, and that this form was always maintained in spite of reactions in the circuit. Experiments on wave-forms have clearly shown that this is not the case, and that a theory which may be quite correct on the above supposition, fails entirely when the wave-form of current and E.M.F. differs considerably from the true sine. Another basis for a theoretical consideration of the behaviour of rotary converters, was that the magnetic distribution of lines of force round armatures was sinusoidal. Here, again, the assumption is not warranted by fact, and this distribution of magnetic lines is largely dependent on the armature current at any time. With these difficulties in view, Dr. W. M. Thornton attacked the problem of the running of synchronous converters entirely from the experimental side. A description of his investigations was brought before the Newcastle Local Section on Monday last in an interesting paper, which we reproduce in the supplement to this issue. The investigation in question is a complete one from an experimental point of view, and hence the author's conclusions can be investigated by anyone interested in the subject. The problem was suggested by some observations made by Dr. Thornton on the synchronous-motor system of the Newcastle-on-Tyne Electric Supply Company in connection with their Wallsend station. The bulk, however, of the investigations were carried out in the laboratories of the Durham College of Science. In the first place, he points out in his paper how the regularity of supply in all large distribution systems is dependent on the stability of the electromagnetic systems of the generators and motors under all loads. The mode of procedure adopted by the author consisted in arranging experiments under what are practically commercial conditions, and then observing the effect when a single variable is changed. The conclusions arrived at are to a certain extent those which would be expected, but they are all the more useful because they confirm results attained independently by other experimenters. For instance, it is found that, except at low magnetisation, the efficiency of a system of synchronous converters is only influenced by the copper losses. If, however, the excitation of the converters is reduced, large idle currents are set up, which very considerably reduce the efficiency. Another interesting, and, we believe, new, experiment carried out by the author in connection with the investigation is on the fluctuation of the magnetic fields in such machines. Readings taken by means of a Duddell oscillograph connected to the terminals of an exploring coil in the core of the machines, disclosed the existence of subsidiary waves of magnetisation which must be responsible for a considerable loss. This effect is much more apparent with single-phase than with three-phase machines. The general conclusions from the investigation are that

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over-excitation of the synchronous motor improves the stability of the system, but if the first machine or generator be under-excited, there may be instability in consequence of a swinging in the phase displacement. It is pointed out that it is more economical to expend energy in over-excitation than to make a slight saving here with a great increase due to eddy currents set up in consequence of oscillations in the phase displacement. These fluctuations can, of course, be kept down by damping coils, but these again waste energy which could frequently be saved if the alternating-current machinery were working under a more stable field. Incidentally, it is shown that the eddy-current losses in continuous-current machines are by no means confined to the pole-pieces and armature cores. Experiments in the above paper clearly show that there may be very considerable losses in the solid cores of the field-magnet system. It is in consequence of this that the field magnets of alternators are usually laminated, although fluctuations in the magnetic flux has not been generally suspected. We believe that Dr. Thornton is one of the first to show experimentally that such fluctuations are almost inevitable.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MOTOR.

SIR,—With further reference to "Motor" in your issue of Nov. 14, may I offer a friendly criticism to the answer given by "M. M."?

"Motor" distinctly states that he requires his motor to run at the same voltage as the dynamo—namely, 110; how then does "M. M." make out that 80 volts will meet the case?

The current required will not be 65·2, as "M. M." states, but $\frac{7 \times 746}{110} = 47{\cdot}472$, or, roughly, 48 amperes, which will alter the time for charging, etc. His other calculation, $\frac{7 \times 7 \times 6}{80} = 65{\cdot}2$, should evidently be $\frac{7 \times 746}{80} = 65{\cdot}2$.—

Yours, etc., M. GREGORY.

TUNBRIDGE WELLS TELEPHONES.

Mr. A. R. Bennett, consulting telephone engineer to the Corporation of Tunbridge Wells, has addressed the following letter, dated Dec. 2, to the Postmaster-General on the subject of the proposed transfer of the Corporation telephone undertaking to the National Telephone Company:

Sir,—I feel compelled to enter the strongest possible protest against the manner in which my name was made use of by the deputation of the Town Council of Tunbridge Wells which waited upon you in connection with the proposed sale of the Corporation telephone undertaking to the National Telephone Company. I deny most emphatically that the prices estimated were inadequate, for they were in all cases calculated to afford a liberal margin; and the causes of the loan proving inadequate must be sought in the policy of expansion which was at first adopted by the Telephone Committee, a policy which no doubt would be amply justified by results were it given time to mature. Contributing causes, and very material ones, were also the substitution of small underground cable for the overhead wires which were originally estimated for, for which change I was in no way responsible, and in wayleave difficulties, which led to much of the work being reconstructed several times over. In none of these matters had I a controlling voice, and it would be as logical to expect an engineer to build two miles of railway at the cost of one as to hold my estimates responsible for what has happened. The undertaking so far has not shown any loss, and the loss which is expected to occur next year is extremely small, and would not take place at all if reasonable prudence were exercised in the management, which has not hitherto been the case. It has been suggested to you that I was responsible for the fact that some £600 due for detention money on the cable contract was not included in the liabilities, but such a suggestion is absolutely without foundation. The fact that detention money was due was embodied in the cable contract, which was in the custody of the town clerk, and, by means of the certificates for instalments of cable work that had been made, must also have been made known in the borough accountant's office, as it most certainly was to the telephone manager. I must also protest against the remarks made by the Mayor in reference to the employment of the new manager. He states (according to the Press) that I recommended the appointment of the assistant manager to the position of manager, but this is only partly true My recommendation was that the assistant manager should be entrusted with the business control of the office, he having an adequate knowledge of the district and people, and having shown commendable capacity and energy as assistant manager. But I also recommended that the chief technical inspector should be put in charge of the engineering and electrical department, for which he was eminently qualified by long experience. This combination would, I am sure, have been attended by the best results, and could have been carried out at a far less cost to the department than the arrangement which was ultimately decided upon.

I do not expect that these considerations will have any influence on your decision in the matter, but it is necessary for me to put them on record, as the attempt which is being made to saddle me with responsibility is unjust and despicable, and has its roots, I am afraid, in causes which are not apparent to the public view. Notwithstanding the increase in the capital cost, the telephone department of the Corporation is in a solvent condition, and with careful management would certainly pay its way without any increase on the present tariff The Post Office telephone undertaking in London is only in its first year of working. Large sums have been expended in anticipation of future wants, a circumstance which makes its case parallel with that of the Tunbridge Wells and Glasgow Corporation undertakings. If, Sir, the Post Office telephone exchange were burdened in this its first year of existence with full interest and sinking fund in the way in which the Tunbridge Wells enterprise has been burdened, an enormous loss would have to be confessed to, although no reasonable doubt could exist as to the ultimate success of the enterprise if persisted in. Yet we do not hear of any public clamour to have the Post Office system sold to the National Telephone Company, but if there is any sense or justice in the view taken by the Tunbridge Wells Town Council, public meetings ought to be held all over the country to insist on the immediate transfer of the Post Office undertaking at a ruinous sacrifice.

I would strongly suggest that before consenting to any transfer you order an investigation as to how the Tunbridge Wells loan has been expended.—I have the honour to be, Sir, your obedient servant,

(Signed) A. R. BENNETT.

REVIEWS.

Elementary Manual of Steam and the Steam-Engine. By ANDREW JAMIESON, M.I.C.E., M.I.E.E., F.R.S.E., etc. Ninth edition; revised and enlarged. C. Griffin and Co., Limited.

Elementary Manual of Applied Mechanics. By ANDREW JAMIESON, M.I.C.E., M.I.E.E., F.R.S.E., etc. Fifth edition; revised and enlarged. C. Griffin and Co., Limited.

The constant and abundant supply of text-books is some evidence that there is a demand to be met, but unfortunately, and speaking generously, probably more than those forming 50 per cent. of the supply are not worth the paper they are written on. The value of a text-book can be safely estimated by the demand for it, and the demand may be fairly estimated by the number of editions into which the sale runs and the frequency with which those editions appear. If this is logic, Prof. Jamieson may be classed at once as one of the most successful professorial writers. His elementary manuals of "Steam and the Steam-Engine" and "Applied Mechanics" respectively have been revised,

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extended, and brought up to date, and reissued, the former in a *ninth* edition and the latter in a fifth. They are written in a clear, concise, convincing manner, and are admirably illustrated. Each chapter ends with a series of questions appropriate to the matter dealt with therein—questions which have been for the most part set at Government examinations. Both volumes are well printed and substantially bound, and issued at a reasonable price (3s. 6d.), which places them within the reach of students of all classes.

ON ELECTRONS.*

BY SIR OLIVER LODGE, F.R.S., VICE-PRESIDENT.

INTRODUCTION.

In Maxwell's "Electricity," published in 1873, Section 57, the following sentence occurs in connection with the discharge of electricity through gases, especially through rarefied gases: "These and many other phenomena of electrical discharge are exceedingly important, and when they are better understood they will probably throw great light on the nature of electricity as well as on the nature of gases and of the medium pervading space."

This prediction has been amply justified by the progress of science, and no doubt still further possibilities of advance lie in the same direction. The study of conduction through liquids first, and the study of conduction through gases next, combined with a study of the processes involved in radiation, have resulted in an immense addition to our knowledge of late years, and have opened a new chapter—indeed, a new volume of physics. The net result has been to concentrate attention upon the phenomenon of electric charge, and greatly to enhance the importance of a study of electrostatics. Not long ago Fitzgerald used chaffingly to speak of electrostatics as "one of the most beautiful and useless adaptations of nature," and it was becoming the custom with teachers who felt that they must attend exclusively to the practically useful, and not waste their students' time on decoration and superfluities, almost to ignore, or at any rate to scamper through, the domain of electrostatics, and to begin the study of electricity with the phenomenon of current, and especially of the connection between electricity and magnetism. And certainly from the severely practical point of view, as well as from many other aspects, this part of electrical science remains the most important; but to him who would not only design dynamos and large-scale machinery, to him who in addition to the training and aptitude of the engineer possesses something of the interests, the instinct, and the insight of a man of science, to such a one the nature and properties of an electric charge at rest and in motion constitute a fascinating study; for there lies the key to the inner meaning of all the occurrences with which his active life is so intimately concerned—there lies the proximate solution of problems which have excited the attention and taxed the ingenuity of philosophers and physicists and chemists since men began to escape from the struggle for bare existence—that most immediately practical of all occupations—and felt free to devote themselves, some to art, some to literature, some to the accumulation of superfluous wealth, and some to the gratuitous pursuit of speculation and pure theory. Your president, Mr. Swinburne, realising that a society like this was sure to contain men eager to pursue their subject into some of the intricacies far removed from their immediately practical occupations, wrote and pressed me to come up and give an explanatory sketch of what had been done of late in the world of pure science towards the elucidation of the most familiar electrical processes; and with but little hesitation I consented, feeling sure that what the President urged would not be regarded by the Institution at large as out of place or unsuitable, though of my own motion I should never have thought of offering any such paper.

PART I.

First I must lay a basis of pure theory: we must consider the properties of the ancient and long known phenomenon called an electrified body. Two substances placed in contact and separated are in general united more or less permanently by lines of force, the region between them being in a state of tension along the lines and of pressure at right angles. These lines have direction: they begin at one body and end at another, they map out a field of electrostatic force, and their terminations on one or other of the bodies constitute what we call an electric charge. Electric charges are of two kinds, one corresponding to the beginning of the lines, the other to their ends. To one class of bodies called insulators the lines appear rigidly attached, whereas in another class they slip easily along and are transferred from one such conducting body to another in contact with it with great ease. The tension in the lines tends to bring the ends together as near as possible, giving rise to what is observed as electrical attraction. In empty space it is probable that the only way of destroying such a field of force will be to allow the two bodies to approach each other, and thus shorten up the lines to nothing, though even so it is not probable that the charges are destroyed, but only approach so close that they have no external effect at any moderate distance. When matter is present it may be able to assist this collapse of the lines in various ways, giving rise to the various phenomena of conduction and of disruptive discharge. If one of the two oppositely charged bodies is set away to a considerable distance, while the other is isolated and regarded alone, the lines of this latter start out in all directions in nearly straight lines, giving rise to the simple notion of a single charged body—a thing which is no more really possible than is a single magnetic pole. The other ends of the lines must be somewhere, though they may be so far away as to be spoken of as for all practical purposes at infinity. Now consider how far this field of force belongs to the body and how far it belongs to space—that is, to the ether surrounding the body. The body is the nucleus whence the lines radiate, but the lines themselves, the state of tension and other properties which they represent and map out, do not belong to the body at all; at each point of space there is an electric potential, and this potential represents something occurring in the ether and in the ether alone.

A Charged Sphere.—Picture in the mind's eye such a charged body, say a charged sphere, and let it change its position; how are we to regard the effect of the displacement on its field of force? Nothing in physics is more certain than this, that when a body moves, the ether in its neighbourhood does not move. The ether, in fact, is stationary: it is susceptible to strain, but not to motion; it is the receptacle of potential, not of locomotive kinetic energy. The effect of the motion of the body, then, is to relieve the strain of the ether at one place and to generate it at another; the state of strain travels *with* the body, but *through* the ether. Regarding the matter from the point of view of the ether, we might say that the field of force is constantly being destroyed and regenerated as the body moves. Regarding it from the point of view of the moving body, we should say that it carries its field with it.

The question now arises—and it is far from being an easy question—what sort of occurrences go on in the ether when this decay and regeneration of an electrostatic field is occurring, or when a field of force is moving through it? Can it adapt itself instantly to the new conditions, or does it require time? Fix the eye upon a point a mile distant from the body. Does the information about the motion of the body reach that point instantaneously so that all the lines of force move like absolutely rigid spokes, every part simultaneously; and if so, how is the communication carried on so that the distant parts of the medium can be thus instantaneously affected, or does the disturbance only arrive at the distant point after the lapse of a small but appreciable time; in other words, has there to be an adjustment to the new conditions—an adjustment which reaches the nearest parts first and the further parts later; and if so, what additional phenomena can be observed during the unsettled period? The answer is that during the motion of the charged body, and even after the cessation of its motion until the disturbance has had time to die away and everything to settle down into static

* Paper read before the Institution of Electrical Engineers.

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condition again, the phenomena of *magnetism* make their appearance: a new set of lines of force quite different from the electrostatic lines (although they, too, exhibit a tension along them and a pressure at right angles) come into temporary being. These do not originate at one place and terminate at another: they are always and necessarily closed curves or rings, and in the present simple case they are circles all centered upon the path of motion of the charged body. At any point of space there are now three directions to consider: (1) there is the original direction of the electrostatic field—the original electric line of force; (2) there is the direction of the motion—that is, a direction parallel to the movement of the charged sphere; and (3) there is the direction at right angles to the two; this last being the direction of the magnetic lines of force—the direction of the magnetic field. I spoke of the magnetic field as temporary, but that is on the assumption that the charged body is merely displaced, moved from one position to another; if it is not stopped, but keeps on moving, then the magnetic lines continue as long as the motion lasts. Its strength at any point r, θ, is $H = \frac{e\,u}{r^2} \sin\theta$. If we are asked whether such a magnetic field is weak or not, I have to reply that that depends entirely on how strong the charge is and how quickly it is moving. There is, in my opinion, no other kind of magnetic field possible; and so, if ever we come across a magnetic field which we feel entitled to consider "strong," we must conclude that it is associated with the motion of a very considerable charge at a velocity we may properly style great. But certainly it is true that for any ordinary charged sphere moving at any ordinary pace—even supposing that it is a cannon ball shot from the mouth of a gun—the concentric circular magnetic field surrounding its trajectory is decidedly feeble. Feeble or not, it is there, and to its existence we must trace all the magnetic phenomena of the electric current. For just as there is no electrostatic field save that extending from one charged body to another, so there is no electric current except the motion of such a charged body, and no magnetic field except that which surrounds the path of this motion. The locomotion of an electric charge *is* an electric current, and the magnetic phenomena surrounding that current are believed to be the only magnetic phenomena in existence. If any other variety is possible, the burden of proof rests on those who make the positive assertion.

One more statement: while the charge is stationary everything is steady, and we have an electric field only. When the charge is moving at constant speed the current is steady, and we have a steady magnetic field superposed upon a steadily moving electric field, and a certain conveyance of energy in the direction of the motion. But what about the intermediate stages, the stages of starting and stopping; what is the condition of things after the charge has begun to move but before it has attained a constant speed, and again when the brake is applied and the speed is decreasing, or when the direction of motion is changing? What phenomena are observable during the epoch of acceleration or retardation of speed or curvature of path? Something more than simple electrostatics and simple magnetism is then observed. We get the phenomenon of induction—the generation of an induced E.M.F. of value at any point equal to the rate of change of the lines of magnetic force there. There being no conductor, this E.M.F. will propel no current, but it will represent an electric force which was not there before, and in a new direction, perpendicular to the direction in which the growing magnetic lines are moving, which is outwards from the charge. Consequently, the new or induced E.M.F. points in the direction of motion, though in the sense opposed to it; and the effect of its supposition upon the magnetic field is to cause a certain small transmission of energy in a radial direction out and away from the accelerated charge. Some energy, therefore, flashes away with the speed of light, though in ordinary cases an exceedingly small amount. It is from an electric charge during its epochs of acceleration or retardation that we get the phenomenon called radiation; it is this and this alone which excites ethereal waves, and gives us the different varieties of *light*. The energy radiated per second is $\frac{2\mu\, e^2\, \dot{u}^2}{\nu}$, where ν is the speed of light and $\dot{u}$ is the acceleration of the charge, e. Thus, or rather by means of a very extensive development of these fundamental ideas, are all the phenomena of electricity and optics summarised, and, so to speak, accounted for

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, DEC. 5.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "The Erection of Steel Bridges," by Mr. A. Reynolds.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "The Planimeter explained simply without Mathematics," by Mr. Wm. J. Tennant.

SATURDAY, DEC. 6.

Institution of Electrical Engineers.—At 2 p.m., students' visit to the generating station of the Central London Railway.

British Association of Waterworks Engineers.—At 10.30 a.m., at the Geological Society's Rooms, Burlington House, W., seventh winter meeting. Papers: "The Coating of Cast-Iron Water-Pipes," by Mr. W. H. Humphreys; "Description of Softening Plant at Wilmslow—Stockport Corporation Waterworks," by Mr. T. Molyneux; "The Detection and Prevention of Underground Pollution," by Mr. John Shaw.

King's College Engineering Society.—At 7 for 7.30 p.m., annual dinner, Hotel Cecil.

MONDAY, DEC. 8.

Society of Arts.—At 8 p.m., Prof. Vivian B. Lewes on "The Future of Coal Gas and Allied Illuminants." (Lecture III.)

Society of Engineers.—At 9 p.m., at the Institution of Mechanical Engineers, réunion.

TUESDAY, DEC. 9.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "High-Speed Electrical Generating Plant," by Mr. T. H. Minshall.

Institution of Electrical Engineers (Glasgow Section).—Ordinary meeting.

WEDNESDAY, DEC. 10.

Society of Engineers.—At 6.30 for 7 p.m., annual dinner at Hotel Cecil.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to inspect the widening operations in progress at London Bridge.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "French Rural Education and its Lessons for England," by Mr. C. Brereton.

Institution of Junior Engineers.—At 3 p.m., visit to Messrs. Elliott Bros.' mathematical electrical works, Conington-road, Lewisham.

Institution of Electrical Engineers (Birmingham Section).—At 8 p.m., ordinary meeting. Address by chairman (Mr. H. Lea) on "Recent Progress of Electrical Engineering in Great Britain."

Cold Storage and Ice Association.—At the Institution of Mechanical Engineers. Ordinary meeting. Discussion on "Municipal Trading."

THURSDAY, DEC. 11.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper: "The Photometry of Electric Lamps," by Dr. J. A. Fleming.

FRIDAY, DEC. 12.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "A New Automatic Railway Coupling compared with the Existing System on British Railways," by Mr. A. T. Swaine.

Institution of Electrical Engineers (Dublin Section).—Ordinary meeting.

North-East Coast Institution of Engineers.—At 7.30 p.m., general meeting. Paper: "Large Stop-Valves for High-Pressure Steam," by Mr. J. Hamilton Gibson.

SATURDAY, DEC. 13.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Advancement of Machine Tools," by Mr. J. H. Davey.

Errata.—Since printing Dr. W. M. Thornton's paper, we have received from the author notice of the following corrections being required. The paper appears in the supplement to this week's issue. The corrections are: In Table V. the fifth figure for the second converter output should be 2,474, not 2,494; also in the fourth set of figures in this table the total armature efficiency is 36 per cent. for the first line as well as for the second. On p. 8 the two sentences just before Table IX. should be omitted, and at the bottom of the same column, where "watts loss per second" is printed several times, the words "per second" should be omitted. The same correction is needed in the sixth line of the second column of p. 5.

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ELECTRICITY AS A COMPETITOR OF GAS.

At the Restaurant Frascati, W., on Tuesday evening last, Mr W. R. Rawlings read a paper on this controversial subject before the London Electrical Contractors' Association. At the opening, the author explained that he had been led to prepare the paper in view of the many erroneous and exaggerated statements which had been circulated abroad recently by the suppliers of gas with regard to the electric light, and a great part of the paper was devoted to a criticism of the truth of such statements. For example, it had been asserted by one advocate of gas lighting that the cost of electricity at 6d. per unit was 13 times dearer than gas at 3s. per 1,000 cubic feet, and the author showed on the statements of the gas companies themselves that, so far from this being correct, the cost of electric lighting calculated on the above basis was not more than 4·5 times greater than gas. He then went on to refer to some of the difficulties with which the electrical contractor was beset in carrying out electric lighting contracts, which tended to bring about delay and consequent loss of orders, and pointed out that everything possible that could be done to expedite the time it now took to make an electric light connection would without doubt improve business generally. Further, it was a duty of every supply company to attend more promptly than at present to urgent orders for repairs to their own main fuses. With regard to the rules laid down by the companies, the fire offices, and the consulting engineers for the guidance of contractors, he pointed out that it was impossible to interpret the three combined, and suggested that such a state of affairs was one, if not the worst, obstacle in the way of successful work. It was to be hoped that the best efforts of the Institution of Electrical Engineers and their new rules would do much to remedy this evil. He went on to state that in the metropolitan boroughs alone there were no less than 11 different voltages at which supply was given, and as some of these were with alternating current at several different frequencies, it would be seen that the difficulties in the way were many. Again, the differences in the wiring rules and requirements of the respective supply companies were serious hindrances to electrical contractors, and, further, delays were often caused by having to alter certain parts of the wiring or accessories to comply with the particular rules of the supply company, owing to the contractors not having seen the same. The result was that the consumer often came to the conclusion that the work was faulty, and the contractor in the end suffered for a state of things over which he had no control. The inconvenience and unnecessary expense which consumers often suffered was the cause of many being deterred from adopting the electric light, and in this connection he regretted that the supply companies were their own principal enemies, and in turn the industry suffered. One of the chief causes of delay in connecting up consumers was the variation in voltage, and he suggested the question was of such importance that it required the attention of the Board of Trade with a view to standardising the voltage supplied at the consumers' terminals for the whole of the country, or the metropolitan boroughs at least. Dealing with the relative cost of gas and electric lighting, the author gave the case of a large college where electricity had been recently installed in a portion of the building. During the months of October and November last year, when gas only was used, the cost came out at £63, and during the same months this year the gas cost £34. 13s. 3d. and electricity £20. 12s., making a total of £55 5s. 3d., and a saving of £8. 3s. 9d. in the two months with the part use of gas and electric light In conclusion, the author recognised that, in spite of the improvements in gas and its uses, and the way in which electrical contractors were hampered by rules and a general want of uniformity, electricity was advancing with rapid strides, and proving itself to be a real competitor on merit alone with gas. But, nevertheless, care and united action was necessary to bring about a universal system of distribution and trading if they were to maintain the lead. In the discussion which followed the reading of the paper, Mr. Millard and Mr. Noble gave instances in which the electric light had proved more economical than its rival illuminant. Mr. Woodward also mentioned a case where the use of arc lamps had proved much cheaper than gas, the relative cost per quarter being £10. 4s. 8d. and £8. 3s. respectively. Mr. Duncan complained that the electric light was greatly hampered by the rules made by the supply companies and the consulting engineers, and that the contractor did not get the same support as was accorded the gas contractors. He was followed by Mr. Berry, who contended that the only way to bring the supply companies on to a proper level with regard to their rules was by taking the matter before a court of law and fighting it out there; while Mr. R. Tweedy Smith, the hon. solicitor of the association, suggested that that body should take action by appearing upon Bills in Parliament and getting the insertion of clauses which would meet their grievances. He also thought that a deputation to the Board of Trade on the matter would have good results. Mr. Troup mentioned that after a six months' test West Ham had adopted incandescent gas lamps for street-lighting, and he heard that this form of illumination was also being adopted at Birmingham and Manchester. The author, in reply, contended that there was no argument whatever in favour of gas as against electric lighting. The crux of the whole problem was the distribution of the light, and the gas companies, in making comparisons between gas and electric lighting, would not take that into consideration. He claimed, finally, to have shown that the statements made by the gas companies were not founded on fact, and that the basis of comparison between the two illuminants used was unfair, and led to entirely erroneous conclusions.

NORTHAMPTON INSTITUTE.

On Wednesday the Lord Chancellor (the Right Hon. the Earl of Halsbury) presented the prizes and certificates at Northampton Institute, City Polytechnic, St. John-street-road, Clerkenwell, E.C. A members' and students' conversazione was held, for which a liberal programme had been provided. This included an organ recital, a promenade concert, and a number of entertainments and lectures, such as microscopes, telephones connected with the theatres, kinematography, a lecture on wireless telegraphy by A. W. Martin and Twining, ambulance and athletic displays. In the various classrooms special demonstrations took place at intervals in smiths' work, motor and transformer experiments, liquid air, lens grinding, X-rays and Tesla experiments, colour experiments, electroplating, alternate-current working (single and polyphase), and electric forging. The theatrophone which had been rigged up by the National Telephone Company especially attracted an immense auditorium, 20 of which were admitted at a time, and were enabled, sitting around a sort of capstan, to listen to the performers at the Tivoli and other places of amusement. The quiet behaviour of the vast crowds which filled the buildings was most remarkable.

Punctually at 7.30 the president, Dr. W. M. Walmisley, opened the proceedings with a short report of the work of the session—September, 1901, to July, 1902. He said during the period named the work of the institute showed steady progress, but, as in the session immediately preceding, the effect of the war still continued to be felt, although the total enrolment showed a substantial advance, more especially on the educational side. The successes of the students in outside examinations and competitions were very gratifying. In the examinations of the City and Guilds of London Institute the record of the previous year was surpassed, and 14 medals and prizes in money of the aggregate value of £31 were secured, whilst in the open competitions for the London County Council's scholarships in art and in science and technology the value of the numerous awards obtained was in excess of the preceding session. In the art competitions the work of the silversmiths was specially commented on by the examiner, Mr. Walter Crane. The electrical and optical classes continued to be increasingly successful and to win the good opinion of employers and experts in the respective industries. The new electrical engineering laboratory was now fairly well equipped and, well worth a visit from all interested in electrical developments. The work of the institute as a "qualified institution" of the University of London was now recognised, and the institute could claim to be a people's branch of the university. During the year Mr. John Ashford, the first head of the mechanical engineering department, which he had efficiently organised, had resigned, and he welcomed his successor, Mr. C. E. Larard. On the social side, the numerous clubs continued to flourish

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and develop. The most noteworthy development during the period was the growth of the Northampton Institute or "M" Company of the 21st Middlesex R.V.C.

The CHAIRMAN (Mr. L. B. Sebastian, chairman of the governing body) dwelt upon the increasing advantage which had been taken of the educational and social opportunities afforded by the institute, the number of class entries having reached 4,000, so that daily the question cropped up whether the buildings should not be enlarged. They were paying special attention to training in the local industries—saddlery, for instance. Their Saturday concerts had frequently attracted an audience of 1,000. There were now connected with the institute four clubs for both sexes, two exclusively for male students and two for ladies, all being mainly under the management and control of the students themselves.

The EARL OF HALSBURY, in most felicitous speech, emphasised that practically everyone was nowadays a worker, with the exception, perhaps, of the few who were enabled to dwell in the unvexed silence of their studies, and who, he ventured to say, were hardly to be called the most productive class. National pre-eminence depended upon national improvement and trade, as the sovereign would surely find its way to the country where the best piece of work could be purchased by it. He was glad to see that so many availed themselves of the opportunity afforded to them by the institute of acquiring the education and training to produce an efficient article. While a few received prizes, all had been enabled to fit themselves for their future work by such education and training. In other countries great results had been achieved in this direction by the aid of Government—notably in chemistry. We, however, liked to be independent, and to rely upon our own individual effort to uphold our national commercial reputation by endeavouring to present to the world the best possible article. Those who made the cheap and bad destroyed the national credit. The healthy supervision formerly exercised by the guilds, who had a right to prevent imperfectly-made articles from leaving the workshops, had now ceased, and the remedy in modern times lay in the spirit fostered by such institutions as this. He was greatly in sympathy with the social side of the work. The welfare of the State suffered by the separation of classes, and he had no doubt that the differences of class and class were made less harsh by the common interest taken by the members not only in their work, but also in their recreation.

Nearly 400 prizes and certificates having been distributed, the visitors, which comprised a great many well-known men in the educational world, made a tour of inspection around the building, not, however, before individual votes of thanks had been passed to the Lord Chancellor, the chairman, Dr. Walmisley, and the staff of the institute.

FORTHCOMING BILLS AND ORDERS.

Saturday was the latest time allowed by the Standing Orders for depositing at the Private Bill Office of documents in connection with Bills for 1903 for the making of local improvements. There have been deposited for the ensuing session 46 plans in connection with railways, 38 in relation to tramways, 60 miscellaneous, and 150 provisional orders, including tramways and electric lighting—total, 294. Last year there were: railways, 48; tramways, 23; miscellaneous, 73; provisional orders, including tramways and electric lighting, 174—total, 318, marking a decrease of 24 in the total number, but the aggregate number of Bills as distinct from provisional orders is exactly the same this year as last year. Tramway enterprises show an increase of over 50 per cent., and the total mileage is also considerably larger.

The following are the particulars of Electric Bills and Orders not already noted in these columns:

A.—To the Board of Trade.

1. *Electric Lighting.*—Bromley (Syndicate), Sittingbourne and Milton (Syndicate), Bexley (East Wickham) (U.D.C.), Warmley (R.D.C.), Horsforth (U.D.C.), Wickham (U.D.C.), Horbury (U.D.C.), Southgate (U.D.C.), Bromby and Frodingham (U.D.C.), Calverley (U.D.C.), Yeovil (Corporation), Wimbledon Extensions (U.D.C.), Strood and Dartford Districts (Kent Electric Power Syndicate), Sandwich, Deal, and Walmer (Kent Electric Power Syndicate), Newton-in-Makerfield (U.D.C.) Sevenoaks (Kent Electric Power Syndicate), Chipping Norton (Undertakers), Slough (U.D.C).

2. *Electricity Supply.*—Uxbridge and District (Company), Leatherhead, Dorking, and District (Company).

3. *Electric Tramways.*—Ramsbottom (U.D.C.), Leeds (Corporation), Horsforth (U.D.C.), Keighley (Corporation) Leeds and Guiseley New Lines (Promoters) Brixham (U.D.C.), Stroud (U.D.C.), Wigan (R.D.C.), Port Dinorwic (Undertaker), Launceston (Corporation), Carisbrooke and Northwood (Company), Auckland (Company), Stafford (Corporation), Hucknall-under-Huthwaite (U.D.C.), Illogan (Company), Abersychan (U.D.C.) Falmouth (Corporation), Bedwellty (U.D.C.), Portland (U.D.C.), Orrell (U.D.C.).

B.—To Parliament.

1 *Electric Lighting.*—Carmarthenshire (Company), Shropshire, Westershire, and East Denbighshire (Company), Dewlish (U.D.C.), Whitchurch and Paignton (Company).

2. *Electricity Supply.*—Huddersfield (Corporation), Chatham and District (Light Railways Company), London County Council (Council), Somerset and District (Company).

3. *Electric Tramways.*—Gosport, Fareham, Portchester, and Cosham (Company) Bournemouth (Corporation), West Cumberland (Company), L.C.C., Dewsbury, Batley, and Birstall (B.E.T. Co.), Belfast Street Tramways (Company), Worthing (Corporation), South Shields, Sunderland, and District (B.E.T. Co.), Notts and Derbyshire (Company), Birmingham and District (U.D.C., R.D.C., and Companies), Aston Manor Improvements (U.D.C.), Salford New Lines (Corporation), Preston and Horwich (Company), South Shields (Corporation), Wakefield and District Construction (Company), Exeter (Corporation), Luton, Dunstable, and District (Company), Hastings Extensions (Company), Rochester, Chatham, Gravesend, and Maidstone (Company). Torquay and Paignton (Company).

To the Light Railway Commissioners.

Devonport (Corporation), Light Railway Commission; the High Peak District, Light Railway Commission; Central London Railway, New Lines (Company); Totton, Hythe, and Fawley (L. and S.-W. R. Company); Lastingham and Rosedale Extensions (Company); Newton Toney Curve, New Lines (L. and S.-W. R. Company); Avonmouth, New Lines (Company); Dudley and District Extensions (Company); London and Brighton Electric Express Railway (Company); Grimsby District, New Lines (Company); Dartford Extensions (U.D.C.); Quary Bank, Brierley Hill, Rowley Regis (U.D.C.); Rugby and District, New Lines (Promoters); Torquay and District (Company); Rowley Regis (U.D.C.).

NEW COMMITTEES.

The following new committees have been appointed:

CARDIFF.—*Electrical and Lighting*—Alderman Carey, chairman; Mr. Good, vice-chairman.

CROYDON.—*Lighting and Electricity*—Alderman Miller, chairman; Alderman Goodwin, vice-chairman.

DONCASTER.—*Electricity*—Councillor Dowson; Aldermain Wainwright; and Councillors Bennett, Clark, Gyles, Halmshaw, Kay, Smith, Theobald, Tuby, Wightman, and the new councillor.

GRAVESEND—*Electric*—Aldermen Paine, Russell, Wood, Willis, Cooper Fletcher; Councillors Rhodes, Enfield, Mason, Hooper, Cosh, Archer, Byrne, and Tolhurst.

HAMMERSMITH.—*Electricity and Lighting*—Alderman Glasier, chairman; Councillor Johnson, vice-chairman.

HUDDERSFIELD.—*Electricity* (number of members, exclusive of the Mayor, 19)—The Mayor; Aldermen Hellawell, Whitehead, E. Woodhead; Councillors William Joseph Barras, Berry, Chatterton, Cook, Dobson, Gledhill, J. Holroyd, Jepson, Longbottom, Pogson, Ernest Shaw, Smith, Alfred Sykes (North), Charles Frederick Sykes, Thomson, Whittell, Woolven. *Tramways* (number of members, exclusive of the Mayor, 21)—The Mayor; Aldermen Firth, Jessop, Whitehead, Willans; Councillors Ainley, Frederick Arthur Barras, Broadbent, Cartwright, Cockin, Cook, Coward, Dobson, Gee, Lawley, Moore, Oxley, Pogson, Ernest Shaw, Swallow, A. Sykes (North), Thomson.

KINGSTON (SURREY).—*Lighting*—Councillor Clarke, chairman; Councillor Francis, vice-chairman; the Mayor and ex-Mayor; Aldermen Salmon and Walker; Councillors Cawley, Lambourn, Minnitt, Rampton, Sprunt, and Woolnough. *Tramways*—The Mayor, chairman; the ex-Mayor; Aldermen Collings, Hart, Mostt, Salmon, and Walker; Councillors Minett, Welbelove, and Woolnough.

MORECAMBE.—*Electric Light*—Aldermen Carleton, Snowden, Wilson; Messrs. Holroyd and Alderson.

NEWPORT (MON.).—*Electricity and Tramways*—The Mayor; Alderman Moses; Councillors Greenland, Brown, Linton, Liscombe, F. Phillips, Gower, Williams, Baker, Abrahamson, Robjent, Swash.

ST. MARYLEBONE.—*Lighting*—Alderman Mr. W. Dennis, Mr. J. A. Michell, J.P. (chairman).

STEPNEY.—*Electric Lighting*—Aldermen Barker, Hirst, and Osman; Councillors Algar, Brady, Coveney, Fage, Gordon, Kearsley, Robinson, Holland, and J. Gibbs.

The Mersey Railway.—The arrangements for inaugurating the electric service on this railway are fast approaching completion, and it is expected that the electric trains will be running by February next.

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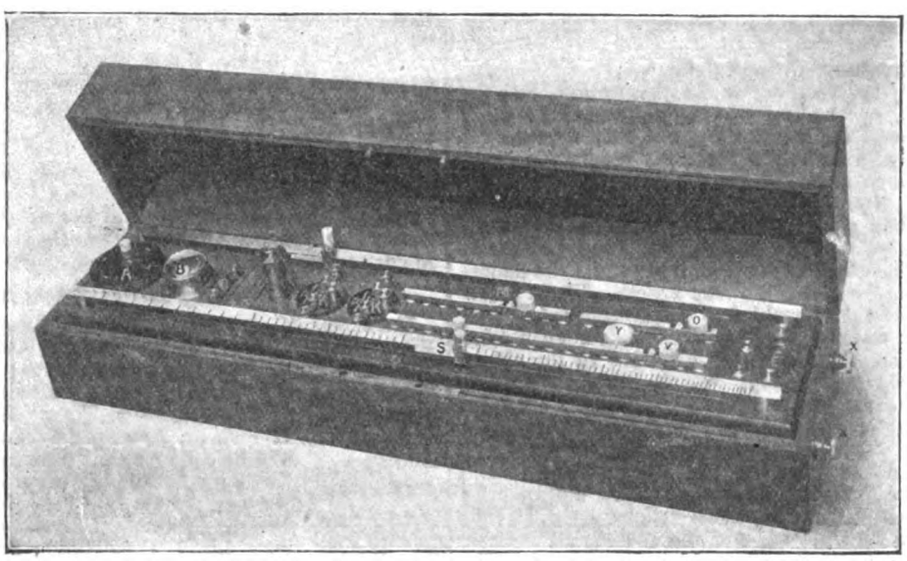
TRADE NOTICES AND NOVELTIES.

Vulcan Portable Potentiometer.

We illustrate herewith a form of potentiometer which is being introduced into this country by Messrs. Gopel and Lange, Parliament-mansions, Westminster, S.W. In principle the potentiometer method of measurement is that of comparison of various unknown potentials with a known potential. The different values of the standard cells used at various temperatures are ascertained by the use of the formula:



Vulcan Portable Potentiometer.

E.M.F. $= 1{\cdot}4342\,[1 - {\cdot}0007\,(t - 15)] = 1{\cdot}4508 - {\cdot}001104\,t$, where t = degrees C.

The construction of the Vulcan potentiometer (see the accompanying illustrations) is briefly as follows: A wire of high resistance and negligible temperature coefficient, with as far as possible a perfectly even diameter throughout its length, is traversed by a cursor, S, that slides along a graduated cursor bar, the front face of which is divided into 1,000 equal parts. Over a part of its back face the cursor bar is marked with a scale of compensation in degrees C., which eliminates the necessity of calculation of the E.M.F. of the standard cell at various temperatures. Another wire of similar material and of the same specific resistance as the above is arranged inside the potentiometer case. This wire is divided into 15 equal sections, the resistance of each section being exactly equal to the single extended length first mentioned. Each of these sections terminates in a contact step, the series being traversed by a cursor, V, which in turn slides on a numbered cursor bar bearing the numbers 0 to 1·5. A group of seven resistances of the same construction, each of equal resistance, is arranged in a similar way, the steps being traversed by a cursor, M, sliding on a numbered cursor bar bearing the numbers 1·5 to 2·2. There is also a second extended wire, identical with the first mentioned, which the cursor, R, traverses, whilst the covering cursor bar has no graduations. Two standard Latimer Clark cells, K K, are provided, each furnished with an internal Centigrade thermometer. The galvanometer is dead beat; its needle appears under the lens, B. A four-way switch, A, places successively in the circuit of the galvanometer (1) standard cell No. 1; (2) standard cell No. 2; (3) source of potential to be ascertained; (4) difference of potential between the ends of a resistance in which current is being measured. A standardised resistance, divided into three sections, is connected to four steps which are traversed by cursor, O, sliding on a numbered cursor bar bearing the figures 0, 1, 2, 3. A two-way switch, Y, controlled by the movement of the cursor O cuts the resistance in or out of circuit. Two small terminals, C, ordinarily short-circuited, are utilised when desired for the insertion in the circuit of the galvanometer of a second instrument. Two plug-holes, 1, take the ends of two flexible cords, which connect to the standard shunts when currents are to be measured. Two terminals, E, connect to the points between which there is a difference of potential for the measurement of potentials. Two terminals, X, serve to join up the resistance in the potentiometer to the terminals of a secondary cell, which may have 20 to 40 ampere-hours capacity, and a voltage not exceeding two volts. This cell must be capable of furnishing a perfectly constant current of ·05 ampere for several hours in succession.

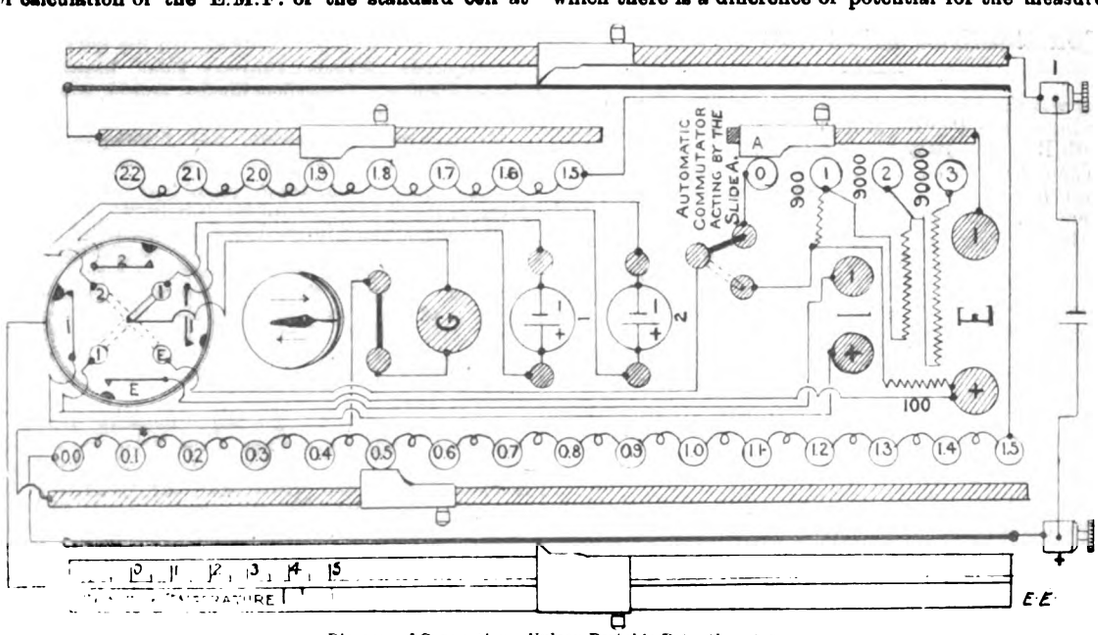


Diagram of Connections, Vulcan Portable Potentiometer.

As will have been gathered from the above description, the Vulcan portable potentiometer is a self-contained piece of apparatus, the standard cells and the whole of the resistances for measurements of pressure being contained in the case, whilst it only requires standard resistances, which can be supplied for

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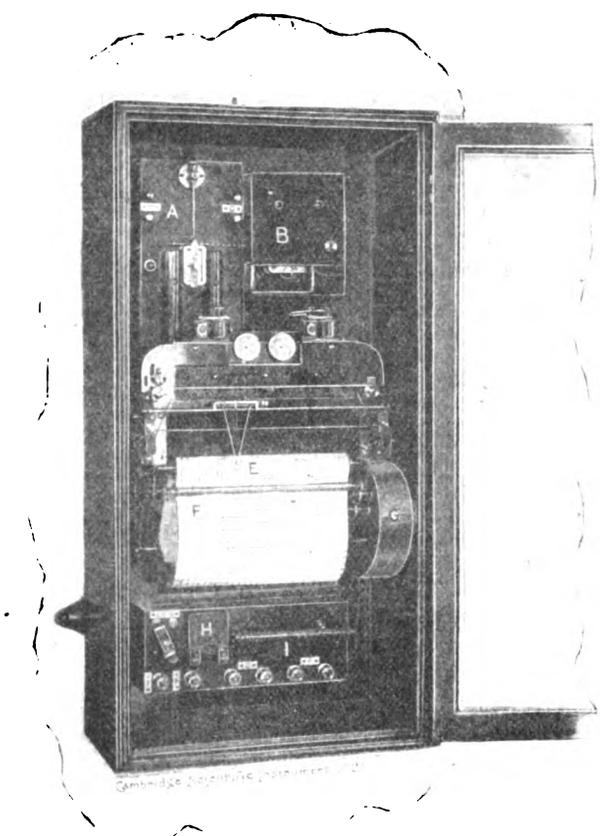
the measurement of current of any size. As regards portability it will be sufficient to mention that the dimensions of the instrument are 26in. × 6in. × 6in., and its weight 17lb. It is claimed that the instrument is suitable for measuring pressure, current, and resistance within ·0001—that is to say, it can be made with an accuracy within 1 in 10,000. It is further claimed that with this instrument equally accurate results can be obtained, whether it is carried from place to place or stationed permanently in the laboratory. Very full directions for use are contained in a leaflet issued by Messrs. Geipel and Lange, and from which we have gleaned most of the above information. Being self-contained, portable and accurate under different conditions, the Vulcan potentiometer should find a ready welcome.

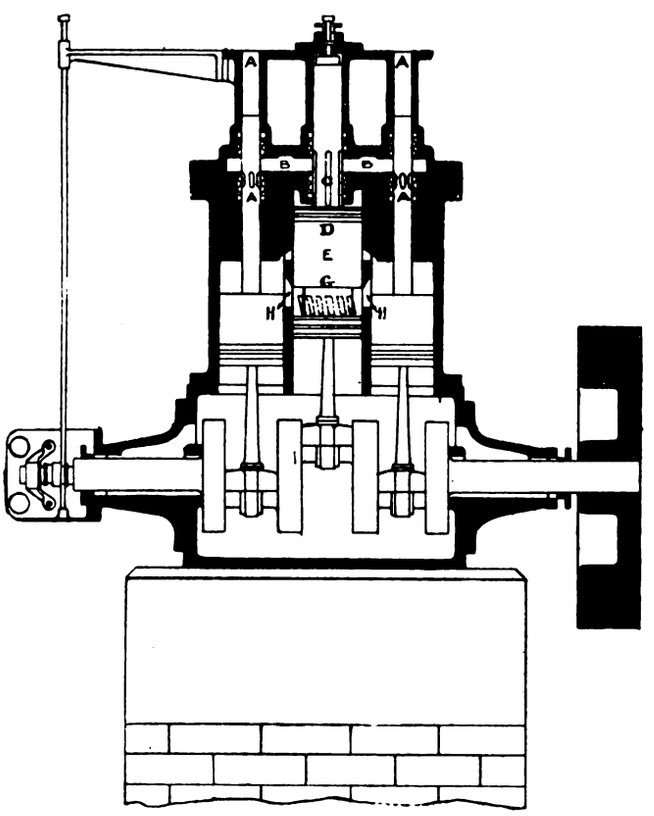
The Measurement of Temperature by Electrical Means.

From the Cambridge Scientific Instrument Company, Limited, Carlisle-road, Cambridge, we have received a copy of a pamphlet just published by them, which contains some interesting information on the above subject. We are told that the firm have been experimenting with the electrical thermometers of Prof. H. L. Callendar and Dr. E. H. Griffiths for many years with a view to rendering them capable of standing the rough treatment of commercial work, and without sacrificing their scientific accuracy. In this praiseworthy endeavour the firm claim to have been successful.



Callendar Patent Recorder.

The electric thermometers which they make are of two kinds: (1) resistance thermometers—those depending on the way in which the resistance of a coil of wire is affected by its temperature; (2) thermo-electric thermometers—those depending for their indications on the current generated by heating one of a pair of metallic junctions. In the first-mentioned type of instrument a fine platinum wire is wound on a mica frame, and suitably protected from the action of fumes or mechanical damage. This fine wire is connected by means of stouter wires to the indicator or recorder. An arrangement of compensating leads is fitted to eliminate the effect of temperature on the stem and wires connecting the thermometer to the temperature measuring apparatus. These resistance thermometers can be placed in positions where it would be absolutely impossible to use or read mercury ones. At the same time, the compensating leads permit of the thermometers being placed at considerable distances from the instrument employed to read the temperature. Either of two instruments may be used with these thermometers for reading the temperature—namely, the Whipple patent temperature indicator for direct reading or the Callendar patent recorder. We shall concern ourselves here only with the latter. A Callendar recorder of the simple Wheatstone bridge type is shown herewith. Essentially this instrument consists of a Wheatstone bridge or potentiometer, in which the movement of the slider along the bridge wire is automatically effected by relays worked by the current passing through the galvanometer between the bridge arms. According as the moving coil of this galvanometer, A, deflects in one direction or the other, a relay circuit is completed through one or other of two electro-magnets, C. Each of these magnets is mounted on a clock, the movement of which is prevented by a brake. When a current passes through the magnet this brake is lifted, allowing the clockwork to revolve. These clocks are connected by differential gearing with a recording pen, E, which is hauled in one direction or the other, according as the brake is lifted from the corresponding clock. The bridge slider moves with this pen, and tends to restore balance. As soon as this is done the galvanometer coil returns to its normal position, the relay is cut out, the brake springs back, stopping the clock, and the recording pen comes to rest until the equilibrium of the circuits is again disturbed. One of the illustrations in the pamphlet under notice shows a Callendar recorder in position at the dust destructor station, Nelson, Lancs. As regards the thermo-electric type of thermometer mentioned above, this form is especially useful for measuring very rapid changes of temperature, such as those taking place in a steam or gas engine cylinder, or in places where there is a great risk of the destruction of the thermometers. The temperature obtained is measured on a special form of voltmeter. Owing to the high internal resistance of this voltmeter, the instrument may be set up at a considerable distance from the furnace, etc., without the necessity of making allowance for the resistance of the conducting wires or the temperature of the voltmeter. On the other hand, it requires more frequent standardising, and is less accurate than the resistance thermometer, we are told. Temperatures as high as 1,300deg. C. can be measured without difficulty by means of either of these thermometers. It is unnecessary to dwell upon the wide range of usefulness which exists for apparatus of the kind in question.



Goodfellow's High-Speed Engine.

Goodfellow's High-Speed Engine.

We illustrate herewith a new high-speed engine of the compound single-acting type, the main feature in regard to which is that it possesses no valves in the ordinary sense of the term. For the drawing from which the accompanying illustration was made, and the following particulars relating to the engine, we are indebted to the makers, Messrs. Benjamin Goodfellow, Limited, of Hyde, Manchester. The boiler steam is admitted through the ports, A A, along passages, B B, and through ports, C, into the high-pressure cylinder, D. When the high-pressure piston has moved so far down that the top edge of the ports, C, are level with the bottom edge of passages, B B, steam is cut off from the high-pressure cylinder, and when the high-pressure piston has moved on down so far that the top of the high-pressure piston uncovers the top edge of ports, E E, steam is admitted from the high-pressure to the low-pressure cylinders through ports E E until the high-pressure piston has reached

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the same position on its return stroke and closes the ports E E. Expansion takes place in the low-pressure cylinder until the edge, G, of high-pressure piston has uncovered the bottom edge of ports H H, when exhaust takes place round the high-pressure piston and out of ports J. It will be noted that on the top of the trunks there is always sufficient pressure to keep the working parts under compression, so that a very high rate of speed can be obtained without resorting to special devices, such as cushions, etc. The method of admitting steam to the cylinders as described is one that dispenses with eccentrics and rods, whilst the governing of the engine is effected in a very simple manner by means of a twist valve which works inside the high-pressure trunk. This valve so acts upon the steam that the point of cut-off is made either sooner or later according to the load. By the arrangement of the pistons it is impossible for any water to lodge in any of the cylinders, as the tops of the pistons are so arranged that any water collecting in any of the cylinders is readily drained away. All the main working parts are enclosed, and the bearings are lubricated on the splash principle. The simplicity of the engine is at once apparent, there being no complicated parts, and the steam distribution is such, it is claimed, as will lead to very economical running. There being very few working parts to get out of order, and these being enclosed, it could, with safety, be left in charge of an unskilled workman, and the makers anticipate that it will be very largely adopted for driving dynamos, fans, and other machines which require high speeds.

COMPANIES' MEETINGS AND REPORTS.

BRITISH WESTINGHOUSE ELECTRIC AND CONSTRUCTION.

The third annual report of the directors for the year ending July 31, 1902, states that the profits for the year, including the sum brought forward from last year, amount to £79,594. 11s. 7d. Out of this an interim dividend of £23,257. 16s. 4d. and debenture interest to the amount of £6,132. 4s. 1d. have been paid, and the directors propose to appropriate a further sum of £30,000, making a full 6 per cent. on preference shares to July 31. Of the £20,204. 11s. 2d. remaining, £14,903. 17s. 6d. has been written off for stamp duties and fees incurred on the formation of the Company and the expenses connected with debenture issue, leaving a balance of £5,240. 13s. 8d., which is placed to reserve account. The growth of the Company's business is indicated by the following figures: orders received during the year ending July 31, 1899, £279,000; 1900, £547,000; 1901. £738 000; 1902, £932,000; and for the first four months of this year—viz., since July 31, 1902—the orders received exceed £825,000. This rapid growth of the Company's business necessitates an increase of capital, and the directors will propose to the shareholders that an additional £200,000 6 per cent. preference shares of £5 each shall be created, although it is only proposed to issue one-half of such shares at present. Pending the completion of the the Company's works at Manchester, orders have been executed at Pittsburg on terms whereby the British Company have shared the profit with the American Company, but now that the Manchester works are completed and manufacturing operations begun there, the whole of the profits will go to the British Company. A construction department has recently been organised, under the management of Mr. James C. Stewart, to carry out building and general construction, thus enabling the Company to undertake the complete installation of large railway, power, and lighting plant. Among important contracts obtained in the past year by the Company are those with the Metropolitan District Railway Company, the Metropolitan Railway Company, the Clyde Valley Electrical Power Company, the London United Tramways Company, Limited, the Bath Tramways Company, Limited, Exeter Corporation, Newcastle Corporation, Swansea Corporation.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Interest on 4 per cent. mortgage debenture stock	6,132	4	1
Interim dividend on 6 per cent. preference shares	23.257	16	4
Preliminary expenses written off	8,176	5	0
Expenses of debenture issue written off	6,787	12	6
Reserve account	5,240	13	8
Balance to balance-sheet	30,000	0	0
	£79,594	11	7
Cr.	£	s.	d.
Balance brought forward from last account	34,533	4	6
Less final dividend on preference shares	15,625	0	0
	18,908	4	6
Profit for the year, including estimated profit accrued to date, after providing for the expenses of management, directors' fees, and all other working charges	60,686	7	1
	£79,594	11	7

MARCONI INTERNATIONAL MARINE COMMUNICATION.

The report of the directors for the year ended June 30 last, to be submitted at the meeting on 9th inst., states that during the year the operations of the Company have been greatly extended, and many stations are now available for communication with vessels fitted with Marconi apparatus. Orders have also been received from Lloyd's to equip many of their signal stations. An agreement has been entered into with the Canadian Government providing for the equipment and maintenance of wireless telegraph stations on the Canadian coast. Contracts have been secured with the Belgian Government under which one land station and nine of the Belgian mail steamers, plying between Ostend and Dover, are being equipped with Marconi apparatus. An agreement has also been concluded with the Government of the Congo Free State in pursuance of which two Marconi stations, one at Banana, in the Congo Free State, and the other at Ambrizette, in the Portuguese colony of Angola, are now in course of erection. By the adoption during the past year of the Marconi system by the American, Allan, and Atlantic transport lines, the business of the Atlantic sea telegraph service is virtually assured to this Company, and it is confidently anticipated that so soon as arrangements can be made for the erection of land stations at suitable points those shipping companies owning vessels plying on other routes will avail themselves of the advantages offered by the Marconi system, which have already been proved on the Atlantic route. During the visit of the Colonial Premiers to this country, a demonstration of the practicability and utility of the Marconi system of wireless telegraphy was arranged for them on board the steamer "Koh-i-Noor." As a result, enquiries have been received from and proposals submitted to several of the Colonial Governments.

NERNST ELECTRIC LIGHT.

The report of the directors for the year ended Sept. 30 last, to be presented at the meeting on the 10th inst., states that the result for the year, after crediting interest and dividends received, has been a net loss of £1,643. In addition to this, there has been further expenditure amounting to £1,513. 17s. 6d., which is carried to development suspense account, and £443 for cost of new patents. As already announced by circular, the directors have concluded a working arrangement for a term of years with the Allgemeine Elektricitäts-Gesellschaft of Berlin, by which this Company has the benefit of their large existing manufacturing resources, and is spared the necessity for making a heavy capital outlay on a factory situated out of England. At the same time the legal proceedings in connection with the compulsory license were terminated, and in return for the cession of certain patents taken out in Great Britain by the directors and staff of this Company the Allgemeine Elektricitäts-Gesellschaft have made valuable concessions relating to the territories comprised in this Company's field of operations. Since the signing of this agreement in June over 30 agencies have been established in the Company's most important centres, and a supply of lamps has been sent out to enable demonstrations to be made without delay. The receipt and execution of orders has already commenced, and it is hoped that with the further retrenchments that have become possible, the Company may soon be in a position to cover expenses.

LEGAL INTELLIGENCE.

DUBLIN ELECTRIC TRAMWAYS.

The House of Lords on the 27th ult. heard the appeal of the tramway company in the case of the Dublin United Tramways Company *v.* Fitzgerald from an order of the Irish Court of Appeal affirming a decision of the King's Bench Division, by which the appellants' motion to set aside a verdict and judgment for £1,000 in favour of the respondent was refused, with costs. The action was brought by the respondent to recover damages for injuries sustained by him through being thrown out of a trap in Dublin, owing, it was alleged, to the road, for which the company were responsible, being slippery and unfit for traffic. This view was upheld by the Court of King's Bench and confirmed by the Court of Appeal last December. The House of Lords now dismissed the further appeal of the company on the same ground, the Lord Chancellor stating that it was for the company to keep the part of the roadway in a condition fit for public traffic; and although no precise method was exclusively obligatory, the use of sand was that which was actually enjoined on the company, and seemed to be the most satisfactory.

WINDING-UP PETITIONS.

Mr. Justice Byrne, in the Chancery Division on Tuesday, heard the petition of Disconto Maatschappij in the case of the New Imperial Electric Lamp Company for a winding-up order. His Lordship appointed the official receiver as provisional liquidator, and directed the petition to stand for a week. The books showed assets of £74, but it was stated that the busy season was coming on and there was a hope of resuscitating the Company's fortunes.

In the case of the British Motor Traction Company, the petition was presented by the Holborn Viaduct Land Company, Limited, but nobody appearing when it was called, the petition was dismissed.

DAMAGE TO AN ELECTRIC LIGHT MAIN.

In the Westminster County Court on Wednesday, before his Honour Judge Woodfall and a jury, the case of the Charing Cross and Strand Electricity Supply Corporation *v.* Israel and Joel was tried. It was an action by the plaintiff company to recover damages against the defendants, a firm of Covent Garden fruit brokers, in respect of an electric light main.

It appeared from the opening statement of counsel that in July of this year the plaintiff company were engaged on some electrical operations in the roadway between Floral-street and Bow-street, when owing, as alleged, to the negligence of the driver of one of the

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defendants' wagons, a truck laden with bitumen was overturned and thrown into a trench, with the result that a water-main was broken and flooded the plaintiffs' work. Not only had the plaintiffs suffered loss, but they had been called upon by the water company to make good the damage done to their pipes.

The defence was that there was no negligence on the part of the defendants' driver, but the jury, after hearing the evidence of a number of witnesses, found a verdict in favour of the plaintiff company for the amount claimed, and his Honour entered judgment accordingly, with costs.

NEW COMPANIES REGISTERED.

Longfield and Sons, Limited.—Capital, £2,000. Objects: to carry on in all their branches the business of electricians and electrical engineers, cycle and motor builders, etc.

Llangollen and District Electric Light and Power Company, Limited.—Capital, £6,000. Objects: to contract with the Urban District Council of Llangollen for the execution and maintenance of any works for the purpose of supplying electricity under the electric light provisional order, etc.

Electric Traction Company of Hong Kong, Limited.—Capital, £325,000. Objects: to adopt and carry into effect an agreement made by this Company with the British Corporation, Limited; to construct in any part of Hong Kong or elsewhere electric and light trams and railroads, etc.

North-West London Electric Supply Company, Limited.—Capital, £75,000. Objects: primarily to carry on business as producers and suppliers of electricity for the purposes of light, heat, or traction, etc.

Electrical Mining Company, Limited.—Capital, £5,000. Objects: to acquire, as a going concern, the business and undertaking of the Electrical Mining Company, of Derby, to develop and carry on the same, to carry on the business of general, mechanical, and electrical engineers, etc.

Empire Electric Light and Power Company, Limited.—Capital, £50,000. Objects: to construct and maintain any rail or tram roads in Romford and Ilford, Essex, etc.

APPOINTMENTS VACANT.

Electrical Engineers. Elland Urban District Council. Dec. 22. Fulham Borough Council, £400 per annum, rising by £25 per annum to £600 per annum, Dec. 15. See advertisements.

Test-Room Assistant. Aberdeen Corporation Electricity Department. 30s. per week, Dec. 8. See advertisement.

Engine Driver, Royal Masonic Institute for Boys Bushey, Herts, 23s. per week, rising to 33s. per week, Dec. 11. See advertisements.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

St. Pancras.—The Borough Council invite tenders for supplying a covered testing truck. Tenders by Dec. 9. See advertisement.

Bristol.—The Electrical Committee invite tenders (from boiler makers only) for water-tube boilers and accessories. Tenders by Dec. 11. See advertisement.

Bristol.—The Electricity Committee invite tenders (from arc lamp manufacturers only) for 380 5-ampere direct-current open-type arc lamps. Tenders by Dec. 8. See advertisement.

Sunderland.—The Corporation invite tenders for the supply of a Lancashire boiler, 28ft. by 8ft. 6in. diameter, with fittings, etc., complete. Tenders by 12 noon on Jan. 2, 1903. See advertisement.

Wallasey.—The Urban District Council invite tenders for engine and dynamo for traction purposes, Lancashire boiler, condensing plant, and water-cooling tower. Tenders by Jan. 15, 1903. See advertisement.

Cardiff.—The Tramways Committee invite tenders for the supply of tools necessary at their main car depôt. Specifications, etc., can be obtained on application to Mr. Arthur Ellis, The Hayes, Cardiff. Tenders by 18th inst.

Burnley.—The Health Committee invite tenders for the supply and delivery of steel steam-piping required for conveying steam from the refuse destructor boiler to the electricity station. Tenders by Dec. 20. See advertisement.

Dewsbury.—The Corporation invite tenders for the supply and delivery of one 200-kw. and one 300-kw. continuous-current steam dynamos, with Allen, Belliss, Browett-Lindley, or Willans engines. Tenders by Dec. 11. See advertisement.

Salford.—The Tramways Committee invite tenders for the supply of 50 electric tramcars. Full particulars may be obtained upon application to Mr. Ernest Hatton, general manager, Tramway Offices, 32, Blackfriars-street, Salford. Tenders by 4 p.m. on 15th inst.

Croydon.—The Town Council invite tenders for the extension of the car-shed at the Brighton-road (Purley) depot. Specifications, etc., may be seen and obtained at the Deputy Borough Engineer's Office, Town Hall, Croydon. Tenders by 11 a.m. on Dec. 8.

Bexley.—The Electric Lighting and Traction Committee invite tenders for car-shed buildings and steelwork. Specification, etc., may be seen at the Public Hall, Bexleyheath, and obtained at the offices of the Engineers, 82, Victoria-street, S.W. Tenders by Dec. 8.

Hebden Bridge.—The Urban District Council invite tenders for gas-engines for direct coupling to dynamos; dynamos, booster, and balancers; storage battery, switchboard, travelling crane, and supply and laying of cables. Tenders by Dec. 22. See advertisement.

Caen (Calvados, France).—The Prefect at this place requires tenders for the concession and working of a light railway between Trouville and Honfleur, a distance of about 10 miles, for goods and passenger traffic. Electric traction preferred. Tenders by Jan. 1, 1903.

Sidmouth.—The Urban District Council invite tenders from electrical engineers and others for the lease for a period of 42 years of a provisional order for the supply of electricity for lighting, heating, and power throughout their district. Tenders by Dec. 20. See advertisement.

London.—The County Council invite tenders for wiring and fittings for electric light and electric bell installations at fire brigade stations at Clapham and Highbury. Specifications, etc., may be obtained at the Chief Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Dec. 11.

Dublin.—The Dublin United Tramways Company invite tenders for the supply of general stores, including car fittings, iron, steel, castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, timber, etc., during year ending Dec. 31, 1903. Tenders by Dec. 8. See advertisement.

Manchester.—The Trafford Park Estates Company, Limited, invite tenders for permanent way, roadmaking, draining, etc., overhead equipment, and steel poles, etc. Specification, etc., can be obtained from Messrs Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Dec. 13.

Brighton.—The Council invite tenders for the construction of the permanent way of the tramroads in London-road, St. Peter's-parade, and Old steine, etc., including the bonding and all contingent works, and paving with wood the whole of the area of such roads, including the tramway tracks. Tenders by Dec. 23. See advertisement.

La Valette.—The Municipality invite tenders for the establishment and working for 99 years of a tramway between La Valette and Senglea Cospiena, Vettoriosa and Casal Zebbug. Deposit £300. Tenders by Nov. 25 to Wm. Casolani, receiver-general and director of contracts, La Valette. Plans and particulars will be ready by March 1, 1903.

Swansea.—The Graigola-Merthyr Company, Limited, invite tenders for the supply of the following stores during six months ending June 30: electrical goods, etc., gunmetal fittings, steam-piping, etc., files, and steel, packings, waste, indiarubber and asbestos sheeting and washers. Forms of tender may be obtained upon application in writing up to 9th inst.

Bradford.—The School Board invite tenders for the electric lighting required at the Feversham-street New Baths and the Green-lane School and Baths. Full particulars may be had on application to the architects—for Feversham-street, Messrs. Mawson and Hudson, Exchange-buildings, Bradford; for Green-lane, Mr. E. P. Peterson, Sunbridge-road, Bradford. Tenders by 8th inst.

Clacton.—The Urban District Council invite tenders for the supply and erection of boiler-house plant, two Economic boilers with fittings and accessories, steam and exhaust piping, two high-speed engines, two 100-kw. dynamos, balancer and boosters, switchboard, street work, underground cables, switch pillars, etc., accumulators, travelling crane, and rails. Tenders by Dec. 22. See advertisement.

York.—The North-Eastern Railway Company invite tenders for the following articles, in such quantities as they may require, during six months ending June 30, 1903, delivered carriage paid in the telegraph stores at York: telegraph apparatus, and telegraph wire and line stores. Forms of tender may be obtained on application to Mr. C. H. Ellison, Telegraph Department, York, and tenders must be sent to the Secretary at York by noon on Dec. 8.

Trimdon Grange (Durham).—The Owners of East Hetton, Trimdon, and Trimdon Grange Collieries invite tenders for 12 months' supply of iron, steel, castings, gas and steam tubing, indiarubber, packing, tallow, grease, oils, wicks, waste, etc., and electric light fittings. Forms of tender, etc., may be obtained from the Storekeeper, Trimdon Grange Colliery, co. Durham, and tenders are to be addressed to Messrs. Walter Scott, Limited, Trimdon Grange Colliery, by Dec. 8.

Bulawayo (Rhodesia).—Tenders are invited by the Municipal Council for the establishment and working of an electric tramway system for that municipality. A limited number of copies of a draft agreement upon which the Council is prepared to grant the right, together with plan of township, suggested route, and other details, can be obtained upon application to Messrs. Davis and Soper, 54, St. Mary's-axe, London, E.C., London agents of the municipality, by whom sealed tenders, endorsed "Tramways," will be received up to noon on Feb. 26.

London, S.W.—The Wandsworth and Clapham Board of Guardians invite tenders for providing and fixing up an electric wiring installation, and the fittings thereto, to the new buildings now being erected, and known as the receiving ward block, servants' block, and waiting-hall block at their infirmary, St. John's-hill, Wandsworth. Specification, etc., may be obtained up to and including Dec. 8, between 10 a.m. and 4 p.m. (Saturdays until 1 p.m.), upon application to the Guardians' architects, Messrs. Lansdell and Harrison, 65 and 66, Basinghall-street, E.C. Tenders by 12 noon on Dec. 10.

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RESULTS OF TENDERS.

Colchester.—The Town Council have accepted the tender of Siemens Bros. and Co., at £219, for the supply of a motor-generator.

Portsmouth.—Messrs. C. A. Parsons and Co. have secured the order from the Corporation for two 500-kw. turbo-alternators, with surface condensers and pumps.

Newcastle-on-Tyne.—The Town Council have accepted the tender of Mr. W. Worley, jun., Benwell, for the erection of a concrete tram-car shed at Wingrove, at £10,254.

Burnley.—The Town Council have accepted the tender of Messrs. Simpson Bros., Hapton, to supply and fix a motor pump, condensers, etc., at the electricity works, at £156.

Dungannon (Ireland).—The Urban District Council have accepted the tender of Messrs. Smith and Parkes, Donegall-street, Belfast, for the electric lighting supply, at £4,430.

Barrow-in-Furness.—The tender of Messrs. D. Bruce Peebles and Co., Tay Works, Bonnington, Edinburgh, has been accepted by the Corporation for reversible lighting booster and reversible traction booster for their electricity station, at £1,090. 10s.

Premier Incandescent Lamps.—The Premier Company have recently secured the contract for Premier electric lamps for the Lancashire and Yorkshire Railway, and the Midland Railway have also accepted the same company's tender for incandescent lamps for 1903.

Ipswich.—The Corporation have accepted the following tenders: Allgemeine Elektricitats-Gesellschaft, Berlin, switchboard and motor boosters, £2,833 (26 firms tendered); British Electric Equipment Company, London, overhead construction of tramways, £9.301 (15 firms tendered).

Reading.—The contractors for the electrical overhead equipment for the Corporation tramways, Messrs. R. W. Blackwell and Co., Limited, have accepted the tender of Messrs. Rowland Carr and Co. for the supply of the whole of the cast-iron bases, collars, finials, and pole guards required.

Southampton. — The Corporation have accepted the tenders of Hirst, Nelson, and Co., Limited, for the supply of 12 car bodies, at £3,532; Westinghouse Electrical Company, for the supply of equipments, at £2,405; Hirst, Nelson, and Co., for the supply of standards, at £123: and Westinghouse Electrical Company, for the supply of 13 Brill trucks, at £715.

Bristol.—The Corporation have accepted the tender of C. A. Parsons and Co., Newcastle-on-Tyne, for the supply, delivery, and erection at the Avonbank electricity works of two direct-coupled single-phase steam turbo-alternators, each having a normal output capacity of 750 kw., at 2,200 volts, and an emergency output of not less than 950 kw., at 2,200 volts, for three hours.

Heckmondwike.—The Urban District Council have received the following tenders for supply and erection of a water-tube boiler and accessories at their electricity works: Babcock and Wilcox, Oriel-buildings, Farringdon-street, London; B. S. Rowland and Co., Climax Works, Reddish; Stirling Boiler Company, 2, St. Andrew's-square, Glasgow, with mechanical stokers (accepted).

Storage Batteries.—The Electrical Power Storage Company, Limited, London, E.C., have received orders for the supply of storage batteries from the War Office for the Stanhope and Marlborough Lines, Aldershot; Bury Corporation; the Roundhay and District Electric Lighting Company, Limited; Roxburgh District Asylum, Melrose; North Riding Lunatic Asylum; and the Langho Asylum.

Southampton.—The Corporation have received the following tenders for the extension of car-sheds and other buildings at the Portswood tramway depôt:

Dyer and Sons, Southampton (accepted)	£2,775
Jenkins and Sons, Limited, Southampton	2,983
H. Stevens and Co., Southampton	2,984
F. Osman, Southampton	3,100
Coston and Co., Limited, Southampton	3,263
J. Nichol, Southampton	3,295

BUSINESS NOTES.

TRACTION.

Dunstable.—The tramway scheme has been revived.

Quarry Bank.—The Council have agreed to apply for a light railway order.

Lancaster.—In a few weeks the electric tram service is expected to be commenced.

Prestwich.—The electric tramway system will probably be opened for traffic this week.

Pontypridd.—The demand for a poll on the tramways question has been withdrawn.

Southampton.—In future not more than six persons will be allowed to stand inside the tramcars.

Stroud.—The local traders' association is welcoming the introduction of tramways into the district.

Bolton.—This place is considering the question of the transport of merchandise by the electric cars.

Worthing.—The Corporation have agreed to themselves apply for powers to lay down a system of electric tramways in Worthing.

Stapleford.—A committee of the whole Council has been formed to consider the plans of the proposed light railway in the district.

Ilford.—A resolution was adopted at the last meeting of the Urban District Council to apply for a provisional order for tramway extensions.

Brighton.—The complete return for the past year's working of the tramways on the Lewes-road route is: passengers, 2,468,588; income, £10,285.

Gloucester.—The negotiations between the Corporation and the County Council with reference to a joint tramways scheme are still going on.

Stretford.—At Tuesday's meeting of the Urban District Council it was decided to oppose the Manchester Southern Tramways (Lancashire) Bill.

Long Eaton.—In connection with the electric tramways scheme for the district a committee has been appointed to examine plans and to report thereon.

Fairfield.—The subject of the proposed light railway for the district was referred to committee at Tuesday's meeting of the Urban District Council.

Cleckheaton.—The District Council have concluded their negotiations with the British Electric Traction Company, and an agreement has been arrived at amicably.

Hove.—A special meeting of the Town Council on Monday decided to proceed with the Corporation Tramways Bill with the exception of the proposed Western-road route.

Batley.—No settlement has yet been arrived at between the Corporation and the British Electric Traction Company with regard to leasing the lines within the borough.

Dundalk.—The Louth County Council have decided to support the application of the Dundalk and Blackrock Electric Tramways Company for an extension of time of their order.

Soyland.—After discussion at the meeting of the District Council on Tuesday it was decided to apply to the Halifax Corporation for the extension of the tramways to Ripponden.

Lancashire Tramways.—The British Electric Traction Company are applying for powers to lay down a system of tramways in the outlying districts of Manchester and Salford.

Penge.—Plans showing the route and method of construction of the proposed tramways being promoted by the British Electric Traction Company have been referred to committee.

Halifax.—The Town Council on Wednesday approved the intention to apply to the Board of Trade for a provisional order to authorise the construction of new tramways in the borough.

Huddersfield.—The work of widening portions of New-street and Buxton-road, so as to permit a double length of tramways being laid in place of the present single one, has been commenced.

Carlisle.—The adoption of ½d. fares on the tramcars a few weeks ago is said to have been attended with great success, the increase in the receipts on this account for four weeks being put at over £22.

Aberdeen.—The Town Council on Monday rejected a proposal to run workmen's cars in the early morning and ordinary cars late at night for the convenience of those attending places of amusement.

Penarth.—At the last meeting of the District Council it was agreed to approach the Cardiff Corporation with a view to appointing a committee to discuss a joint tramway scheme between Cardiff and Penarth.

Keighley.—A meeting of the Rural District Council was held on Tuesday, when a representative attended on behalf of the Mid-Yorkshire tramways scheme and explained the sectional plans which had been received.

Sunderland.—The Rural District Council have agreed to consent to the Bill promoted by the British Electric Traction Company, in which it is proposed to construct a tramway from South Shields to Whitburn and Sunderland.

Belfast.—After a lengthy debate at the meeting of the Borough Council on Monday the refusal of the Tramways Committee to accede to the terms of the tramways company for the sale of their undertaking was confirmed.

Beckenham.—The District Council have refused their consent to the proposal of the British Electric Traction Company for a tramway through the district. A ratepayers' meeting will be held in January to discuss the question.

Warrington.—On Wednesday the Corporation approved the light railway order as amended, and decided to urge upon the Commissioners the desirability of giving the Corporation compulsory running powers over the Northwich line.

Manchester.—The electric tramway routes on the southern side o the city were opened on Monday, when about 30 miles were added to the length of lines previously run over by the cars. Particulars of the new routes appeared in our last issue.

Hull.—A mass meeting of the Corporation tramway employés has unanimously agreed to request a meeting between the whole Tramway Committee and the representatives of the employés to finally discuss and settle the demands already tendered.

Newcastle.—The Tramways Committee propose to lower some of the roads over which the electric cars run in order to allow of the use of double deck cars. At present this type of car is unable to pass under certain bridges on the line of route.

Burton.—A special meeting of the Town Council has sanctioned an application to the Board of Trade for a provisional order authorising the construction by the Corporation of additional tramways within the borough on the Derbyshire side of the Trent.

Heckmondwike.—At the last meeting of the District Council it was reported that the negotiations with the British Electric Traction Company had been completed, and a resolution was unanimously adopted authorising the signing of the necessary agreement.

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Gillingham.—The proposed extensions of the tramways by the Chatham and District Light Railways Company came under the consideration of the District Council at their last meeting. The Council decided to reconsider the question when the plans are received.

Preston.—On Thursday last week the Town Council confirmed the appointment of Mr. Walter H. Tittensor, of Dundee, as resident electrical engineer for the design and construction of the electrical tramways, on a three years' engagement at a salary of £600 per annum.

Ipswich.—The construction of the electric tramways in the town has been commenced, but the only sign at present of outside work is the starting of the laying of the cable at Whitton. It is reckoned that the electric trams will be running shortly after October next year.

Swansea.—A special meeting of the County Council has decided to acquire certain sections of the Swansea tramways system—viz., the St. Helen's-road section and that portion that extends from the High-street terminus to the Hafod Bridge, opposite the entrance to the Strand.

Greenwich.—The Borough Council have agreed to sanction the proposal of the London County Council to construct a tramway from Trafalgar-road through the Blackwall Tunnel, on condition that the County Council pave the roadway from the Trafalgar-road to the tunnel with granite setts.

Southport.—A meeting of the Ruridiaconal Conference of North Meols has passed a resolution strongly deprecating the running of Sunday trams in Birkdale and Southport. The General Purposes Committee of the Corporation this week also finally decided against the running of trams on Sundays.

Derwent Valley Light Railway.—A joint committee, consisting of representatives of the Escrick Rural District Council and Riccall Rural District Council, the promoters of this light railway, has been appointed in accordance with Clause 4 of the order recently confirmed by the Board of Trade for the construction of the above railway.

Bournemouth.—A special meeting of the Town Council last week decided to promote a Bill in the next session to empower the Corporation to maintain and use the tramways authorised by the Bournemouth Corporation Tramways Order, 1900, and to confer further powers upon them in regard to tramways and light railways, and for other purposes.

Rotherham.—A special committee is to be appointed for the purpose of considering and reporting as to the appointment of a manager in connection with the tramways. It has been referred to the Parliamentary Committee to consider an application from the Sheffield Corporation to construct a tramway to Blackburn, passing through Rotherham.

Wembley.—A letter was received from the Wealdstone Urban District Council at the last meeting of the District Council giving a negative reply to a request of the Wembley Council to join in a petition to the Middlesex County Council to appeal to the Board of Trade against the recent decisions of the Light Railway Commissioners affecting the district.

Crewe.—Reporting at the last meeting of the Town Council, the Electric Light Railway Committee stated that four firms who had been in communication with them regarding the provision of light railways for Crewe had withdrawn their applications for the present, one of them stating that the conditions of the Corporation were too formidable for them to accept.

The Peak District.—Application will be made to the Light Railway Commissioners by the Derbyshire and District Traction Syndicate, of Buxton, to construct a light railway in Derbyshire and Cheshire. The proposed line will commence at Macclesfield, and then, by way of Hartington-Upper-Quarter and Burbage, go to Buxton. It will also serve Chapel-en-le-Frith, Peak Forest, and Wormhill.

Bakewell.—The Bill is now in course of preparation for introduction into Parliament next session for the purpose of incorporating a company with powers to construct a new light railway in Derbyshire from a junction with the Dore and Chinley branch of the Midland Railway, near Grindleford Station, to a junction with the Derby and Manchester branch of the Midland Railway at Bakewell.

North London.—The Metropolitan Electric Tramways, Limited, which is an off-shoot of the British Electric Traction Company, have taken over the undertaking of the North Metropolitan Tramways Company. For the eight miles of lines, including depôts, equipment, horses, cars, and goodwill, the price paid is £200,000. The tramways run between Edmonton and Wood Green and Finsbury Park.

Twickenham.—The District Council have obtained from the London United Tramways Company an undertaking not to lay the tramlines in those parts of Hampton Court-road which are to be widened until the widening has been carried out in accordance with the plans approved by the County Council. The cost to the Council of appearing on Tramway Bills and light railway orders has amounted to £14,000.

Blackburn.—During the week ending Nov. 21 the total number of passengers carried on the Corporation tramways was 126,138, and the receipts amounted to £718, as compared with 116,415 passengers and £643 receipts in the corresponding period last year, an increase of 9,723 passengers and £75 receipts. For the 241 days' running in last year the receipts were £28,776, as against £24,940, an increase of £3,836

Birmingham.—At the forthcoming meeting of the authorities adjoining Birmingham it is anticipated that some criticism will be offered on the action of the General Tramways Committee. Six local councils are promoting a Bill seeking running powers into Birmingham At the next meeting of the Yardley Town Council the formal consent of the Council will be asked to the proceedings already taken.

Edinburgh.—In connection with the proposed tramway between Edinburgh and Queensferry a syndicate are applying for a provisional order to construct a tramway from the west end of Princes-street to Queensferry, and have applied to obtain the approval of the Suburban District Committee of the County Council. The committee, however, have declined to consider the matter until they have the full details and plans before them.

West Sussex.—In any agreement the County Council may enter into with the British Electric Traction Company with reference to their proposal for a tramway between Hove and Worthing, the County Council have decided to insist upon a provision that the company should construct no tramway in Worthing without the previous consent of the Corporation, unless the Corporation did not proceed with its Tramway Bill.

New South Wales.—The Government of New South Wales have decided to reappoint for a further term of office the three railway and tramway commissioners of the colony, Messrs. Charles Oliver, David Kirkcaldie, and W. M. Fehon, whose previous appointment expired last October. This makes the third septennial term for which the State railways and tramways of New South Wales have been placed under the control of a non-political board of commissioners.

Perth.—The directors of the Perth and District Tramway Company have submitted a statement to the Board of Trade containing their observations on the resolutions passed by the Town Council to acquire the undertaking so far as it lies within the burgh. The directors again express their willingness to sell their concern to the Corporation on the basis of their being able to pay the shareholders 20s. in the £. They also renew their application for a concession for 32 years.

Croydon.—Sanction of the Board of Trade has been received to spend £3,500 on extending the Purley tramway depôt The British Electric Traction Company propose to commence the construction of the lines in Penge authorised by the Croydon and District Tramways Act of this year, and the new lines in the borough are to be constructed at the same time. A new tramway is proposed by the company between Croydon and Sutton, and has been approved by the Corporation.

Poole.—On Wednesday last week the Poole and district light railway order came before Sir Herbert Jekyll at the Board of Trade for confirmation from the decision of the Light Railway Commissioners, who held an enquiry in June last The order refers to the tramway it is proposed to construct through Parkstone. The confirmation of the order was objected to on the ground that the Bournemouth Corporation were promoting a Bill with the same object. Sir Herbert Jekyll reserved his decision.

South Lancashire.—In a letter to the Swinton and Pendlebury Urban District Council the South Lancashire Tramways Company state that they are hoping to see the network of tramways they are constructing in South Lancashire open for traffic before the end of four years. The company have already completed the route from Bolton through Atherton and Leigh to Lowton, and by the end of the year they will have completed the route from Haydock to Hindley and from Hindley through Atherton to Tyldesley.

Railway Electrification.—The Cheshire Lines Committee are again reported to be considering the advisability of going in for the electric traction between Manchester and Liverpool. For this purpose it is proposed to seek parliamentary powers. The Liverpool line is the joint property of the Great Central, the Cheshire Lines Committee, and other companies. It is suggested that the new scheme should be connected with the overhead electric railway at Liverpool so as to provide a new through route to Southport.

Clydebank.—Every effort has been made to complete the work of laying the rails and erecting the overhead equipment of the tramway to Clydebank, so that it might be possible to run the cars before Christmas, but unfortunately the work of putting up the poles and wires has had meantime to be stopped on account of delay on the part of the Post Office authorities. The Post Office require to alter the position of some of their wires, and the engineers in Glasgow cannot proceed with the work until they get authority from headquarters.

Horsforth.—An interesting arrangement has been come to between the District Council and the Leeds Corporation with a view to keeping the company promoter out of the district. It is to the effect that the District Council shall obtain an order authorising the construction of a tramway from the Kirkstall terminus of the Leeds tramways to Horsforth, and that they shall at once hand over the order to the Corporation on the Corporation paying the bare costs of obtaining the order, and on the understanding that the Corporation shall construct the tramway in question.

Blackpool.—The Town Council have decided to grant tram tickets at 3d. per dozen to school children attending private and elementary schools. When the new double track of the Blackpool Tramways Company is opened in May next, the Corporation will supply the current at 2d. per unit up to 250,000 units, and 1½d. per unit beyond that consumption for the line within the borough. Estimates for the additional plant, with estimates of probable revenue, have been submitted by the engineer, and a special meeting of the sub-committee is to be called at an early date.

Wednesbury.—The deadlock which has arisen in consequence of the failure of the Corporation to come to terms with the British Electric Traction Company as to the tramway service was again brought into prominence at last week's Council meeting by a report from the General Purposes Committee that the Board of Trade had consented to the use of steam power on the tramways for a further period of six months on condition that the lines and engines were efficiently maintained. The engagement of an expert to report on the trams was suggested, but the proposal fell through.

Additional Traffic Returns.—Anglo-Argentine, £309 increase; Barcelona Ensanche y Gracia, £21 increase; Barcelona, £77 increase; Brisbane, £141 increase (month of October, £10,359, increase £979); Buenos Ayres and Belgrano Electric, £24 increase (month of

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November, £13,698, increase £925); Calcutta, £691 increase; Cape Town (month of October), receipts £16,507, expenditure £8,727; Isle of Thanet Electric, £257 increase; Mexico Electric (month of October), receipts £21,600, expenditure £12,580; Perth Electric, £122 increase; Port Elizabeth (month of October), receipts £3,832, expenditure £2,095.

Ripon.—Some complaint was made at Monday's meeting of the Town Council that the Power and Traction Company had rather gone behind the back of the Corporation in applying for a provisional order for tramways, when it had been decided that the matter should be adjourned for six months. The Town Clerk replied that ample opportunity would be given for discussing the matter in the Council, and there would also be a Board of Trade enquiry, at which public objection could be made if desired. The plans and estimates were lodged on Saturday, from which it appears that the company contemplate an outlay of £51,667.

Brierley Hill.—The Dudley, Stourbridge, and District Electric Traction Company have agreed to construct a double line through High-street and pave the whole width with wood blocks. The company are applying for an order under the Light Railways Act to construct a line from Mill-street, Brierley Hill, to Five Ways, Cradley Heath, in connection with the Dudley, Halesowen, and district light railway extensions. The Council have decided to oppose the application, on the ground that they themselves are making joint application with Rowley Regis and Quarry Bank for an order to construct the lines themselves.

Leeds.—The Thermit process of welding tramrails is shortly to be given a trial at Leeds. The process was brought to the notice of engineers at the Düsseldorf Exhibition, and was referred to in this journal at the time. Although it has been somewhat extensively used on the Continent, we do not know that it has yet been given a practical trial in this country such as is proposed at Leeds. A special meeting of the Corporation on Wednesday decided on an application to the Board of Trade for powers to construct a number of new tramways and extensions of existing lines—nine in all.

Nottingham and Derby.—Last year one or two schemes were formulated for establishing an electric light railway system between Nottingham and Derby, taking in the borough of Ilkeston and serving an important adjacent district. But the original schemes were not passed, and a new project is now to be presented to Parliament. The proposed railway will serve Duffield, Belper, Alfreton, Mansfield, and other places. Upon approaching Derby from Duffield, the proposed route is down Belper-road, along Milford-street, Arthur-street, Bridge-gate, crossing St. Mary's Bridge, thence along Nottingham-road. Powers are being asked for to run over tramways within the borough of Derby.

West Bromwich.—On Wednesday members of the Town Council inspected the first of the new electric tramcars which are to be used in the borough. Subsequently at a meeting of the Town Council it was asked whether the Electric Lighting and Power Committee were satisfied that they had sufficient steam power to supply the required energy to drive the trams. The cars were much heavier than the present ones, and if they had a five minutes' service a greater quantity of power would be needed. In reply, it was stated that the committee proposed to put 24 cars in service, and, whilst they had sufficient power to run them between Carter's Green and Handsworth, they would need additional plant.

Bradford.—At a meeting of the Tramways Committee last week plans were passed for the erection of a shed at Saltaire to accommodate 30 tramcars. The committee discussed the desirability of adopting covers for the tops of the cars, and it was ultimately agreed that as an experiment six new cars should be fitted with tops similar to those in use at Liverpool. The tramway employés here have received a report on the negotiations with the Tramway Committee and adopted it. The dispute, therefore, may be regarded as at an end. It has been decided that 10 passengers shall be allowed to stand inside the cars. Hitherto the number of inside excess passengers has been left to the discretion of the conductor.

Automobiles in France.—A Paris correspondent says that the principal features of the forthcoming automobile exhibition at the Grand Palais, which will be much the largest ever held and which is attracting thousands of foreigners to the French capital, are the development of covered carriages, the disappearance of the old-fashioned radiator in favour of the water-cooler introduced in Germany, and the fact that almost every manufacturer is copying the German Mercedes car. The new Mors carriages for 1903 are, indeed, exact copies of the Mercedes. The Mercedes manufacturers will not show their latest types at the approaching exhibition, but it is understood that they have several improvements in progress.

Tube Vibration.—Included in the printed answers to parliamentary questions is the following: Mr. H. D Greene asked the President of the Board of Trade if he could state when arrangements will be completed for stopping the annoyance and damage from vibration arising on the Central London Railway; and whether the Board of Trade will take steps to compel the adoption of the suggestions of their committee. Mr Gerald Balfour replied: The company have recently informed me that, in view of the suggestions made by the committee, they decided to substitute motorcars for the present locomotives; that tenders for the construction and equipment of the cars were let in May last; and that the contractors assure them that delivery of the cars will commence in the early part of next year.

Exeter.—The City Council have decided by 41 votes to 6 to apply to Parliament for powers to take over the existing horse tramways, and to substitute electric for horse traction. Power is also sought by the Corporation to construct new lines, the current to be supplied from the city's new electric generating station; to carry out various street improvements along the new suggested routes, as well as to run 'buses in connection with the trams. The British Electric Traction Company have applied to the Board of Trade for ratification of an agreement whereby they would become possessors of the existing horse tramways, but the Board have sanctioned notice being served by the City Council on the present company for a compulsory transference of their undertaking to the Corporation.

Hebden Bridge.—The Mayor of Halifax has suggested a conference between his Corporation and the Hebden Bridge Urban District Council to discuss the position arising out of the fact that simultaneous with the opening of the Halifax Corporation's new electricity generating station at Hebden Bridge the Urban District Council have resolved to advertise for tenders to provide generating plant of their own. The object of Halifax in incurring an expenditure of £27,000 was not only to generate electrical current to run their tramcars, but also to provide Hebden Bridge and other places with electricity. The Hebden Bridge Council are not satisfied with the terms offered by Halifax, but the Corporation contend that the District Council cannot supply their own wants at a less cost.

Salford.—The Tramways Committee are experimenting with a device patented by Messrs. H. and C. W. Collins, of Salford, for operating automatically the street and overhead points at tramway junctions which at present are worked by hand. The construction of the new electric tramways on the route from Kersal Bar to Prestwich has proceeded so satisfactorily that it is anticipated that the work will be completed in the course of a few days. The work of relaying the double track of lines running from the Height Wesleyan Chapel along Manchester-road to Swinton Church for electric traction has now been commenced. On Wednesday the Town Council adopted a resolution confirming the propriety of promoting a Bill in Parliament to empower the Corporation to construct new tramways in the borough, to carry out street improvements, and for other purposes.

District Railway.—At a meeting of the Preference Shareholders' Committee of the Metropolitan District Railway Company last week it was agreed to advise the holders of £1,500,000 5 per cent. preference share capital to accept the following proposals for a guaranteed dividend made by the Underground Electric Railways Company of London, Limited: the Underground Company will pay to each preference shareholder who accepts their guarantee the following rates of interest—namely: 1 per cent. from Jan. 1, 1903, to Jan. 1, 1904; 2 per cent. from Jan. 1, 1904, to Jan. 1, 1905; 3 per cent. from Jan. 1, 1905, to Jan. 1, 1907; and 3½ per cent. thereafter in perpetuity. The surplus, if any, beyond the above amounts earned in any year up to 5 per cent. will belong to the guaranteeing company, who will, during the continuance of their guarantee, exercise all voting powers in respect of the aforesaid stock, subject to the restriction that the vote shall on no occasion be used for the purpose of reducing the interest payable by the Metropolitan District Company upon their preference stock.

Barcelona.—The directors of the Barcelona Tramways Company, Limited, have issued a circular to the shareholders and debenture stockholders of the company recalling that in July last the directors invited subscriptions for £51,900 4½ per cent. redeemable debenture stock, being the unissued balance of the £200,000 authorised issue. The amount offered, the circular continues, was largely over-subscribed, and the Board would have proceeded to allotment but that in the interim certain gentlemen in Barcelona concluded a contract with the company giving them the option of purchasing the company's undertaking, against a forfeitable deposit of £4,000, subsequently increased, in consideration of a short extension of time, to £5,000. This option has not been exercised, and the company therefore retains possession of the £5,000. The directors now offer the stock again at the same price, and any balance not applied for on or before the 13th inst. will be taken by the directors and their friends on the same terms. The electrical equipment of the Ensanche system is now practically complete and the proceeds of this issue will be applied towards payment for the electrification of that line, and the Bona Nova extension recently constructed.

Cardiff.—A singular incident occurred on the Corporation tramway system on Saturday afternoon. A passenger was riding on top of one of the electric cars, and while passing under the Taff Vale Railway Bridge it is stated that his head was caught by a trolley wire, by which he was thrown to the roadway and received severe injuries. The tramway officials consider it highly improbable that the man was caught by either the trolley or one of the wires. But if that actually occurred, then he must have been standing while the car was passing under the bridge, a danger which passengers are warned against. Mr. Harpur, the borough engineer, has reported as follows on the various tramway works now being executed in the borough: "The total mileage of tramways reconstructed, reduced to single lines, is 11 miles 4 furlongs, of which 1 mile 2 furlongs were reconstructed under the contract for the Cardiff Tramway Company. The total cost of the work, after deducting credit for old material sold, etc., and adding engineering charges, is £67,260, which is equivalent to £5,829 per mile, to which must be added the cost of altering the levels of the footways and carriageway in Newport-road, near Roath Court, £983, and the cost of lowering the road under Bute-street Bridge, £2,314, making a total of £70,577. It will be within your recollection that I estimated the cost of reconstructing the tramways at £70 263, but the estimate did not include the £3,297 mentioned above in connection with the alteration in Newport-road and under the G.W.R. bridge in Bute-street. The credits above mentioned as due to sale of old material were £5,282, and the cost of the work carried out by the contractor for the tramway company, after making due allowance for the proportion for the credits due in respect of same, was £9,787, or at the rate of £7,249 per mile, whilst the cost of the work carried out by the Corporation amounted to £6,039 per mile."

London County Council.—The Highways Committee have abandoned their proposals to lay down tramways from Rushey Green, *viâ* Bromley-road, to the county boundary near Bromley-hill, and from Battersea Park-road, *viâ* Battersea Bridge-road and Battersea Bridge,

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to a point in Beaufort-street, near King's-road. The committee presented the Council on Tuesday with a report concerning the contracts for generating station plant and boilers. Contracts have been entered into with Messrs. Dick, Kerr, and Co., Limited, and the Stirling Boiler Company respectively, for the supply and erection of the generating station plant and boilers required in connection with the electrical working of the Tooting-to-Westminster, etc., tramways. The form of contract in each case provides that no payments on account of the work shall be made to the contractors until the plant, etc., shall have been placed in position at the generating station. The temporary engine-house at Loughborough Junction, where a portion of the plant is to be erected, is not yet completed; and the contractors have asked that certain payments on account may be made to them in respect of work already completed, in view of the fact that the Council is unable to take delivery within the periods specified in the respective contracts. The committee accordingly recommended that authority be given for advances to be made to Messrs. Dick, Kerr, and Co., and the Stirling Boiler Company respectively, on the amounts of their contracts, notwithstanding the provisions in the contracts relative to payments to the contractors. The work devolving upon the electrical engineer and his assistants in the tramways department in connection with the reconstruction of the tramways and the making of the necessary arrangements in anticipation of the electrical working of them is now of such magnitude, and, moreover, will be so largely increased in the near future when the electrical working is commenced, that it is proposed to engage further expert assistance. The Highways Committee informed the Council on Tuesday that they are of opinion that the want would best be met by the appointment of an assistant electrical engineer, who shall have received both technical and practical training in his profession, and shall also have experience in the designing and construction of electrical machinery and equipment, in preparing specifications, and in the running, repair, and maintenance of electrical plant generally. They think that, having regard to the nature of the qualifications required in the officer to be appointed, that a salary of £500 should be attached to the post. The committee recommended accordingly. Provisions have been included in the London County Council (Tramways and Improvements) Bill for next session with regard to the construction of the following tramways: Hampstead-road (tramways terminus), across Euston-road and along Tottenham Court-road, to a point near Oxford-street; Hammersmith-broadway, *via* Bridge-road, to and across Hammersmith Bridge; Trafalgar-road, Greenwich (London County Council tramways), *via* Blackwall-lane and Blackwall Tunnel, to the Council's (northern) tramways in East India Dock-road; Harlesden (near the county boundary), *via* Scrubbs-lane, Wood-lane, Shepherd's Bush-road, and Brook Green-road, to Hammersmith-broadway; Edgware-road (from a point near the Marble Arch) to the county boundary at Cricklewood; Deptford (London County Council tramways), *via* Blackheath road and hill and Shooter's Hill-road, to Herbert Hospital, Woolwich; Garratt-lane, Wandsworth (authorised London County Council tramways), *via* Wimbledon-road, to the county boundary; Westminster Bridge-road (tramways terminus), *via* Westminster Bridge and the Victoria-embankment, to join the underground tramway authorised by the London County Council (Subways and Tramways) Act, 1902, at a point between the Strand and the Embankment; and widenings of the following thoroughfares: Brook Green-road and Scrubbs-lane, Hammersmith; Edgware-road, High-road, Kilburn, and Shoot-up-hill, Cricklewood: Shooter's Hill-road; Southampton-row (between Fisher-street and Theobalds-road); Southampton-row (between Vernon-place and Bloomsbury-place); Wimbledon-road, Wandsworth.

LIGHTING AND GENERAL.

Derby.—An extension of the mains to Longford-street has been ordered.

Deptford.—The Borough Council are in favour of the London County Council's Wiring Bill.

Electric Coal-Cutter.—Electric coal-cutting machinery has been introduced at the Snibstone Colliery.

Nottingham.—The School Board propose to light with electricity all its schools used for evening classes.

Oulton and Carlton.—The compulsory area for electric lighting for Carlton and Oulton has been fixed.

Leek.—The Electric Lighting Committee have applied for a three years' extension of the provisional order.

Monmouth.—At the last Town Council meeting the Electric Committee reported increasing earnings from the light.

Stafford.—The Town Council are considering a revision in the existing scale of charges for electrical motive power.

Carmarthenshire.—The Llanelly Urban District Council propose to oppose the Carmarthenshire electric power scheme.

Dover.—The Chamber of Commerce have decided to urge the Postmaster-General to give a special telephone wire direct to Deal.

Commercial Cable Co.—Payment is announced on the 2nd prox. of a quarterly dividend of 1¾ per cent. and a bonus of 1 per cent.

Lowestoft.—The compulsory area for the electric light has been fixed, but the whole question now stands suspended for the present.

Darlaston.—The Midland Electric Power Company hope to be in a position to supply electricity in the Council's district in the spring.

Pembroke (Ireland).—Application is to be made for sanction to borrow £20 000 for extending the electricity supply plant and mains.

Neath.—The Corporation propose to engage an electrician to report upon the arrangement to be made in the supply of electric light in the district.

Rhyl.—Mr. R. H. Bicknell, C.E., has held an enquiry into an application of the Urban District Council for sanction to borrow £9,567 for purposes of electric lighting.

Pacific Cable.—President Roosevelt has signed the contract with the Commercial Pacific Cable Company for a cable from San Francisco to China *via* Honolulu, Guam, and the Philippines.

Deal.—We understand that the Councils of Deal, Walmer, and Sandwich are simply waiting for the draft order before doing anything further in regard to the Kent electric power scheme.

Wimbledon.—The further hearing of the appeal against the assessment of the electric lighting works has been adjourned until the meeting of the Assessment Committee in December.

Penge.—The Urban District Council will receive a deputation from the Blackheath Electric Supply Company with regard to their application to Parliament for the purchase of the Lewisham Company.

Maidenhead.—The works at the central station will be formally started on Wednesday, Dec. 17, at 3.30 in the afternoon, by Ernest Gardner, Esq., M.P. The current will be switched on on Dec. 8.

Electric Organ.—The Organ Committee of the Swansea Parish Church will meet shortly to decide upon the erection of an electric organ. Meanwhile some £500 has been subscribed towards the fund.

Western Telegraph Co.—The directors have declared an interim dividend, payable Dec 19, of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended Sept. 30, 1902.

Wednesbury.—A discussion arose on the question of improvements in the street-lighting at the last Town Council meeting, and a suggestion that electric lighting be tried experimentally was favourably received.

Wallasey.—Mr. R. H. Bicknell has held an enquiry into the application of the District Council for sanction to borrow sums amounting to close upon £60,000, including £52,230 for electric lighting and tramways.

Oswestry.—The Town Council have agreed to defer the purchase of a photometer until tenders have been received from both the gas company and the electric light company on the termination of the present contract.

Leek.—The tender of Messrs. Taylor and Burgess, of Longton, for the plans, specifications, bills of quantities, and supervision of the works connected with the electrical generating station at 3¾ per cent. has been accepted.

Birmingham.—The Watch Committee have decided to provide electric and telephonic communication between the prisoners in the cells and the officers. At present prisoners can only attract attention by kicking the doors.

Maidstone.—A Board of Trade inspection has been made of the bridge, the scene of the recent gas explosion. It is stated that nothing has been found wrong with the electric light, and that there has been no fusing of the cable.

Perth.—The question of the charges to be made for lighting churches now that the Corporation has departed from the Brighton system has been remitted to Mr. Lambert, the engineer of the electric lighting department, for report.

Wirral.—It is suggested that electric lighting of the hospital, if it could be done in conjunction with the Clatterbridge Workhouse, would be cheaper. The purchase of lamps has been left with the chairman of the Joint Hospital Board.

Coggeshall.—In reply to a letter from the Post Office asking if the Council would become a subscriber in the event of a Post Office telephone exchange being established at Frinton, it has been decided to try the telephone for one year.

Gloucester.—Mr. Walter J. Bache, resident electrical engineer, in his last report shows that a number of new applications have been received for electric light installations, and that several of the old consumers are extending their installations.

Amble.—The electric incandescent lamps have been installed at the harbour, both along the quays and on the staiths. It is intended to still further augment the number of new lights, of which there is double the number of the old gas lamps.

Weymouth.—The poll recently taken to decide whether or not the Town Council should adopt the scheme of electric lighting, estimated by Prof. Kennedy at £44,800, has resulted as follows: for the Council's scheme 756, against 699; majority in favour, 57.

Manchester.—The Finance Committee have been considering a resolution of the Electricity Committee requesting the borrowing of £150,000 for electricity purposes, and have instructed the treasurer to allocate loans to that amount to the electricity account.

Bedwellty.—The District Council have received from the Horsfield Destructor Company an offer to put down their refuse destructor at New Tredegar for £1,414, or the Meldrum system at £2,450. They have also decided to apply for an electric lighting provisional order.

Taunton.—It is stated that some of the consumers whose names were mentioned in the case already referred to by us have since applied to the committee to refund alleged overcharges. There is also, it is said, a likelihood of the Local Government Board being asked to hold an enquiry.

Cheshire Power Scheme.—It is proposed to erect generating stations at Sutton, near Runcorn; at Stone, in Staffordshire; at Bollington, in Cheshire; and at Acrefair, near Wrexham. The water required for condensing purposes is proposed to be drawn from the Macclesfield Canal.

"Daily Mail" Year-Book.—This is the third issue, and is edited by Percy L. Parker, and published by the Amalgamated Press, Limited, at 1s. It contains a vast lot of the information incidental to such publications compressed into about as many pages as there are days in the year.

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Dundee.—The Post Office authorities have received consent to the erection of poles on the north side of Arbroath-road, but that for the Strips of Craigie has been refused on the ground that the same is too narrow. Sir Reginald Ogilvy, Bart., has received permission to carry wires across the road at Harestane.

Greenock.—Mr. James M'Intyre has been appointed chief electrical engineer on board the yacht "Nahma," belonging to Mrs. Goelet, now lying in the Gareloch. Mr. M'Intyre has a staff of electrical engineers under him. He was trained under Mr. Neilson, chief engineer of the Greenock Corporation electrical staff.

Newport (Mon.).—The charges for current have been reduced to 5d. per unit for private houses and places of worship, and for other premises a graduated charge commencing at 5½d. per unit to 3d. per unit, according to consumption, for lighting, and for power a graduated rate of from 4d. to 2d. per unit, will be adopted.

Lancaster.—The electrical engineer is about to instal four arc lamps at the sum of £74. 12s. Application has been made to the County Council for a special grant for the electrical laboratory and classes in connection therewith, and the matter is now under consideration by the North Lonsdale Hundred Committee of the County Council.

"The World's Work."—This is yet another new monthly, edited by Mr. Henry Norman, M.P., and well got up. It is published by Mr. W. Heinemann at 1s. How Mr. J. C. Stewart, manager at the British Westinghouse Company's building, Trafford Park, recently dealt effectively with the local labour problem and another article dealing with parcel post trade is worth reading.

Award.—We are informed that the Körting two-cycle gas-engine, for the manufacture of which Messrs. Mather and Platt are the licensees, was awarded two gold medals at the Düsseldorf Exhibition, one of these gold medals going to Gebrüder Klein for a 700-h h.p. Körting engine made by them, and the other to the Siegener Maschinenbau Actiengesellschaft for a similar engine of 500 b.h.p.

Keighley.—Colonel A. C. Smith has held an enquiry into an application of the Corporation for sanction to borrow £4,775 for purposes of electric lighting. A sum of £37 392 has already been invested in the works and mains, etc., £2 087 having been laid out more than the authorised amount. In the period July 1 to Oct. 31 this year about 20J per cent. more electricity has been sold than was the case a twelvemonth ago.

"Journal of Commerce."—The second number of this journal is, if anything, even more luxurious in get-up, the plates alone being well worth the price asked for the number, while the letterpress contains much which is both instructive and entertaining. We note specially "The Port of London," "The Markets of the Future," "Secret Commissions," and some pertinent remarks on consuls which we heartily endorse.

Eastbourne.—Mr. W. C. C. Hawtayne has reported that the rubber-covered cables which were at one time used largely by the late company have gradually given out, and that the breakdowns have all occurred on these old cables. About 11,600 yards of new cable will be required to replace that which is practically worn out. The Electric Lighting Committee have recommended the Council to proceed with the work in sections.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and grant a quotation to and to allow the following to be quoted in the official list: Electrolytic Alkali Company's 29,233 vendors' ordinary shares of £1 each, fully paid, Nos. 35,001 to 58,146 and 68,914 to 75,000; Power Gas Corporation's 66,462 vendors' ordinary shares of £1 each, fully paid, Nos. 1 to 66,462.

"Calvert's Almanac."—The proximity of the New Year is heralded by the advent of diaries, etc., and the thirtieth issue of "Calvert's Almanac and Workshop Companion" (John Heywood, London and Manchester; 4d.) is one of the first of the series we have seen this year. The little work is too well known to need any description; suffice to say that this year also many useful hints and valuable tables are included in the reading matter.

Dovonport.—The Corporation Electric Power Committee have decided to extend their works during the next two years at an estimated cost of £16,000. Sanction for a loan for this amount will be applied for, and the principal items in the estimates are £8,000 for extension of mains, £3,500 for a 2,000 ampere-hour traction battery, £1,500 for reversible booster for the battery, £1,600 for 200 consumers' meters, etc., and £1,000 for negative booster for tram return currents.

South Wales Electrical Power Distribution Co.—The directors find their business developing so rapidly that it has been necessary to separate the duties of the general manager and secretary. Mr. Edmund L. Hill, the general manager of the company, who has also been acting as secretary *pro tem.*, has resigned the latter position, and Mr. George P. Tutcher, who has been acting as Mr. Hill's assistant, has been appointed secretary. Mr. E. P. Martin has joined the Board.

Change of Address.—We note the following changes of address of Messrs. Robert W. Blackwell and Co., Limited, branches: Paris office, from 50, Boulevard Haussmann, to 20, Rue St. Georges, Paris; Paris stores, from 83, Rue Philippe de Girard, to 40, Quai Michelet, Levallois-Perret, Paris (the firm having taken over the works lately occupied by the Dunlop Tyre Company); Brussels office and stores from 1, Rue d'Arenberg, to our new building, 20, Avenue du Boulevard, Bruxelles-Nord.

Walton-on-Naze.—The Urban District Council have received a letter from the postal authorities, enquiring if the Council would become subscribers to the proposed telephone exchange at Walton-on-Naze. The cost would be £4. 10s. a year, including 360 local calls, but not including trunk messages, which would have to be paid for at the ordinary rates. The Council decided to become subscribers, and to enter into the usual three years' agreement with the postal authorities for that purpose.

Radstock.—The Urban District Council having been approached by Messrs. Pressland and Lippard, electrical engineers, of Broad-sanctuary-chambers, London, S.W., with reference to a proposal to establish an electrical power station at or near Radstock, have decided to appoint a committee, not with a view of actually opposing the scheme, but to see it was established on proper lines. The National Telephone Company have declined to proceed with the work of opening an exchange at Radstock.

Boston.—Messrs. J. H. Simpson and Son have led the van in the use of the electric light in Boston. The installation has been put in by Messrs. Gent and Hurley, Leicester; the engine, a National, being supplied by Messrs. Holland Bros., Bargate. The plant is now in actual work, and is running very successfully, a brilliant and perfectly steady light being given. We understand that the firm are supplying the electric light to the Peacock and Royal Hotels, which installation will be completed in about a fortnight.

St. Annes-on-Sea.—The last report of the electrical engineer contains the following paragraph: "The works costs promise to come out very near to 2d. per unit by the end of the financial year. Units sold to date, 64,823, against 41,762 in 1901; units sold during October, 14,829, against 9,208; total number of consumers, 140, against 53; average approximate cost of production per unit, 2·25d., against 2·8d. During the month seven applications for the equivalent of 478 8-c.p. lamps had been received. The whole of the Nernst lamps have been erected and are now in daily use in St. Alban's-road. Three have been tried without any frosted globe, but as the effect of the frosted globe is so much better and gives a better diffusion of the light, frosted globes on all these lamps were being arranged for."

Accidents.—An outbreak of fire occurred last week at Blackburn, said to be due to leakage from an electric arc lamp. A switchman who had been employed by the Harrogate electric lighting department was on Nov. 27 found dead against a switchbox, the door of which was open, in Victoria-avenue. At the inquest, at which a verdict of accidental death was returned, it was stated that the Corporation had supplied indiarubber gloves, but the man had left them at home. The Corporation had done everything possible in the matter. At the inquest at Middlesbrough into the death of a slag wheeler employed by the North-Eastern Steel Company, who died on Nov. 26, it was said that the deceased stumbled over some slag which was under an electric lamp standard. To save himself from falling he grasped a bracket on the standard. The doctor who had made a *post mortem* was of opinion that death was due to syncope, brought on by congested bowels and lungs.

Felixstowe.—The Urban District Council propose to buy the undertaking of the Suffolk Electricity Supply Company, which, we understand, has been offered them at £8,000, subject to the following agreement: "The company to undertake the duties of undertakers, under the Council's electric lighting order, for 25 years, and indemnify the Council from all liability thereunder, except the Council's legal or other charges and engineer's fees (if any). The company to maintain the works. The company to pay the Council 6 per cent. for interest and repayment of capital on all money raised for the undertaking. The Council to collect all revenue, and hand same to the company; cost of collection to be paid by company. The charges for current not to exceed 8d. per unit. The company to lay all necessary mains, the estimated cost of same being provided by the Council. The Council to provide all capital for extensions of plant, machinery, and mains. The company to deposit £1,000 as security for carrying out their part of the contract. The Council to join with the company in opposing any application for license or provisional order for supply of electrical energy in Felixstowe and Walton. The agreement to be in force for 25 years. At the end of such 25 years the whole of the business passes to the Council, the loans for the purchase and present works being discharged by the 6 per cent. paid by the company.

Colchester.—It has been resolved to lay a new main in Manor-road. The borough electrical engineer (Mr. A. R. Sillar) in his last report gives the following figures: Output of electricity in units during October: 1902, 28,192; 1901, 16,500; 1900, 12,360. Number of consumers at end of October: 1902, 303; 1901, 201; 1900, 133. Total number of 8-c.p. lamps connected: 1902, 18,615; 1901, 11,882; 1900, 8,247. The electrical engineer has also presented a special report relative to the plant necessary for the winter of 1903-4, from which it appeared that plant to the amount of £4,210 would be absolutely necessary. This is made up as follows: steam generator of 500 h.p., £1 800; dynamo of 375 kw. to 400 kw. capacity, £1,600; panels, instruments, and cable connections, £140; steam-pipe lagging and exhaust pipe for generator, £70; excavating and concrete foundations, £50; meters, service boxes, and connections, £550. Under the heading of "plant needful for increasing and maintaining the economy of the station," which would necessitate an outlay of a further £2,240, the engineer included a new exhaust range to cost £180, a condensing plant estimated at £900, and a cooler to cost about £760, whilst he suggested the advisability of putting down a water-softening plant for the purposes of boiler feed, the cost of which he put at about £400. For enabling the station to supply the Tramways Committee with motive power for the trams, the engineer proposed alterations and additions to the engine-room which would cost a further £820, making the grand total required under the three headings £7,270. Application will be made for sanction to the borrowing of £7,000.

London Gazette.—The first meeting in the estate of T. E. Morgan, 367, Ecclesall-road, Sheffield, will be held on Dec. 9 at 12 noon at Official Receiver's Offices, Fig Tree-lane, Sheffield, and the public

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examination on Dec. 18 at 3 p.m. at County Court Hall, Bank-street, Sheffield. The last day for receiving proofs in the estate of the Electric Lamp Regenerating Company, Limited. 3, Crown-court, 62, Old Broad-street, London, E.C., is Dec. 31. Mr. H. de Vaux Brougham, 33, Carey-street, Lincoln's-inn, W.C., is liquidator.

Newcastle.—At the last meeting of the Finance Committee a report was submitted by the new property surveyor regarding the lighting of all public buildings by electricity, instead of by gas, by which some are lighted now, such supply of electricity to take the place of the present supply. It was suggested that the report should be amended to show the probable cost of electricity if supplied from the tramway power station; after which the report should be printed, and circulated amongst the members of the committee.

Football.—On Saturday, the 22nd ult., the first of the annual football matches between the General Electric Company's Head Office, Queen Victoria-street, and the Robertson Lamp Works, Brook Green, took place at Wormholt Farm. The game was a very fast and furious one, and altogether an exceptionally fine game of football. The final result was the same as in several preceding years, the lampmakers managing to come off victorious by one goal to nothing. The return match is to be played some time in the beginning of the year.

Cheltenham.—The electrical engineer reported on Monday that on Nov. 16 there were 642 customers, with the equivalent of 39,540 8-c.p. lamps connected to the mains for private supply. The costs of the private and public lighting extensions between Hale's-road and Hayward's-road would be, if simultaneously carried out, £535 and £505 respectively; that the cost of a private lighting extension along London-road from Hayward's-road to the private road leading to Charlton Court would be £140. The Charlton Kings extension is to be carried out.

Stepney.—The Borough Council at their last meeting accepted a report of the Finance Committee on the wiring and fitting of consumers' premises for electric light, and decided to inform the London County Council that the Council were in favour of a renewed application being made to Parliament for powers authorising any metropolitan borough supplying electrical energy to expend money upon the wiring and fitting of consumers' premises. Councillor R. A. Kersey and the consulting electrical engineer were deputed to give evidence in support of the clause if necessary.

Rome.—The *Review* says that "even in Rome, although there are no outward signs of manufacture, yet from the Tivoli Falls some 15,000 e.h.p. is brought into or near that city for manufacturing purposes. It is almost impossible to dissociate in idea a manufacturing city from dirt and smoke, but with electricity all this trouble disappears, whilst national monuments will not be disfigured. In the Alban Hills will be found power enough to raise a new Rome from the ashes of the past, and they are very substantial ashes as we know personally from a recent visit."

Aberdeen.—At the last meeting of the Gas and Electric Lighting Committee of the Town Council several extensions of electric mains in various parts of the city were approved of. An application from the employés in connection with the electric works asking for payment at the rate of time and half for Sunday, the same as had been recently conceded by the Council to the men similarly employed in the gas-works, was agreed to. The committee resolved that a supply of current should be given to the school at Woodside from the mains connected with the tramways subject to the usual hire rates charged by the department for the hired motors.

Hammersmith.—At Wednesday's meeting the Electricity and Lighting Committee reported that since the last Council meeting 14 additional consumers had been connected, representing a maximum of 1,066 8-c.p. lamps; three consumers had been disconnected; the total number of consumers now taking current from the mains being 1,138. The committee recommended the Council to confirm the appointment of Mr. Robert Howie Paterson as station superintendent at a salary of £200 per annum. A main is to be laid from Becklow-road *via* Albert-cottages at £28. 8s.; the owner of the ground will be paid a fee of £1. 1s. per annum for the wayleave.

Typewriting Telegraph Co.—We are informed that the business of this Company will be removed by Christmas to larger offices and warerooms at 92, Queen Victoria-street, E.C. The demonstrations made recently to the German Government have proved so successful that the Company were enabled to immediately sell their German patent to one of the largest German manufacturers. They have since received orders from the U.S.A. War Office at Washington and from the Postmaster-General of St. Petersburg, and have been asked by both the Austrian and Italian War Offices to give demonstrations of their instrument. The Steljes typewriter telegraph is thus proving one of the few English inventions destined to turn the tables on the German and American invasion.

Blockley.—The committee appointed to superintend the electric lighting of the village have issued circulars containing their report and the balance-sheet for the year. They spoke of the provision for lighting purposes provided by Messrs. Rooper and Robins, of Stafford, as "generally allowed to have been most satisfactory," and said they had entered into negotiations with Mr. Spencer Flower (Messrs. Spencer and Co., Stratford-on-Avon) to continue the contract. Mr. Flower proposes to employ water power only, and to transfer the turbine, dynamo, and battery to a building on the stream and thus utilise the whole fall of 60ft. instead of 16ft., as at present available. The cost will be £800. A public meeting last week decided to adopt the Lighting Act.

Electric Motors for Printing Works.—On June 6 we described fully the machinery installed by Messrs. J. H. Holmes and Co., of London, Manchester, and Glasgow, at Dundee for the printing of the *Dundee Advertiser* and the *People's Journal*. The last number of the *People's Journal* contains good illustrations of the electric driving equipment and of a four-roll machine made by the Northern Press and Engineering Company, Limited, of South Shields, which has just been erected, and upon which that paper is printed. The motive power is obtained from the town supply at a pressure of 400 volts. The 25-h.p. motor equipments on the Holmes-Clatworthy system are geared direct to the machine shaft, and so arranged that the two can run together, driving the whole machine, and printing 16-page papers at the rate of 24 000 per hour.

Electric Lighting Acts.—The following is the text of the Bill to amend the borrowing provisions of the Electric Lighting Act, 1882, and the Electric Lighting (Scotland) Act, 1890. In introducing it on the 12th ult., the Lord Advocate explained that its object was to get over a difficulty under the Electric Lighting Act, which presses very hardly on Dundee in regard to the proper provision of electric lighting: "(1) The amount which a local authority within the meaning of the schedule to the Electric Lighting (Scotland) Act, 1890, may borrow under Section 8 of the Electric Light Act, 1882, shall not be subject to any limit imposed on the amount which such local authority may borrow for the purposes of its gas undertaking, provided that every loan so borrowed with the consent of the Secretary for Scotland after the passing of this Act shall be repaid by the local authority within a period not exceeding 30 years from the date of borrowing; (2) nothing in this Act shall affect any loan borrowed before the passing of this Act; (3) this Act may be cited as the Electric Lighting (Scotland) Act, 1902, and shall extend only to Scotland.

London County Council and Telephones.—Last week we commented upon the remark by the Chairman of the Establishments Committee, who had stated that the National Telephone Company had quoted a charge of £327 for certain work for which the Post Office charge was £430. The attention of the Postmaster-General having been called to the matter, Mr. Austen Chamberlain said he thought the Post Office had some right to complain of the statement, as he had previously explained in a letter to the Council's chief engineer how the apparent discrepancy between the quotations of the company and the Post Office arose. The company already provided for the Council a considerable number of exchange lines and private wires, and on going into the matter they found that they could afford to make some reduction in the rentals of the latter. Their total charge for the whole of the service, including the new lines now required, but giving credit for the reduction on existing lines as above described, worked out at a net increase of £327 on the charge for the old service. The Post Office was asked for a quotation for the new services only, and the charge for those services was precisely the same as that made by the company.

Inverness.—At Tuesday's meeting of the Town Council a letter was received from the Board of Trade stating that the Board would defer consideration of the question of revoking the electric lighting order until Dec. 31, by which date the Board would have before them particulars of any application which might be made by any other body in the coming session of Parliament for an order in respect of the burgh. The superintendent of the Caledonian Canal intimated that a meeting of the Canal Commissioners to consider the town's proposal to acquire water power for generating purposes could not be held until towards the end of February, as the Commissioners would have to consider the rights of proprietors of salmon fishings in the River Ness and other waters. The superintendent suggested that the Town Council should agree that a level of, say, 18ft. 3in. should be fixed at Dochgarroch Loch, and if the water should fall below that level at any time the Canal Commissioners should have power to stop the supply to the Corporation works until the water in the loch had again risen. During the past 24 years the water fell to that level on an average of 6¼ days per annum. The Council resolved to accept the principle of a minimum depth below which the water power would not be demanded.

Charing Cross and Strand Electricity Supply Co.—We have seen a number of circulars issued by this Corporation with regard to the electric supply in the city of London, from which we note that there are already connected up to the City mains of the Corporation the equivalent of approximately 140,000 8-c.p. lamps, and, in addition, contracts have been entered into for about 40,000 further lamps, which are being connected up as rapidly as possible. The supply from their generating station at Bow and the City distributing stations will be capable when completed of furnishing supply to the equivalent of at least 1,000,000 8 c.p. lamps. This maximum rate of 5d. per Board of Trade unit is only charged on the first 18 units consumed (in certain quarterly proportions) per 8 c.p. lamp per annum, all units in excess being charged at the rate of 2d. per Board of Trade unit, while the maximum rate is 3d. per Board of Trade unit, reducible on a sliding scale to 2d. per Board of Trade unit, or, if desired, supply would be given at the firm rate of 2½d. per Board of Trade unit. At the present season we are pleased to see that the directors have paid particular attention to the avoidance of failure of supply or diminution of pressure through sudden fog, and have provided storage batteries, which, it is said, are at present, though forming only part of the proposed installation, of more than twice the capacity of any other battery plant in the United Kingdom. A supplemental supply to the City stations is also available in case of necessity from their West-end stations, and *vice versa*.

Batley.—Good progress is being made with the combined electricity generating station and refuse destructor works now being erected by the Corporation. The buildings are practically complete. The engine-house will contain three engines and dynamos with a capacity of 150 kw. each, and all accessories, and two sets have been erected. The dynamos are being erected by Messrs. John Fowler and Co., Limited, of Leeds, and the engines are by Messrs. Belliss and Morcom, of Birmingham. Each dynamo will be capable of supplying electric current equal to 2,000 c.p. lights. They are to run at a speed of 550 revolutions per minute, and to generate electricity at a pressure of 525 volts, when supplied with steam at a pressure of 170lb. to the square inch. One unit, we are told, will light about 33 8-c.p. lamps for one hour, or one 8-c.p. lamp for 33 hours. The whole plant which the

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Corporation are at present putting down is capable of supplying 450 units per hour. The boiler-house contains three Lancashire boilers, each 30ft. by 8ft., by Clayton, Sons, and Co., of Leeds, and to which Proctor's patent stokers are affixed, with Hopkinson's fittings. Dead-weight safety valves are placed on each boiler, in addition to which there is a safety valve in the middle of the body of each boiler, to blow off at either high or low pressure. There will be ample space for two more boilers. A Green's economiser, containing 288 tubes in all, has been laid down, and it is the intention of the Corporation to erect a Klein's cooling tower. The total area of wood required for evaporating the water is 24,000 square feet.

Ipswich.—The work of construction in connection with the Ipswich electric tramways and lighting scheme, which has been under consideration for so many years, is now in full progress, principally on the Seven-Acre Field, Constantine-road, the site selected for the power station and refuse destructor. The *East Anglian Daily Times* says the concrete foundations of the greater portions of the walls of the latter buildings are already laid, and the brickwork has been commenced. The chimney shaft, which is to serve both the boilers of the power station and the destructor, will be a very large one. The magnitude may be gathered from the fact that the height will be 170ft., and the base 20ft. square. The excavations for such a structure are necessarily considerable, and during the digging operations a somewhat interesting earth formation has been disclosed. For a few feet down the soil was dry and sandy; then a strata of blue clay was come upon, and in the middle a large glacial boulder was found. Messrs. Shillitoe and Co., of Bury St. Edmund's and London, are the contractors for this work. In connection with these operations, an improvement will be effected to the ditch which runs parallel with the arm of the River Gipping - from Alderman-road and across the meadow to Portman's-walk. This will be enlarged and fenced off, and used as a source for the water necessary for condensing purposes. As the watercourse will be wider and deeper, and the quantity of water passing along considerably greater than heretofore, the nuisance which has at times been complained of will, it is hoped, be remedied.

London County Council.—The Council at Tuesday's meeting agreed to lend the Battersea Borough Council £24,035 for electric lighting and meters. With regard to the supplemental vote of £2,000 for the electric light installation for the Victoria-embankment and Westminster Bridge, the Finance Committee reported: "On Feb. 15, 1898, the Council authorised the Highways Committee to carry out the electric lighting of the Victoria-embankment and Westminster Bridge at an estimated cost of £25,300, comprising £6,900 for buildings and £18,400 for machinery, plant, mains, etc.; but the committee subsequently submitted to the Council for acceptance a tender, based on revised plans, amounting to £10,950, for the erection of the electricity generating station on the Embankment, which sum was £4,050 in excess of the amount provided for buildings in the total estimate of £25,300. The committee were advised, however, that the additional cost of the building would probably be met by savings under other heads of the vote, and consequently they did not submit a supplemental estimate. The savings referred to have actually amounted to about £1,900 only. There has also been a small saving on the building contract, reducing the excess over the amount included for buildings in the original vote to about £3,900. A supplemental vote is, therefore, required for £2,000." Notices by the County of London and Brush Provincial Electric Lighting Company of intention to lay low-tension mains along a portion of Hillside-road, and from the St. Pancras Borough Council of intention to lay mains along portions of Lyme-street and Georgiana-street, were approved.

Hull.—A service cable 124ft. long is to be laid in Bourne-street. The following scale of charges has been adopted for power supply: in any month when the units consumed per horse-power less than 80, 2d. per unit; upwards of 80 but under 105, 1½d.; upwards of 105 but under 130, 1¼d.; upwards of 130 but under 160, 1¼d.: upwards of 160 but under 200, 1⅛d.; 200 and upwards, 1d. No allowance will be made for motors which are not worked up to their nominal capacity. Electricity used for cooking or other heating purposes will be charged at 2d. per unit as heretofore. This scale of charges is not to interfere with the special scale for large works. The electrical engineer in his last report states that, in view of the continually increasing load on the works and the length of time required to obtain new plant, it was advisable to consider the question of placing orders for further machinery. There were certain extensions which were absolutely required immediately, and those included additional transformer power at Dagger-lane and Earle's sub-stations. There would also be required additional transformers for supply to the main network. With regard to generating plant, in view of the fact that it was nearly 16 months since the committee decided to order the last two additional engines, and that those engines were not yet delivered or at work, he advised that one additional engine and dynamo of 800 i.h.p. and two additional boilers (30 by 10) should be included in the new plant, as it appeared certain that they would be required by the time they were able to be set to work. An additional economiser was required at the generating works. Finally, Mr. Barnard recommended mechanical stokers and coal elevators for four boilers. The committee have ordered the engineer to prepare plans and estimates for the suggested extensions and to invite tenders. Applications for 25,232 c.p. for eight generators and eight motors have been received. The following notice was on the agenda for last night's meeting of the City Council: "That, in view of the uncertainty as to the financial results of the establishment of a municipal telephone service in Hull at the rates proposed, no farther steps be taken in the matter, unless those who have undertaken to become subscribers will also undertake to pay such higher rates (if any) as may be found necessary to prevent the undertaking becoming a burden on the rates, and that any resolution to the contrary be and the same is hereby rescinded."

Halifax.—Last week we shortly referred to the opening (by the Mayor of Halifax) of the new electricity transforming station which the Halifax Corporation have erected at Hebden Bridge. In connection with the same there has been laid down at the Halifax electricity works a new three-phase plant, consisting of a horizontal combine condensing engine of 500 h.p., with Corliss valves on both high and low pressure cylinders, by Messrs. Pollit and Wigzell, of Sowerby Bridge. The dynamo is by the Electric Construction Company, of Wolverhampton, and consists of a three-phase alternating generator capable of generating 40 amperes at a pressure of 5,500 volts. This set is capable of lighting 4,500 16-c.p. lamps. A similar set is installed at the far end of the engine-room. The cables from the machine are carried to a high-tension switchboard in the switchroom, made by Ferranti Limited, of Hollinwood, near Manchester. From this switchboard two cables are laid direct to the Hebden Bridge sub-station, a distance of 7½ miles from the generating station at Halifax. At this sub-station the high-pressure current is transformed from 5,500 volts to 320 volts, and is then taken to the rotary converters, which transform the alternating current to a direct current suitable for both tramway and lighting purposes. The converters are each of 100 kw. capacity, and each is capable of supplying energy for lighting 1,500 16-c.p. lamps. These rotary converters are also made by the Electric Construction Company, and are intended further for charging a storage battery of 270 cells, which is contained in the second floor at the sub-station. This battery is capable of supplying 300 lamps for eight hours without being recharged. The cost of the whole plant, including the generators at Halifax, has amounted to about £27,000. This high-tension plant was primarily intended for supplying current to the tramways on the Hebden Bridge route, and by using high-pressure current the loss due to resistance of the wires is considerably diminished. It is also hoped to supply Hebden Bridge current for lighting and power purposes, and mains from Halifax have been put in large enough for this purpose. An offer has been made to the Urban District Council by Halifax to supply current in bulk to Hebden Bridge, the latter to lay their own mains and distribute the electricity. Owing to various reasons the Urban District Council are considering the question of laying down their own instalment. With a plant now in their own town, it would appear the wiser step for them to accept a supply from Halifax until the experience of other urban district councils who are entering on such a scheme is known. One great feature about the whole plant is the fact that with the exception of the cable, which was supplied by the Land and Sea Cable Works, Cologne, Germany, the whole plant is of English manufacture.

PROVISIONAL PATENTS, 1902.

Nov. 24.

25761. Improvements in connection fittings or attachments for the insulated electrical conductors or cables employed in the ignition systems of internal-combustion engines, and for analogous purposes. Frederick Harold Hall and Constance Hall, 24, Temple-row, Birmingham.

25778. Improvement in apparatus for controlling the supply of electricity by a combined lock-switch and plug. Henry Carter Watson and Edwin Liddle, Central-buildings, Stockton-on-Tees.

25794. Improvements in or relating to electric controllers. Peter Charles Middleton and William Samuel Hadgraft Smith, 8, Quality-court, Chancery-lane, London.

25797. Improvements in safety fuses for electric current circuits. Ernest Francis Moy and Percy Henry Bastie, 4, Greenland-place, Camden Town, London.

25805. An electric heat indicator and fire-alarm. George Andrew Darby, 67A, Corporation-street, Birmingham.

25827. Improvements in or relating to glass jars or cells for primary or secondary electric batteries, to carboys, and the like. John Forster, 111, Hatton-garden, London.

25829. Improvements in or relating to rotatory current motors. Coloman de Kandó, 111, Hatton-garden, London. (Complete specification.)

25838. Improvements in and relating to roses and switches for electric lamps. James Robert Percival Lunn, 18, Southampton-buildings, Chancery-lane, London.

25840. Improved means for conducting electricity to tram and like cars on the underground system. Fred Alfred Howarth, Fife House, Kingston-on-Thames.

25848. Improvements in and relating to the electro-chemical treatment of gases. Wilhelm Ostwald, 45, Southampton-buildings, Chancery-lane, London.

25860. Improvements in controllers for electric motors. John Bush, 90, Lausanne-road, Peckham, London.

Nov 25.

25864. Improvements in telephone switchboards. F. W. Shorrocks, 69, Stanmore-road, Mount Florida, Glasgow.

25893. Improvement in magnetic ore separators. Charles Arthur Allison, 52, Chancery-lane London. (Camden Eugene Knowles, Greenberry Treakell Young, George Thompson Cooley, Guy Hartwell Elmore, William Elwyn Brinkerhoff, Eugene O'Keefe, and Joseph Herrin, United States.) (Complete specification.)

25904. Improvements in systems of electrical distribution. Edgar Alfred Carolan, 85, Cannon-street, London. (The General Electric Company, United States.)

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25905. Improvements in systems of electrical distribution. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

25906. Improvements in phase modifiers and systems of electrical distribution. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

25914. Improvements in means for controlling electric circuits specially applicable to electric lighting of trains. Henry Leitner and Richard Norman Lucas, Rose Villa, Byfleet, Surrey.

25916. Improvements in electrical resistances. Theodore Butcher Lewis, Westinghouse-building, Norfolk-street, Strand, London.

25917. Electric current generating and motive power machine. Walter Shelverton Frost, 135, High-street, Homerton, London.

25948. A hygienic device for speech receivers and transmitters. William Phillips Thompson, 6, Lord-street, Liverpool. (The Ballard Hygiephone Company, United States.) (Complete specification.)

25949. Improvements in gas or electric light brackets applicable for bakers' ovens. Thomas Gillard, 6, Lord-street, Liverpool.

25965. Improvements in electric arc lamps. Thomas Hamilton-Adams, 4, South-street, Finsbury, London.

Nov. 26.

26027. Improvements in electric engines for dental, surgical, manicure, and chiropedic operations. Frederick Whit Gould, Craven House, Northumberland-avenue, London.

26032. Improvements in controlling the speed of electric motors. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26034. Improvements in electrical recording instruments. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26035. Improvements in photometers. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26036. Improvements in means for automatically stopping an electric railway car or train. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26037. Improvements in electric railways. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26038. Improvements in and relating to electric track brakes. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26039. Improvements in electric train control systems. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26040. Improvements in systems of electric motor control. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26041. Improvements in electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26042. Improvements in electric motors. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26043. Improvements in electrical synchronising devices. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26045. Improvements in electric rock drills. Edgar Alfred Carolan, 83. Cannon-street, London. (The General Electric Company, United States.)

26047. Improvements in electric transformers. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26048. Improvements in electric transformers. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26049. Improvements in devices for smoothing electric transformer coils. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26050. Improvements in magnetic clutches. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26051. Improvements in trolley poles for electric railways. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26071. Improvements in the manufacture of arc lamp electrodes. Robert Hopfelt, 53, Chancery-lane, London. (Complete specification.)

26072. Improvements in and relating to tremblers for induction coils. Thomas Emmerson, 60, Queen Victoria-street, London.

26082. Improvements in wireless signalling systems. Cornelius D. Ehret, 45, Southampton-buildings, Chancery-lane, London.

26090. Improvements in the treatment of metallic sulphides in the electric furnace. Ramón Chavarriá Contardo, 55, Chancery-lane, London.

26062. Improvements in or in connection with current collectors for electric cars and other electrically-driven vehicles. Walter Henry Alabaster, 6, Lord-street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 18.

1901.

23823. Magnetic ore separators. Salwén.

24012. Compound insulating material for electrical purposes. James. (Mica Insulator Company.)

24457. Method of and means for suspending overhead electric conductors. British Thomson-Houston Company, Limited. (Union Electricitäts-Gesellschaft.)

24616. Incandescent electric lamps. Soc. Italiana di Elettricitá Giá Cruto. (Date applied for under International Convention, Sept. 13, 1901.)

24621. Electric incandescent lamps. Soc. Italiana di Elettricitá Giá Cruto. (Date applied for under International Convention, Sept. 13, 1901.)

24987. Lubrication of fluid pressure motors or compressors and their combination with dynamos or electromotors. Boult. (Christensen.)

25208. Electric welding apparatus. Bosshard.

25221. Compounding alternate-current generators and motors. Heyland.

25387. Electric railways on a sectional conductor or like system. British Thomson-Houston Company, Limited. (Farnsworth.)

25396. Machinery or apparatus for perforating telegraphic tape for use in the automatic transmission of telegraphic messages. Croed.

25753. Systems of electrical distribution. Peck. (Date applied for under International Convention, May 18, 1901.)

26344. Insulated electric conductors. British Thomson-Houston Company, Limited. (Emmet and Clark.)

26693. Electric circuit breakers. British Thomson-Houston Company, Limited. (Read.)

1902.

667. Surface-contact electric traction systems working with magnetically-operated switches. Dolter Electric Traction, Limited. (Dolter.)

727. Railway sleepers, brake blocks, driving pulleys, rollers, insulators for electric wires, and other similar articles. Board and Freeman.

809. Lifeguards for electric cars and other self-propelled vehicles. Royle.

1343. Electric fuses. Callender's Cable and Construction Company, Limited, and Hastings.

2019. Coupling socket for electric wiring. Waldron and White.

2377. Electric heating fabrics. Herrgott.

2587. Electrodes for arc lamps. Abel. (Siemens und Halske, Actiengesellschaft.)

4254. Electric cells or batteries. Lake. (Soc. Anon. "Le Carbone.")

7718. Electric punkah motors. Zellweger.

15953. Controllers for electric motors. Read. (Date applied for under International Convention, July 26, 1901.)

17073. Systems for electric railways employing a surface rail. Thompson. (Watson.)

18148. Electrical fire-alarm apparatus. Robertson.

20923. Means for adjusting the height of suspended electric lamps. Huber.

21888. Systems of electrical distribution. Lamme. (Date applied for under International Convention, Oct. 14, 1901.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated and Helsby Cables, Ord., 1-70,000	5 ..	7½-8
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	101-103
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	2½-3
—— 5 per cent. Debentures	100 ..	101-106 p.e
Edison and Swan United, "A" Shares, 1-99,261	5 ..	⅛-¼
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78

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Name.	Amount paid.	Last price.
	£	£
Electric Construction, Limited, Nos. 1 to 112,100	2	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	2¼-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16¼-17¼
—— 4½ per cent. Preference	5	5¼-5⅜
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14¼-15¼
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅛-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	110-113
Bournemouth and Poole, Ordinary	10	12⅛-13⅛
—— 4½ per cent. Cum. Pref.	10	10-11
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	10½-10⅝
—— 7 per cent. Preference	5	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7-8
—— Nos. 20,001-30,000	5	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14⅛
—— ,, ,, £10 Ord.	6	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	105-108 xd
Charing Cross and Strand	5	9-9¼
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4⅜-5⅛
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5⅛-6
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	124-129
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London and Brush Provincial, Ordinary	10	3¼-3⅜
—— 6 per cent. Cum. Pref.	10	11¼-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6-6½
—— 6 per cent. Cum. Pref.	5	6-6½
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3¼-4⅛
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	6-6½
—— 4½ per cent. First Deb Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7⅛-8⅛
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10½
London Electric, Ordinary	3	1⅜-2¼
—— 6 per cent. Pref.	5	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	109-114
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6½
Notting Hill Electric Lighting	10	14-15
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1⅜-2⅛
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	3-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	14-15
—— 7 per cent. Pref.	5	8¼-8½
—— 3½ per cent. Deb.	100	99-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3¼-4⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3¼-4⅛
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	5	6-6½

Name.	Amount paid.	Last price.
	£	£
Electric Railways.—		
Central London, Ordinary	100	105-108
—— 4 per cent. Pref.	100	105-108
—— ,, ,, deferred	100	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-119
City and South London, Consolidated Ordinary	100	75-76
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— ,, ,, ,, '96	100	126-129
—— ,, ,, ,, '01	100	123-127
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	93-96
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	127-132
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-3⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7⅛
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,500	10	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12-12½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12-12½
—— 5 per cent. Perpetual Debenture Stock	100	123-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅜-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4⅜-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14¼-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4⅛-4⅜
—— 4 per cent. Debenture Stock	100	95-98
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	11½-12
—— ,, ,, ,, ,,	10	11¼-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	105-107
—— ,, ,, Prov. Crts.	100	105-107
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Rgd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10⅜
—— 5 per cent. Cum. Pref.	10	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8¼-8⅜
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	18s.	14/16-15/16
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	90 p.c.	90 p.c.
Telephones.—		
National Telephone, Preferred	100	92-94
—— Deferred Stock	100	62-64
—— 6 per cent. Cum. First Pref.	10	12½-13½
—— 6 per cent. Cum. Second Pref.	10	11¼-12¼
—— 5 per cent. Non. Cum. Third Pref.	5	4⅞-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	95-98
—— 4 per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	⅞-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week: Ending	1902.	1901.	Increase or decrease: Week.	Current year.	Miles of single track open: 1901.	1900.	Accounts for past year: Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track: Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 29	839	628	+ 211	+ 6,630	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	,, 29	4,805	4,129	+ 676	+17,083	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	,, 23	668	617	+ 51	+ 3,869	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	,, 27	279	234	+ 45	+ 324	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	,, 29	188	171	+ 17	− 185	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	,, 30	1,527	1,321	+ 205	+ 4,357	32	—		77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	Oct. 26	3,208	1,090	+2,118	+82,937	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57
Bristol Tramways Company	Nov. 28	4,125	3,680	+ 443	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	,, 29	7,092	6,862	+ 230	+11,571*h*	12	12	,, 31	335,086	41,188,389	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	,, 30	3,677	3,262	+ 415	+21,039	12½	9½	,, 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	,, 27	405	363	+ 41	+ 5,936	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	,, 29	168	170	− 2	+ 48	4½	—	,, 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	,, 30	87	75	− 12	+ 884	6¾	6¾	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	,, 28	3,584	3,218	+ 346	+2,782	46	46	,, 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	,, 28	694	696	− 2											
Dundee City Tramways	,, 26	750	623	+ 127	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	,, 29	12,375	10,794	+1,581	− 8,083	104	95	,, 31	582,146*c*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	Oct. 22	1,139	1,028	+ 111	+ 2,225	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	Nov. 29	982	863	+ 119	—	48	48	Sept. 30	29,061*h*	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	,, 29	1,690	1,570	+ 120	+ 2,780	19	9½	,, 30	72,331*h*	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	,, 22	9,393	8,668	+ 725	+35,734	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	,, 30	1,445	1,436	+ 9	− 668	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 30	3,672	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	,, 28	839	691	+ 147	—	11	—	,, 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	,, 30	980	942	+ 38	—	19	17	,, 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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Supplement to "The Electrical Engineer,"

DECEMBER 5, 1902.

EXPERIMENTS ON SYNCHRONOUS CONVERTERS.*

BY W. M. THORNTON, D.SC., MEMBER.

§ 1. The growth of large schemes for the electrical transmission of energy by high-tension alternating currents is probably the most

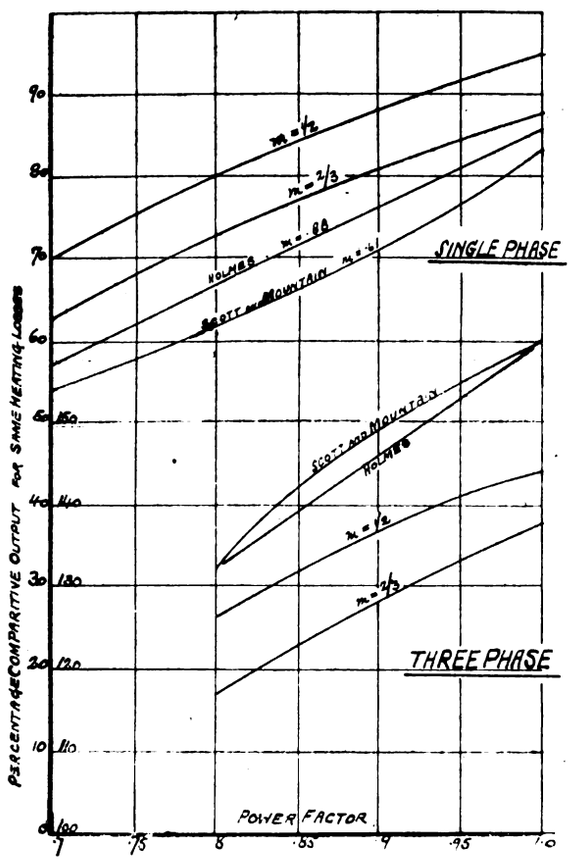

FIG. 1.

remarkable feature in modern industrial development. The success of these schemes depends mainly on unfailing regularity of supply, and this again on the stability of the electromagnetic system of genetors, line, and motors under all loads. Those responsible for these schemes make very cautious experiments, the cost of misadventure is too great, and the machines themselves are rarely available under all the conditions necessary for a complete study of their behaviour. I had the pleasure of making some observations of wave-forms on the synchronous motor system of the Wallsend scheme, and these suggested that a more detailed research into the working of the two synchronous converters in the college laboratory might add to our knowledge of the complex reactions within the armature of this and allied classes of machinery. The research is entirely experimental. There are so many variables that it is useless to attempt to construct a theory including all of them. Steinmetz and S. P. Thompson have given analyses of the ideal case in which the magnetism is distributed sinusoidally around the circumference of the armature. But though, as will be seen, the generated voltage wave-form at no load closely approximates to a sine curve, this can only be obtained by a magnetic distribution which is not sinusoidal. Kapp has considered the variation of output with relative breadth of pole, showing that within practical limits the output is less for the same armature heating when the poles are broader. In Table I., I quote his figures for two cases, and have calculated corresponding values for the machines used in these experiments, which are not specially-designed converters. The figures are percentages referred to the same machine working as a direct-current generator for equal armature heating in each case. In the last two columns are the values which might be expected from the two machines used calculated in the same way as Kapp's.

TABLE I.

Type.	Phase displacement.	Sine distribution	Pole breadth ÷ pole pitch. $\frac{2}{3}$	$\frac{1}{2}$	·61	·88
Single-phase converter	cos ϕ = 1	85	88	95	83·6	85·7
	= ·9	not calculated.	81	88	70·5	75·8
	= ·8	not calculated.	73	80	62·3	67
	= ·7	not calculated.	63	70	54·1	57·2
Three-phase converter	cos ϕ = 1	134	138	144	160	160
	= ·9	not calculated.	128	137	149	146
	= ·8	not calculated.	117	126	132	132

The alternating current, i, which heats the armature to the same degree as the direct, i_1, is $i = \frac{\pi}{\sqrt{q}} i_1$, the values of q being given in Table VII., and from this relation the latter part of Table I. was obtained. The results are not total efficiencies. The watts lost in the field, friction, windage, and eddy currents are all omitted, but the results are instructive, as showing the variations in the principal source of loss of efficiency. The comparative values of Table I. are plotted in Fig. 1. Most of the curves show that the relation between power factor and efficiency is not linear, the curvature being generally upwards. The Scott and Mountain single-phase curve is, however, the reverse of this, and in both single and three phase sets the armature heating is approximately in inverse proportion to the power factor. The meaning of the curves drooping towards the low power factor end is in these cases the loss of efficiency due to change of distribution of the current in the armature, and has nothing to do with the effect of the eddy currents in the poles.

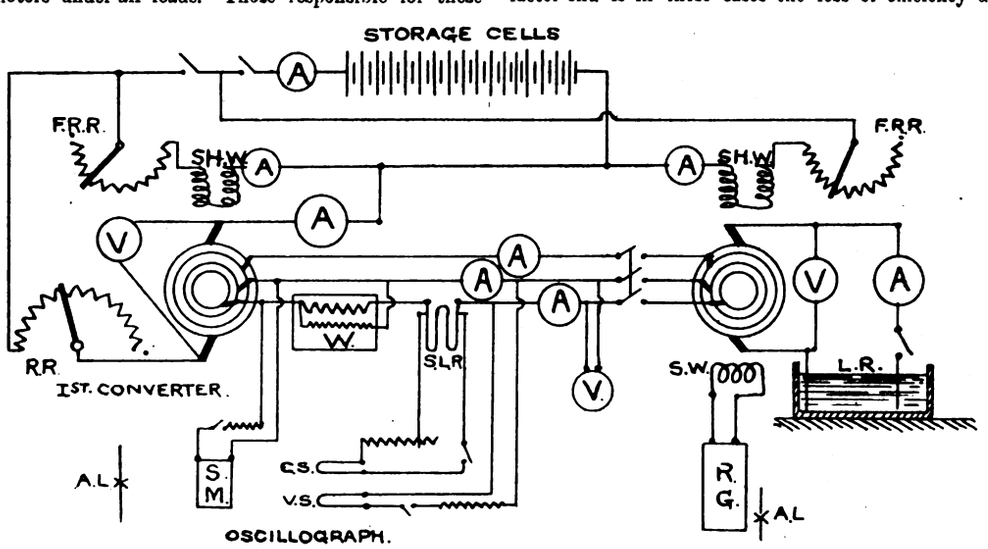

FIG. 2.—A, Ammeters; V, Voltmeters; W, Wattmeter; S H W, Shunt Winding; S W, Series Winding; R R, Regulating Resistance; F R R, Field Regulating Switches; R G, Recording Galvanometer; L R, Liquid Resistance; S L R, Standard Low Resistance; C S, Current Strip; V S, Volt Strip; S M, Synchronous Motor A L, Arc Lamps.

§ 2. The object of the experiments was to find how the efficiency of the plant varied with load for all condition of excitation, to find any discrepancies between the theoretical and observed losses, and to locate

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the causes which would give rise to them. At the same time, it was thought that records of the changes of wave shape might throw some light on the nature and magnitude of the armature reactions. The greatest difficulty in synchronous converter working being periodic fluctuations started from irregular turning moments in the prime mover, the first machine was driven throughout from a set of storage cells. Fifty-two of these were used to drive a 9-kw. bipolar machine (Scott and Mountain), the armature of this being ring-wound and provided with slip-rings, so that single, two, or three phase current could be taken and supplied to a 5-kw. machine (Holmes), also bipolar

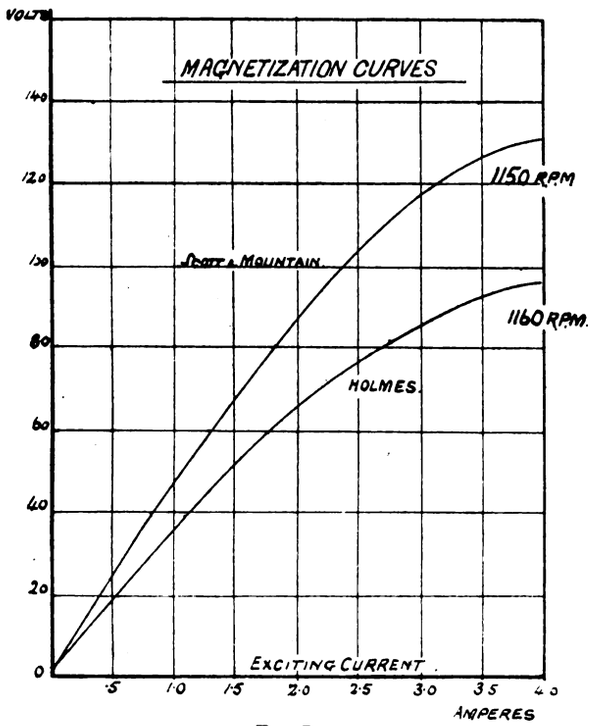

FIG. 3

and ring-wound in the same way. From the second converter direct current was led through an adjustable liquid resistance. The field of each machine was separately excited from the same cells. A direct-reading Siemens and Halske wattmeter was inserted in the line in series with a standard low resistance, from the terminals of which connections were made to one strip of a double oscillograph. The other strip was placed in series with a non-inductive resistance across the line terminals. The resistance and capacity of the cables connecting the machines were always negligible. The general arrange-

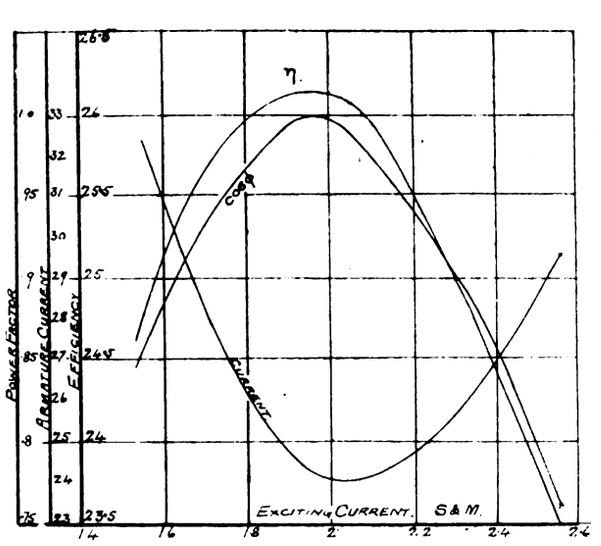

FIG. 4.

ment of the connections is shown in Fig. 2. There is, it will be seen, a double conversion of current, and one point of interest brought out by the experiment was that the heating losses of the system could, by varying the excitations, be moved from one machine to the other. The two machines were run up together from rest coupled by the cables alone, and the load gradually thrown on. Throwing it on suddenly started violent phase swinging in the second converter, which measured in one case 50deg. difference between the limits of the current wave positions, as shown by Curve 23A, Plate II. The highest frequency possible was 23 alternations a second. The first set of experiments was made to find the relation between total plant efficiency and power factor. The observations are given in the following tables, and the magnetisation curves of the machines in Fig. 3. From the latter an estimate of the saturation of the magnetic circuit may be formed. The reluctance of the Scott and Mountain at full excitation is *·00455*, and of the Holmes *·00527*, and the lengths of the air-gaps are *1·15cm.* and *1·06cm.* respectively.

TABLE II. (FIG. 4).

Field of first converter varied. Motor field constant. Loss in motor field, 330 watts. Motor output kept constant as nearly as possible.

First converter input.				Motor input.					Motor output.		Efficiency
Volts	A.	F. C.	Speed	F. C.	V.	A.	W.	Cos φ	V.	A.	%
70	28·5	1·55	1,000	3·7	45·5	32·3	1,125	·85	72	8·2	24·6
71	27·5	1·62	1,000	3·7	46·5	30	1,250	·90	72·4	8·3	25·3
72	26·3	1·70	990	3·7	47·0	28·2	1,225	·93	72·4	8·3	25·8
74	25	1·85	980	3·7	48·0	25·3	1,174	·97	72·4	8·2	26·0
75	24	1·98	950	3·7	48·2	24·1	1,165	·995	72	8·1	26·1
75·2	23·5	2·10	930	3·7	48·5	24·0	1,134	·97	70·6	8·2	26·1
74·5	24	2·12	900	3·7	47·8	25·25	1,150	·95	70	8·0	25·6
76	23	2·34	920	3·7	48·1	25·9	1,100	·89	69	8·0	24·7
76	22·5	2·55	930	3·7	48·0	29·3	1,074	·76	67	7·8	23·5

It will be seen that the maximum efficiency is reached a little before the minimum current.

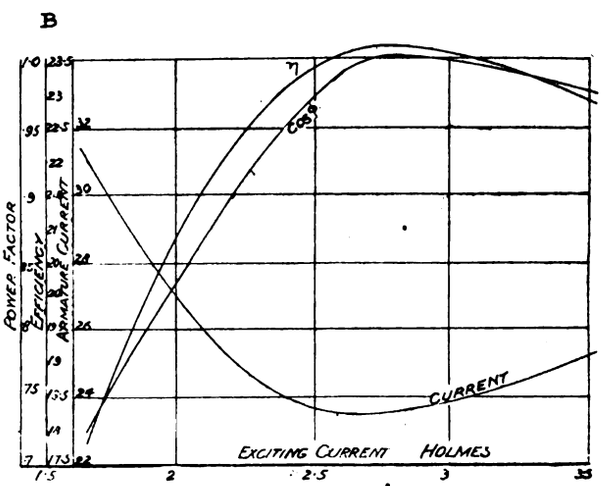

FIG. 5.

TABLE III. (Fig. 5).

Field of first converter constant. Motor field varied. Loss in first converter field, 116 watts. With the same input as in Table I., the output and efficiency are less.

First converter input.				Motor input.					Motor output.		Efficiency
Volts	A.	F. C.	Speed	F. C.	V.	A.	W.	Cos φ	V.	A.	%
73	40·1	2	980	3·7	48·2	25·8	1,210	·97	72	7·4	22·6
74	25·8	2	990	3·29	48·5	24·5	1,180	·99	71·6	7·4	23·2
74·1	25·4	2	1,100	2·98	48·5	24	1,150	·99	70·6	7·3	23·6
74·2	25·2	2	1,010	2·7	48	23·5	1,129	1·0	69 7	7·1	22·9
75	25	2	1,030	2·5	48	23·7	1,104	·97	68 2	7·0	23·5
75·1	24·4	2	1,040	2·3	47·8	24·5	1,079	·92	67	7·0	22·5
75·1	24·4	2	1,060	2·17	47·2	25·3	1,069	·89	65·8	6·9	21·9
75·3	24·2	2	1,070	2·03	47	27	1,060	·83	64	6·7	21·0
75·8	24·1	2	1,080	1·93	46·9	27·8	1,044	·806	63	6·6	20·5
75·8	24·1	2	1,090	1·83	46·2	29	1,034	·77	62	6·3	19·2
75·8	24·1	2	1,090	1·75	46	30·1	1,024	·74	60·8	6·1	18·4
75·8	24·2	2	1,100	1·67	45·5	31·1	1,019	·72	59·8	6·0	17·8

TABLE IV. (Fig. 6).

Field of first converter constant. Motor field varied. Current from motor kept constant.

First converter input.				Motor input.					Motor output.		Efficiency
V.	A.	F.C.	Speed	F.C.	V.	A.	W.	Cos φ	V.	A.	%
71·4	27·6	2	940	3·6	46·2	28	1,255	·96	69	9·1	26·4
71·4	27	2	950	3·2	46·4	27	1,234	·98	69	9·1	27·4
73	26	2	990	2·66	46·8	25·6	1,189	·993	67·2	9·1	28·0
73·2	25·8	2	1,000	2·28	46	26·2	1,160	·97	64·7	9·1	27·6
74	25·8	2	1,030	2·0	45·2	27·9	1,139	·903	61·5	9·1	26·4
74	25·6	2	1,040	1·8	44·8	30·0	1,109	·824	59·4	9·1	25·8
74	25·9	2	1,060	1·65	43·8	32·1	1,089	·775	57	9·1	24 9

The conclusion to be drawn from the above figures is that, as one would expect, the efficiency is greatest when the power factor is unity, *whichever field is varied*, and it is of interest to note the close relation between power factor and efficiency over a wide range of excitation while the output is maintained constant. Plotting the square

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of the continuous armature current against efficiency (Fig. 7), it is found that, except at low magnetisations, the loss of efficiency is proportional to the copper losses. At low excitations, the losses due to the large idle-current component are evident. This is very marked in the three-phase tests, where the change from under to over excitation of the motor reduces the armature losses from 750

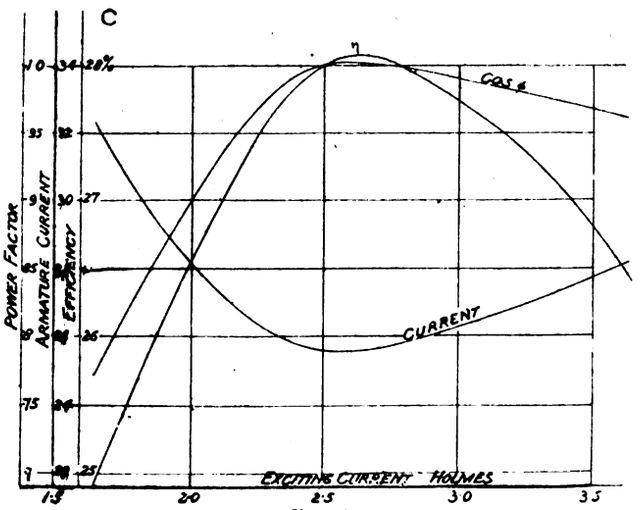

FIG. 6.

to 250 watts at light loads. In order to see whether the higher efficiency was maintained at all loads when the excitation was adjusted for the minimum armature current found above, three more sets of readings were taken, shown in Fig. 8. The second converter fields were kept constant in each test while the load was varied. The improvement in efficiency obtained at light loads is seen to be maintained at the higher.

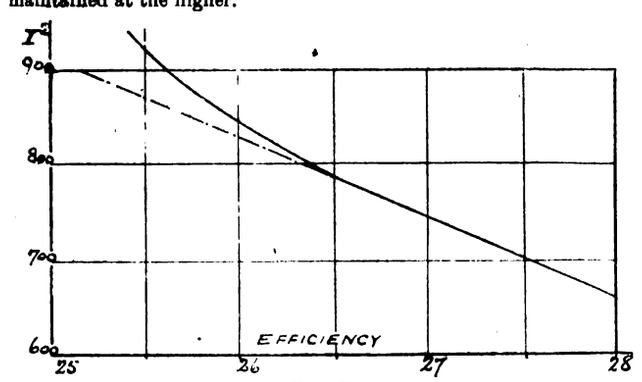

FIG. 7.

§ 3. The next experiment was a variation of the last, the machines being run under all conditions of excitation, and readings being taken of all the variables, including the wave-forms of the line current and voltage. The results with the calculated efficiencies are in Tables V. and VI., and Figs. 9 and 10 are plotted from these.* The remarkable feature of the single-phase curves is their sudden droop at loads which compared with the ordinary continuous-current output are small.

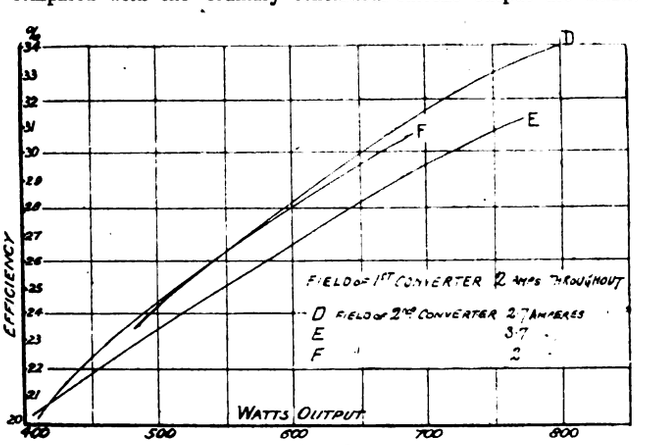

FIG. 8.

The reason for this appears more clearly when the machines are worked from the main generator, which being driven by a single-acting engine has an irregular turning moment. It was almost impossible to reach high loads without the second converter coming out of step, and the only way to get them was to over-excite the second machine and so reduce the eddy-current losses and magnetic fluctuations and gradually reduce the excitation as the load was increased; even then the machine soon worked up a phase swing and came out of step. Fortunately, both armatures have considerable inductance, about ·002 henry, between the slip-rings, single-phase, and there were no ill effects beyond the racing of the first machine.

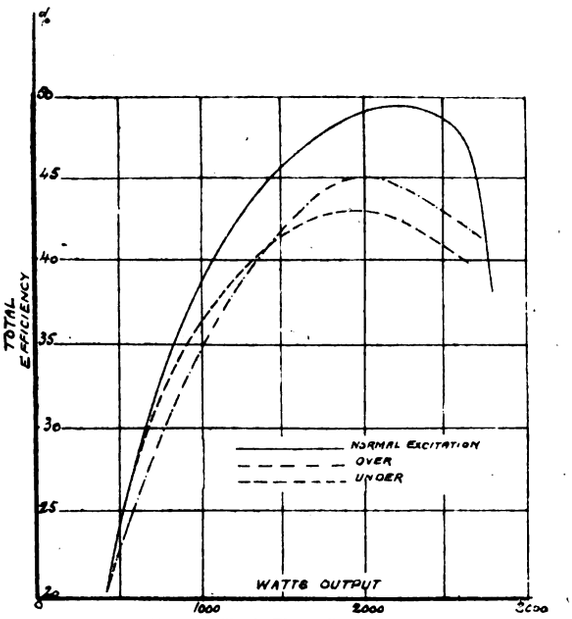

FIG. 9.—Single-Phase Converters.

This was the first intimation, as a rule, that the second had broken step, and it was always necessary to keep someone by the main switch of the first machine to break the current before the armature had accelerated to destruction. The advantage of normal excitation is most marked at the higher loads in both Figs. 9 and 10.

TABLE V. (FIG. 9).

Single-Phase Converters. Variation of Load with excitation constant.
Field Currents: First Machine, 2 Amperes; Second, 1·93.
(Second, Under-excited.)

No. of curve.	First converter input. Vc	Ac	W	Second converter input. Va	Aa	W	Cosφ	Second converter output. Vc	Ac	W	Armature efficiencies %. 1st c	2nd c	Ttl
7	73	31	2260	46·4	44·2	1400	·68	53	13·4	710	62	50·7	28·7
	72·2	40	2890	46·4	51	1976	·83	52	22·7	1180	68·7	59·8	38 3
8	75·5	50·5	4150	43·6	63	2640	·96	55	32·2	1780	69·5	67·5	44
	71	62	4400	40	74	2948	·99	50	39	1950	67	66	42·2
9	80	71	5680	45	84·5	3768	·99	56	44	2494	66·5	65·7	42·0
10	69·2	40	2768	42	48·2	1864	·92	54	22·5	1215	67·4	65	41·0
11	77	81	6240	41·2	96	3944	1·0	52	50	2600	63·2	66	40 5

Field Currents: First Machine, 2 Amperes; Second, 2·72.
(Second, Normal.)

12	73	36	2630	46·6	40	1840	1·0	68	18·75	1275	70	69·3	43·7
	74	49	3620	46	57	2620	1·0	67	28·75	1925	71·2	73·5	49
13	80·5	61	4900	49·6	70	3464	1·0	72	35·5	2550	70·7	73·6	49
14	72·5	100	7250	36	120	4348	1·0	52	46·5	2880	60	66·4	38

Field Currents: First Machine, 2 Amperes; Second, 3·29.
(Second, Over-excited.)

15	71	40	2840	46	44	2000	1·0	68·7	18·75	1275	70·2	63·75	39·5
	75	49	3660	47	56	2636	1·0	70·5	25·7	1820	71·7	69	45
16	78	72	5616	46·5	84	3856	·99	70	36·5	2560	68·5	66·5	42·5
17	75	80	6000	43·2	95	4008	·98	65	38·5	2500	68	61·3	39·5

Field Currents: First Machine, 1·6 Amperes; Second, 2·7.
(First, Under-excited.)

	56	40	2240	44	45	1500	·76	56·1	15·7	885	67	59	33·0
18	50	44	2200	32	50	1500	·94	50·5	17·1	865	68·2	57·6	36·0

Field Currents: First Machine, 3·1 Amperes; Second, 2·7.
(First, Over-excited.)

19	68·5	33	2260	42	47	1480	·75	56·6	15·5	875	65·5	59·7	32·5
	76	45·5	3460	46	57	2400	·92	61	27·5	1675	69·5	70	42·8
20	71	57·5	4080	40·5	70	2860	1·0	52·2	38·5	2010	70	68	44·5
21	77	72	5540	43	88	3880	1·0	55	50	2750	70	71	46·0

The general differences between observed and calculated losses may be better seen from Figs. 11 to 17, drawn from Table VIII. In the single-phase tests the second converter losses were in most cases in excess of those in the first. Fig. 14 shows a well-marked reversal, the losses at higher loads being less than calculated.

* The number of the curves refers to Plate II.

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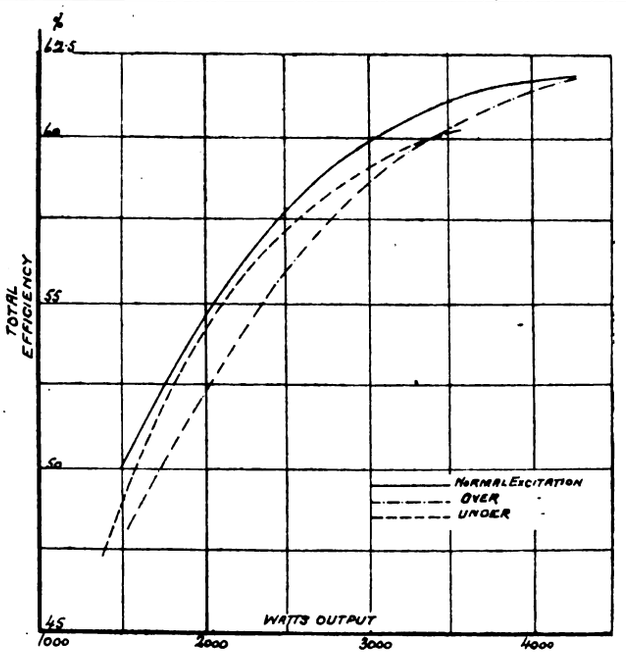

FIG. 10.—Three-Phase Converters.

TABLE VI. (FIG. 10).
Three-Phase Converters.
Field Currents: First Converter, 1·9 Amperes; Second, 3·62.
(Second, Over-excited.)

No. of curve.	First converter input. Vc	Ac	W	Second converter input. Va	Aa	W/2	Cosφ	Second converter output. Vc	Ac	W	Armature efficiencies %. 1st c	2nd c	Ttl.
23	75	36	2700	44	23	896	·88	76	19·8	1500	66·5	83·7	48
	79	44	3470	45·2	33	1176	·79	78	27	2100	41·8	89·5	54
24	85	54·5	4630	50	39	1648	·85	84	34·75	2920	71·3	88·5	57·8
25	81·5	69	5620	46	53	2028	·85	77	47·5	3660	72·2	90·5	60·5
26	77	82·5	6350	40·6	66	2300	·86	71	58·5	4160	72·5	90	61·3

Field Currents: First Converter, 1·9 Amperes; Second, 2·4.
(Second, Slightly Under.)

27	75	37·5	2815	43·2	27	1236	1·0	74	20	1480	88·0	60	50
	70	46	3220	39	35·3	1380	1·0	66	28	1850	86·7	67	53·3
28	75·5	43·5	4050	42	40	1720	1·0	71	35	2480	85·1	72	58
	70	67	4620	37·5	52·5	1920	·98	62	47	2910	81·7	75·7	59·1
29	78	81	6320	65	65	2640	·96	69	58·5	4030	83·0	79	61·4

Field Currents: First Converter, 1·9 Amperes; Second, 1·95.
(Second, Under-excited.)

30	68	39	2650	37·5	33	1300	1·0	63·5	21·3	1350	98	52	47·1
31	65·5	52·5	3440	36·5	43	1600	·96	58	34	1972	93	61·5	54·2
	69	66·5	4580	36·1	54·5	2080	1·0	61	47	2870	90·7	69	60·0
32	64	81	5175	33	67	2200	1·0	52	59·5	3090	85	70	57·6

§ 4. To illustrate the difference between theoretical and actual losses Table VIII. was prepared. The heating was calculated by the formula $P_w = q\,r\,i^2$, q having the following values, and r being the resistance per radian of armature circumference:

TABLE VII.

—	First converter.—Single-phase.	First converter.—Three-phase.	Second converter.—Single-phase.	Second converter.—Three-phase.
$k =$	1·285	1·74	1·375	1·75
$\cos\phi = 1$	14·11	3·85	13·99	3·85
$= ·9$	19·82	4·37	18·55	4·62
$= ·8$	25·27	5·61	22	5·61
$= ·7$	33·52	—	30	—

The three-phase curves are more remarkable. In Fig. 15, which refers to over-excitation of the second machine, the differences are much less in this than the first. Fig. 16 at nearly normal excitation shows a reversal, which is more strongly marked in Fig. 17, where the second converter field is very weak. The inevitable conclusion from this last set is that the armature reaction harmonic is of sufficient strength to disturb the whole circuit, so that the magnetism is rapidly weakened and strengthened in the solid magnet frame sufficiently to cause considerable loss of energy, and that *a change of excitation in the one machine may cause a disproportionate change in the losses of the other*, unless by skilful design and the use of damping coils these fluctuations in the magnetic circuit are minimised. In comparing these machines with motor-generators, it should be remembered that there are similar disturbances in synchronous motors. Beats can always be heard, and each of these means a loss of energy by eddy

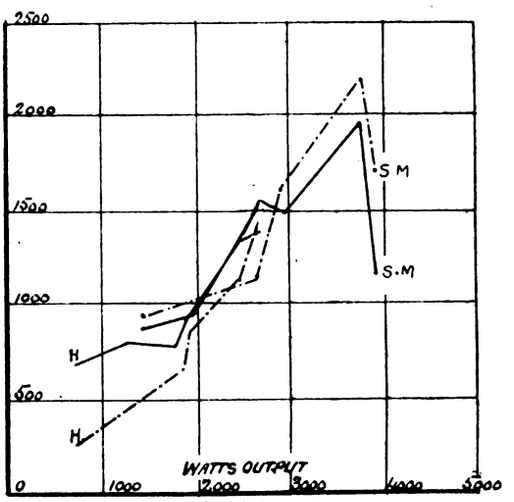

FIG. 11.—Under Excited.

TABLE VIII.—Watts Lost in Armature.

Single-phase. First converter. Cal.	Obs.	Second converter. Cal.	Obs.	Three-phase. First converter. Cal.	Obs.	Second converter. Cal.	Obs.
915	860	225	690	167	908	72·5	292
955	914	435	796	452	1,018	135	242
1,121	1,510	650	760	590	1,334	288	376
1,585	1,450	876	998	960	1,564	450	396
2,120	1,910	1,150	1,294	1,350	1,750	680	440
745	904	348	649				
2,720	2,296	1,440	1,344	154	343	62·5	992
				232	580	123	890
531	790	205	565	312	610	190	960
995	1,000	475	695	491	780	344	930
1,520	1,536	725	914	740	1,040	555	1,250
4,100	2,902	1,260	1,468				
				165	50	71·5	1,250
655	820	200	725	300	240	189	1,328
982	1,044	387	816	475	420	345	1,290
2,175	1,760	800	1,290	715	775	554	1,310
2,715	1,992	890	1,508				
1,160	740	255	615				
891	700	304	635				
805	780	250	605				
1,000	1,060	432	725				
1,350	1,220	850	850				
2,120	1,660	1,440	1,130				

Values of $\frac{2\,r}{\pi}$ . .
First converter, ·0284 (S. and M.).
Second converter, ·0406 (Holmes).

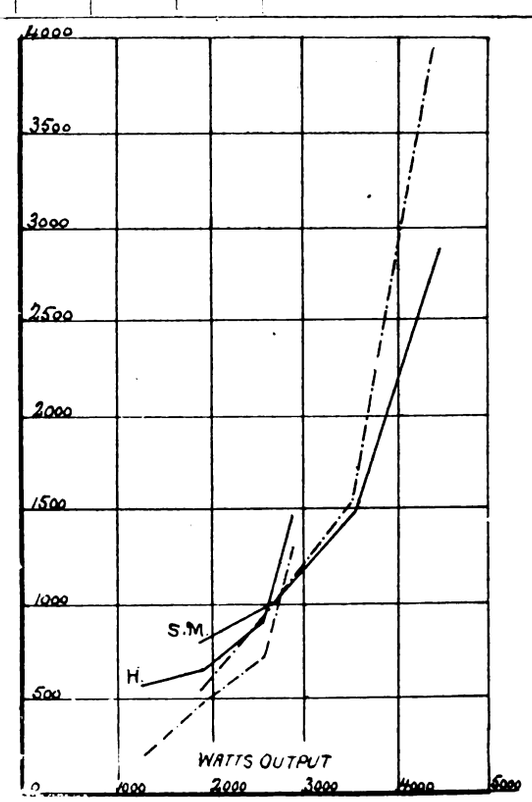

FIG. 12.—Normal Excitation.

currents in the iron of the magnetic circuit. In Fig. 18, I have drawn from Tables V. and VI. the separate efficiencies of the machines for

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three-phase working, in which again there is a remarkable effect. The efficiency of the first converter when the second is under-excited *falls* instead of rising with the load, as much as 12 per cent. with the weakest field, *its own field being maintained constant*. This again points

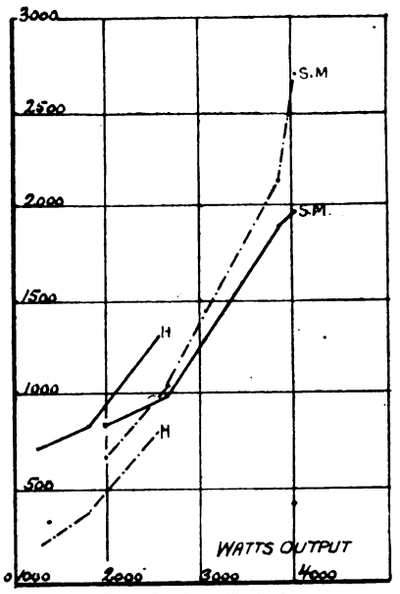

FIG. 13.—Over Excited

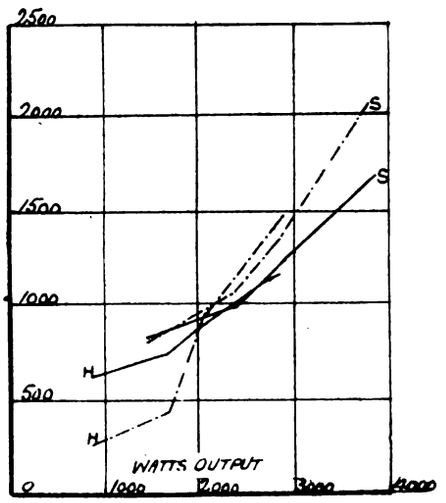

FIG. 14.—Over Excited.

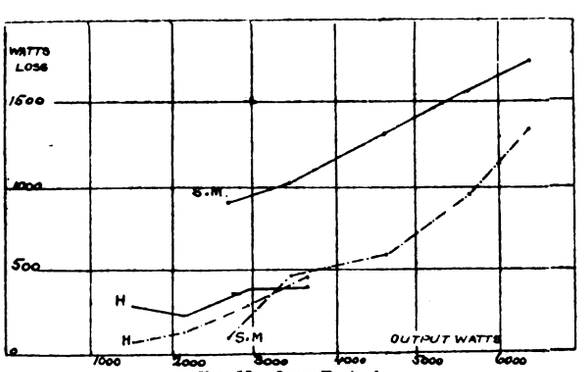

FIG. 15.—Over Excited.

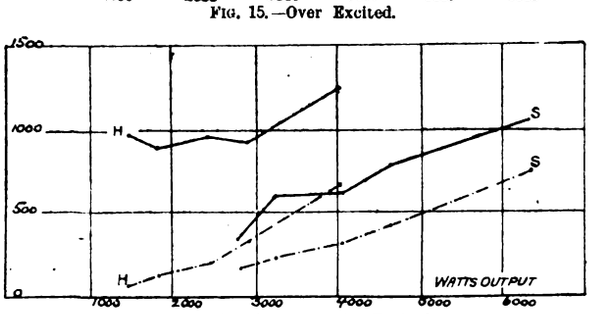

FIG. 16.—Slightly Under Excited.

to an abnormal increase in eddy-current losses. It remains, then, to prove experimentally that these losses are caused by armature reaction, and to estimate their magnitude.

§ 5. I have worked out in a former paper a numerical example of the losses due to eddy currents in magnet cores. These can be calculated when the dimensions and conductivity of the core and the ampere-turns producing the change are known. Thus if c be the radius of the core, l its length, μ the permeability, ρ the specific resistance, f the frequency of alternation of magnetism, and (I T) the maximum value of the ampere-turns causing the change—this being sinusoidal—then to a first approximation, the watts lost per second*

$$w = \frac{4\pi l}{\rho}(\pi^2 c^2 \mu f)\,(\mathrm{I\,T})^2\,10^{-7}.$$

To apply this to explain the difference between the observed and calculated losses it is first necessary to know the ampere-turns of

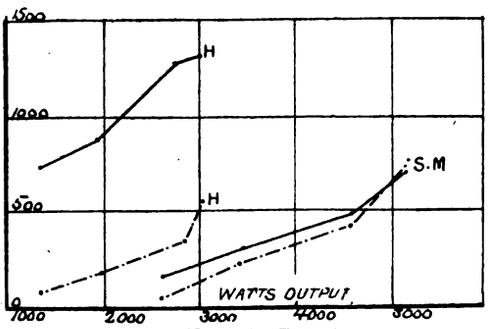

FIG. 17.—Under Excited

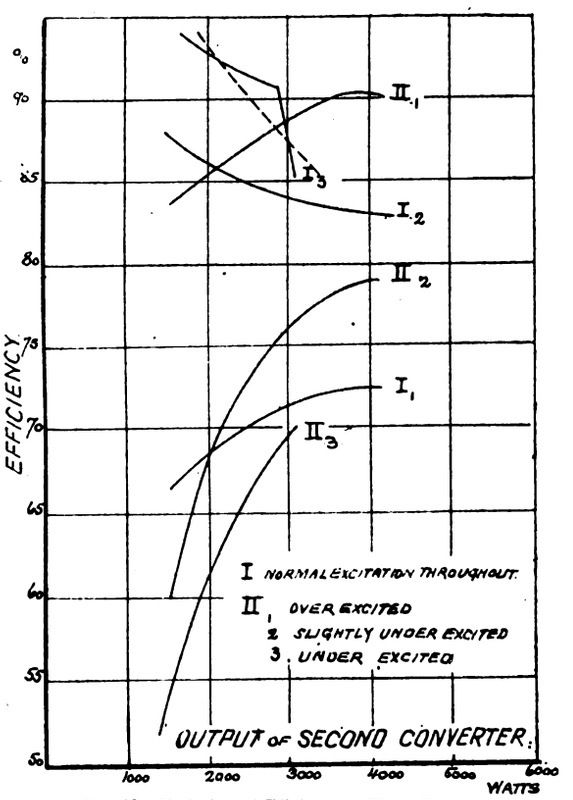

FIG. 18.—Variation of Efficiencies—Three Phase.

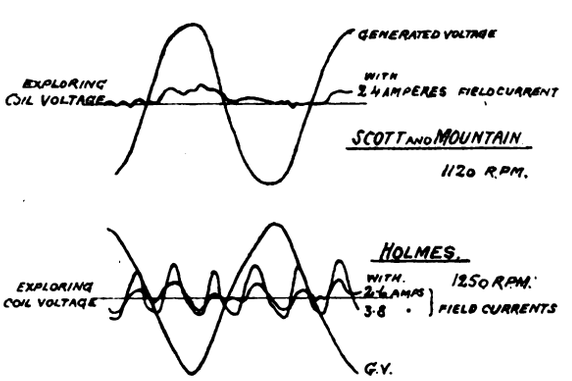

FIG. 19.—Oscillations of Magnetic Fields, in Separately Excited Continuous-Current Motors Running Light.

armature reaction for any given condition of working. This was first done in these experiments by placing a hot-wire galvanometer across the otherwise unused series windings of the Holmes machine, these forming an exploring coil of 58 turns. About one volt was observed when running light, and photographs were taken showing the influence of phase swinging on the magnetic circuit when unprovided with damping coils. It occurred to me later that this voltage is sufficient

* Heaviside, "Electrical Papers," Vol. I., p. 353.

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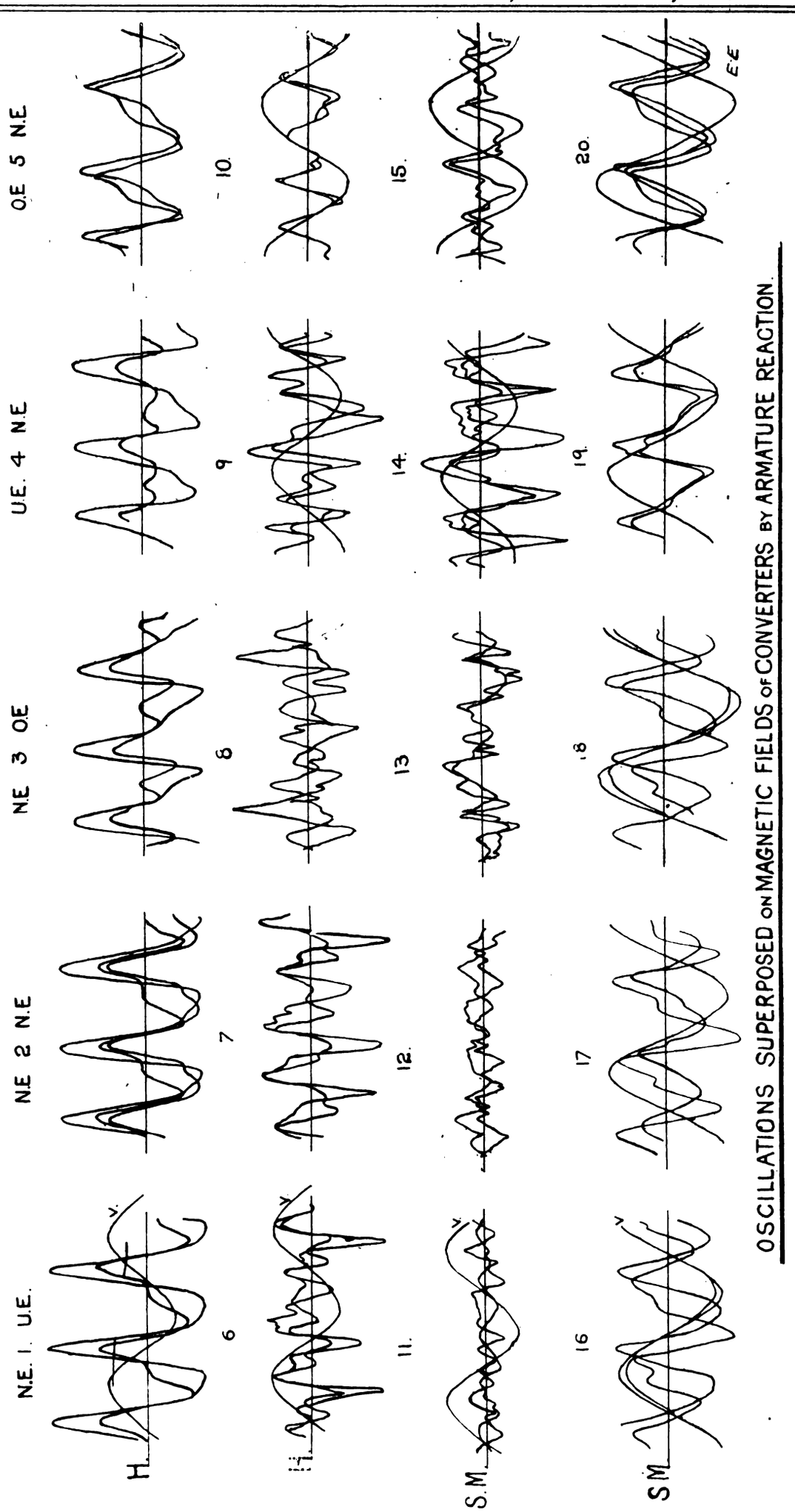
PLATE I.



OSCILLATIONS SUPERPOSED ON MAGNETIC FIELDS OF CONVERTERS BY ARMATURE REACTION.

to give good readings using the oscillograph as a dead-beat galvanometer, and I ran the oscillograph motor at the same time to see whether the harmonics of armature reaction could be directly observed. The results are shown in Plate I., the corresponding con-

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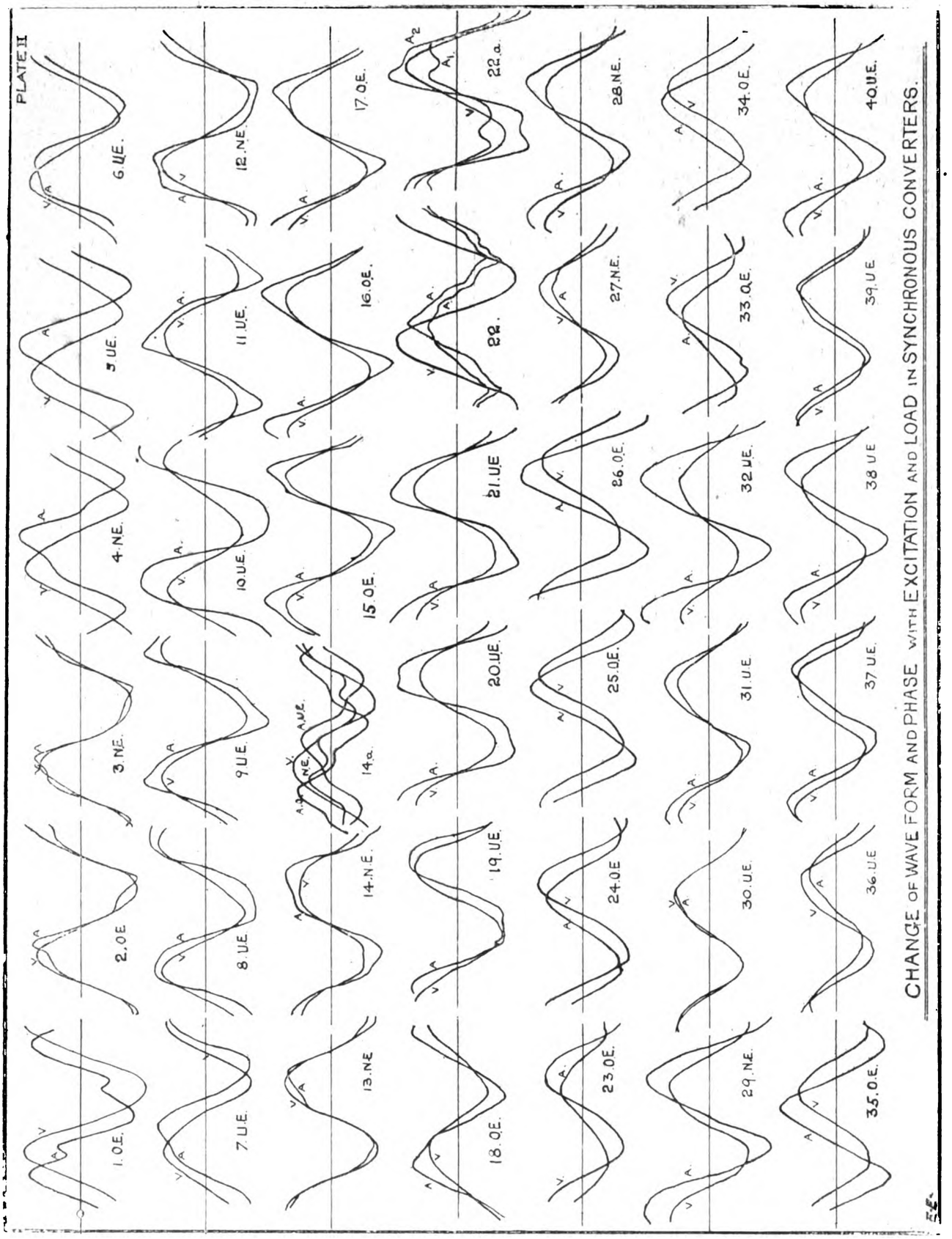
ditions being given in Table IX. These curves are records of the rapid magnetic changes occurring within the core when this is worked at various saturations and with different values of armature reaction. They are, in effect, the voltage in the secondary coil of a transformer of which the magnetic frame is the core and the armature the primary. They are interesting, as showing, for the first time I believe, what kind of action really goes on within the magnetic circuits of these machines, and, I have reason to think, of all kinds of dynamo-electric machinery, for I have obtained similar curves (Fig. 19) from continuous-current motors separately excited, driven from cells, and running light. The most curious point, I think, about the curves is the absolute constancy of form observed, except when a phase swing starts. All the ripples remain steady, and the curves can always be repeated. The same applies to the records of Plate 1. This method of examination seems to me to afford a most delicate test of whether the armature was perfectly symmetrical in the gap and should be useful in the study of flicker, or to indicate the magnitude of the disturbances, mechanical or magnetic, caused by the armature running out of truth. The records of Plate I. are no doubt complicated by the presence of these oscillations, especially the more rapid movements in the three-phase curves.

A detailed analysis of the curves in Plate I. would be very laborious, but some general conclusions may be drawn. Taking the first converter single-phase set first (curves 16 to 20), it is seen that the light load losses are practically the same for all excitations, and that over-excitation more than doubles them for the same load, for the amplitudes of the curves are much the same, and the strip resistance was 16·1 ohms in 16, but only 6·1 in 20. The first three and 20 show a change of phase of the harmonic of about 45deg. backward in 16 and 18·20 forward in 17. Under-exciting the first machine causes the harmonic to lag with respect to the voltage more than in the other cases. This double frequency harmonic alternately weakens and



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strengthens the flux in the gap, and this can be seen by 19, where it is in the first half opposite to and in the second in phase with the voltage. The motor reaction curves (1 to 5) shows a remarkably constant type; there is a quadruple harmonic present, and the phase of this is moved 180deg. of its own between 17 and 19. The reason for the existence of these still higher waves and the meaning of this shift of phase I have not had the time to examine more fully, but it is of interest to see that the same changes occur in the three-phase curves, and that, as before, the losses are greatest with an over-excited first converter. The second converter curves (1 to 5 and 6 to 10) show very little change of position with load. The quadruple harmonic is again strongly in evidence, and moves 180deg. between 3 and 5, in which the conditions of excitation are reversed.

TABLE IX.

—	Curve.	1st conv. Field current.	2nd conv. Field current.	2nd conv. Con. cur. output.	Total strip Light.	ohms in circuit. Loaded.	Revs.
Single-phase (Holmes)	1	2	1·93	28	21·1	21·1	1,150
	2	2	2·72	32	21·1	21·1	1,000
	3	2	3·29	34·5	6·1	23·1	1,075
	4	1·6	2·7	22	13·1	23·1	1,000
	5	3·1	2·7	31·5	29·1	33·1	1,020
Three-phase (Holmes)	6	1 9	3·62	34	3·1	4·1	1,000
	7	1·9	2·4	41·7	4·1	4·1	1,020
	8	1·9	1·95	30	4·1	6·1	1,000
	9	1·6	2·7	20	2·1	2·1	1,000
	10	3·1	2·7	29	11·1	11·1	1,000
Three-phase (Scott and Mountain	11	1·9	3·62	33	2·1	2·1	900
	12	1·9	2·4	39·5	2·1	8·1	1,030
	13	1·9	1·95	30	2·1	4·1	1,000
	14	1·6	2·7	20	2·1	2·1	1,050
	15	3·1	2·7	20	2·1	2·1	1,000
Single-phase (Scott and Mountain	16	2	1·9	24	4·1	16·1	1,060
	17	2	2·7	20	4·1	14·1	1,080
	18	2	3·2	30	4·1	9·1	1,060
	19	1·6	2·7	non-p.	6·1	6·1	1,060
	20	3	2·7	15/25	6·1	6·1	840

To return to the determination of the ampere-turns of reaction. Let e be the voltage generated in the exploring coil, as found by a hot-wire galvanometer or from the curves, and let there be s turns on the coil. Then, when f is the frequency of oscillation (which will not be that of the machine if there are harmonics),

$$e = 4\,N\,f\,s/10^8,$$

where N is the mean flux through the coil, e is root mean square, and N an ordinary average. Hence the value of

$$N = \frac{e}{4fs} \cdot \frac{\cdot 637}{\cdot 707} \cdot 10^8.$$

s is 58 on the Holmes machine, 55 on the Scott and Mountain, f and e are observed; thus N is known. Now, N = Magnetomotive force/reluctance. Thus, writing

$$N = \frac{4\pi}{10}\,\frac{it}{R},\ \text{the ampere-turns}\ it = \frac{N\,R}{1{\cdot}257}.$$

The maximum value for sine waves is 1·57 this. Hence

$$I\,T = 1{\cdot}25\,N\,R.$$

For the Holmes R = ·005, as found from the magnetisation curve for 2·7 amperes, so that

$$(I\,T) = 2{,}420\,e/f;$$

and when the speed is 1,000 revolutions per minute,

$$(I\,T) = 146 \text{ per volt in the exploring coil.}$$

For this machine the mean length of solid iron core is 100cm., the radius 7·8cm. Taking the specific resistance as 10,000, and the permeability as 100, the watts lost per second at 1,000 revolutions per minute are *125 per 100* maximum ampere-turns. Thus we have finally, since the loss depends on the square of the reaction ampere-turns, *266 watts per second per volt*. Considering the double frequency harmonic, this loss is reduced from 266 to 65 watts per second. When there is little or no phase swinging, the voltage is from two to three at medium loads. The oscillograph calibration was 2·1cm. deflection per volt with 10·1 ohms in circuit, from which the amplitudes of Plate I. may be worked out in volts. Taking an equivalent sine maximum of 2·5 volts, with the double frequency harmonic of Curve 2, there are *102 watts* per second lost by eddy currents in the magnet core. It will be seen from Fig. 12 that this accounts for a good deal of the discrepancy between the observed and calculated loss in the Holmes machine, and I think that all the wide differences are due to the same cause.

§ 6. *Effect of Armature Reaction on Wave-Form.*—The relation between excitation and phase displacement has been shown in Figs. 4, 5, and 6. These were verified by direct observation in the oscillograph and the waves sketched. The voltage curve remains singularly constant in shape under all conditions, but the current wave, depending as it does on the phase relations of the two machines, is very sensitive to changes in the magnetic circuits. The chief cause of the variation of form is the harmonic of armature reaction, and the phase of this changes considerably with regard to the main wave. Plate II. contains a selection from the wave-forms sketched. Curves 1 to 22A are for single-phase working, the rest for three-phase. On all the curves but 22 and 22A the conditions of excitation are indicated by the letters O E, U E, or N E, signifying over, under, or normal excitation. In 14A the phase displacement from lag to lead as the excitation is increased in the second converter is shown; 22 gives the magnitude and nature of the wave changes during moderate phase swinging, and 22A is the single curve in which the brushes have been moved from mid-position, A_1, corresponding to a slight backward shift, and A_2 to the extreme backward shift when the sparking was too heavy to be long continued. The first set, from 1 to 6, were taken after the readings of Table IV. These were approximately repeated, as in Table X., to which the curves correspond. In these the full effect of change of excitation can be seen both on form and phase. The strong harmonic of Curve 1 always appears when the second machine is fully excited and the field of the first gradually reduced, the speed being maintained constant by varying the armature current. The lateral shift of the harmonic is most marked from 1 to 2, the other curves showing a variation in its amplitude.

TABLE X.

No. of curve.	First converter input. V.	First converter input. A.	Second converter input — V.	Second converter input — A.	Second converter input — W.	Second converter input — Cos ϕ.	Second converter output. V.	Second converter output. A.
Field Current of First Converter, 2 Amperes; Second, 3·7 Amperes.								
1	92	13·5	62	13·6	532	·65	0	0
2	82	37	54·5	40	2,190	1·0	79	19·5
Field Current of First Converter, 2 Amperes; Second, 2·7 Amperes.								
3	80	35·7	48	39·5	1,910	1	68	19·4
4	82	13·5	52·4	20·5	472	·44	0	0
Field Current of First Converter, 2 Amperes; Second, 2 Amperes.								
5	79	16	48	30	504	·35	0	0
6	78	30	45·6	37·5	1,484	·87	61	15

Curves 7 to 21 were taken simultaneously with the readings of Table V., as indicated, and it is of interest to trace the nature of the change with load in each case of excitation. In 11, for example, the current being more than double that of 7, the harmonic has moved over 60deg. and its amplitude increased.

The curves from 23 to 40 are for three-phase working, and partly correspond to Table VI. In the last eight the first machine was driven mechanically by belting, but the differences between these and the previous nine are not important. It is evident that the field distortion is extremely small when working three-phase compared with single-phase. With the exception of a weak third harmonics are almost absent. There is a slight distortion of the field as in a continuous-current motor, which is met in practice by suitable brush displacement, but phase swing is difficult to start, and is not maintained to anything like the same extent as in single-phase running.

It may be concluded from these experiments that over-excitation of the second machine or motor improves the stability of the system, but that if the generator or first machine is under-excited, although the ratio of the flux densities in the gaps may be kept constant, there will be both an increase in the eddy-current losses and in the instability of working by reason of phase swinging. It is more economical then to expend energy in over-excitation than to allow phase swing to start and stop it by damping coils. These are necessary in any case where there is a periodic irregularity in the generator speed, but they depend upon a well-marked change in the magnetic circuit, and when this is saturated the magnitude of the disturbance is less.

Eddy currents in continuous-current machinery have been previously thought of as almost entirely located in the armature and pole-faces. From these tests it is seen that with a periodic oscillation through the whole magnetic circuit the losses in the solid cores are considerable, and I believe that the greater part of the iron loss found by any of the usual tests takes place in the solid frame. If this is to be prevented, the mechanical construction must be as accurate as in engine fitting. The pole-faces must be bored smooth and set to gauge. The armature must be as true as a gun barrel and perfectly centred. Its shaft must be stiff enough to prevent the least bending and must not whirl at any speed, for the most violent magnetic changes will be set up if this occurs. If it is attached to overhung pulleys or flywheels, which cause bending, these must be compensated as in a balanced engine. Of course, all this is if it is worth doing. It is merely a question of first cost—the supply company pays for the energy lost in the damping system.

I hope that these experiments will be preliminary to others on sub-station machines under working conditions, and a rather lengthy series of tests on the effect of brush position on efficiency and wave-form has already been made. I think it will be admitted that our experimental knowledge of the reactions in alternators and converters, and in continuous-current machinery also when subject to changes in the mechanical torque, is at present imperfect. I venture to hope that the experimental methods of studying the changes in the magnetic circuits given in this and my former paper will contribute a little to a more thorough knowledge of what really goes on inside the machines, and to an improvement in their efficiency and stability of working.

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NOTES.

Electro-Harmonic Society. — The next smoking concert of the Electro-Harmonic Society takes place on Friday evening, the 19th inst., at the Holborn Restaurant. An excellent programme has been prepared, and the chair will be occupied by Mr James Swinburne, president of the Institution of Electrical Engineers.

Long-Distance Telephony.—The German Post Office is reported to be carrying out a series of tests with Dr. Pupin's new device for extending the present limited distance over which it is possible to maintain communication telephonically. The authorities are working in co-operation with Messrs. Siemens and Halske, who hold the European rights of the invention.

Electric Switch Lights.—Electric lamps of 1 c.p have recently been introduced in connection with railway interlocking systems in the States. The use of this light has followed upon a sufficient number of trials to demonstrate that an electric lamp of this power placed at the focus of the lenses is entirely satisfactory. Four of the lights are arranged in series on a 110-volt circuit, the current used being one-fifth of an ampere.

The Nobel Prizes.—According to a telegram from Stockholm, this year's Nobel prizes have been awarded as follows : literature, Prof. Theodore Mommsen, of Berlin ; peace, Prof. Friedrich von Martens, professor of international law at St. Petersburg ; medicine, Major Ronald Ross, of the School of Tropical Medicine, Liverpool ; chemistry, Prof. Emil Fischer, of Berlin ; physics, divided between Profs. Lorenz and Zeemann, of Holland.

Power Development in the States.—Plans are being prepared in the States for harnessing the Susquehana River and supplying electrical energy to Baltimore for industrial purposes. Two developments of 50,000 gross horse-power each are provided for under the scheme, which is said to involve work of an elaborate nature. The availability for industrial purposes of electrical power in the Baltimore district is expected to result in the introduction of new industries, including electro-chemical and electro-metallurgical works, such as marked the advent of electricity at Niagara.

American Electro-Chemical Society.—This society has sent us Vol. II. of its *Transactions*, in which are reprinted a large number of papers read at the second meeting of the society held at Niagara Falls in September last. It was only last April that the society was inaugurated, and it now claims a membership of some 270, so that the progress of a few months has been rapid. The majority of the papers in this volume are of large interest to the electro-chemical industry generally, and the society has adopted the exceptionable but convenient practice of binding its *Transactions* in stiff cloth covers.

Electrical Fog-Signalling Device. — The Great Central Railway is, we understand, experimenting with an electrical device, the invention of Mr. R. Clarke, of Churchover, in Leicestershire, for automatically controlling the placing on the line of the detonators used by railways as signals during a fog. The apparatus is operated electrically from the nearest signal box, the primary object of the invention being to cover the interval between the sudden approach of a fog and the arrival of the signalling men on the line. The arrangement has been put on its first trial at Lutterworth, which so far is said to have given satisfactory results.

Shoreditch Technical Institute.—This institute has now been provided with a science lecture theatre, a physical laboratory, and a chemical laboratory and balance room, which new apartments were publicly opened on the 4th inst. by the Countess Carrington. The laboratories have been fitted up in the first instance to meet the requirements of the students of the institute, but at the same time the fittings have been designed so as to afford the best examples available of the methods of equipping laboratories for ordinary secondary schools and for small technical institutes. After formally opening the new accommodation, the Countess Carrington presented prizes and certificates to the successful students in the recent examinations.

Appointment.—We are glad to be able to congratulate Mr. J. S. Highfield, the borough electrical engineer of St. Helens, Lancs., on his appointment as chief electrical engineer to the Metropolitan Electric Supply Company, which is now engaged in extending its very large undertakings in London. Mr. Highfield's career has been an eminently successful one, but he has gained no greater success than at St. Helens, where he succeeded Dr. Hopkinson in the charge of the Corporation's electrical enterprise. During his stay in that town the borough has spent nearly £130,000 on the undertaking, and Mr. Highfield's marked ability has had much to do with the successful accomplishment of the work, for which he was mainly responsible.

Electrochemical Behaviour of Sulphur.—During a research into the electrochemical behaviour of sulphur Mr. F. W. Küster has observed that during the electrolysis of a solution of a polysulphide both the current and the voltage undergo periodic variations, which are shown to be due to the deposition of sulphur on the anode. The periodicity of the phenomenon is, however, difficult to understand. In order to throw light on this, a number of measurements of the potential differences between electrodes of platinum or of silver and solutions of sodium polysulphides are made. The results show that such electrodes may be regarded as sulphur electrodes, just as a platinum plate saturated with oxygen may be regarded as an oxygen electrode.

British Association.—The British Association has, we understand, accepted the invitation of the Chartered Company to hold its annual meeting in 1905 at Victoria Falls, on the Zambesi River. The arrangements for the reception of the members are already in progress, as the authorities in Rhodesia have decided to offer the fullest measure of hospitality to the visitors. A large sum of money is to be set aside to defray the expenses of the scientists from London and back, and for their entertainment while in South Africa. A saloon train will convey them from Cape Town to their destination, and a stop will be made at all places of interest near the railway. A fine hotel, to be erected at the Falls, will accommodate the travellers during their stay.

The American Institute.—The October number of the *Transactions* of the American Institute of Electrical Engineers is to hand. It contains the official report of the summer meeting of the institute in New York last May, and, curiously enough, the papers all deal with applications of electricity in one form or another to the requirements of the army and navy. Thus, following President Steinmetz's address, these are the titles of some of the papers which are reprinted : "Electricity in its Application to Submarine Mines," by Captain J. S. Sewell ; "Wireless Telegraphy—U.S. Navy," by Lieutenant A. M. Beecher ; "Electricity in the Navy," by Lieutenant Harry George ; "Electricity in Permanent Sea-Coast Defences," by Major G. W. Goethals ; "Electricity in the Signal Corps," by Lieut.-Colonel S. Reber ; and "Emergency Engineering for Harbour Defence," by Dr. Louis Bell.

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Conference of Science Teachers.—Arrangements have been made by the Technical Education Board for London for the holding of a conference of science teachers at the South-Western Polytechnic on Jan. 9 and 10. In past years these conferences have been found to be productive of much good. They have especially been of great service in enabling teachers in the various scientific institutions all over the country to compare various methods of instruction, and they have been accompanied by exhibits of special apparatus devised and frequently made by the teachers themselves. The result has been in many instances to improve the appliances available in the schools. The assistance of teachers who have designed such apparatus is specially desired for the forthcoming conference. Packages should be forwarded to Mr. H. B. Harper, South-Western Polytechnic, Manresa-road, Chelsea, S.W.

Technical Education.—Sir Arthur Rücker distributed prizes to successful students at the West Ham Municipal Technical Institute on Thursday last week. In a few pertinent remarks on the question of technical education he complimented the local authority on the finely-equipped institution they had established. One of the best and most hopeful signs of the times was the fixed determination of the people of England to give their children the best possible education, and all seemed to agree, in spite of many differences, that if this country was to maintain her position as the most enlightened nation of the world a higher education would have to be placed within the reach of all men. He expressed great pleasure that the London University, of which he was chairman, was formulating a scheme by which it would be possible for the working men and women of England to receive a full university education, and so obtain that culture and knowledge which until recent times had only been the privilege of the few.

Deviable Rays of Radioactive Substances.—Messrs. E. Rutherford and A. G. Grier, in a recent paper on this subject, state that uranium, thorium, and radium emit both deviable and non-deviable rays, the proportion of deviable rays being largest in the case of uranium; polonium, on the other hand, gives out no deviable rays. The active products separated from uranium and thorium contain all the substance responsible for the deviable rays, whilst the original radioactive material still retains the power of emitting, in the case of uranium a large proportion, and in the case of thorium 30 per cent., of the non-deviable rays. The authors think that most of the deviable rays from uranium and thorium may be given out by a secondary product, derived by disintegration from the uranium or thorium molecule; the difference in properties between these secondary products (uranium X and thorium X) and the original substances renders their separation possible. The non-deviable rays may be due to the other secondary product, or to an inductive action of UrX or ThX, on the mass on the radioactive material.

Electric Traction in England.—An article on the traffic of London in the current number of the *Week's Survey* has much to say with regard to the tramway question. Consisting, however, mainly of such generalities as "tramways have come as a boon and a blessing to man," we cannot find much in the article to recommend it to those who would be instructed on the subject, nor, at the same time, is there much to quarrel with in what the writer says. For instance, he gives as the real cause of England's backwardness in electric traction "the lack of intelligent public opinion," and holds the people of London alone to blame for not being in possession of a system of electric tramways at the present time. Later on the writer explains that the article is a plea for open-mindedness generally, and we thoroughly endorse his words. The tramway question especially must be approached in a spirit of open-mindedness if any good is to result, each individual case being judged entirely on its own merits and with due regard to local conditions. The sinking of private interests in this matter would go a long way towards providing a satisfactory solution of the traffic problem, and England would not be long before she cast off the reproach of being the most backward country so far as electric traction is concerned.

Royal Institution.—The following are the lecture arrangements at the Royal Institution before Easter, so far as they are of interest to engineers: Prof. H. S. Hele-Shaw, six lectures (adapted to young people) on "Locomotion, on the Earth, through the Water, in the Air" (experimentally illustrated); Prof. Allan Macfadyen, Fullerian professor of physiology, R.I., six lectures on the "Physiology of Digestion"; Sir William Abney, three lectures on "Recent Advances in Photographic Science"; Sir Robert Ball, three lectures on "Great Problems in Astronomy"; Sir Clements Markham, three lectures on "Arctic and Antarctic Exploration"; and six lectures by the Right Hon. Lord Rayleigh. The lectures on Tuesdays and Thursdays during the season 1903 will be delivered at five o'clock instead of at three, as in previous years. The Christmas course of juvenile lectures and the Saturday lectures will continue to be delivered at three o'clock. The Friday evening meetings will begin on Jan. 16, when a discourse will be delivered by Prof. Dewar on "Low Temperature Investigations." Succeeding discourses will probably be given by Dr. Tempest Anderson, Prof. W. E. Dalby, the Right Hon. Sir Herbert Maxwell, Bart., M.P., Prof. S. Delépine, Principal E. H. Griffiths, Dr. A. Liebmann, Prof. J. G. McKendrick, Prof. Karl Pearson, Prof. E. A. Schäfer, Prof. W. A. Herdman, the Right Hon. Lord Rayleigh, and other gentlemen.

Wireless Telegraphy in France.—Recent events in France point to the fact that that country is working steadily towards a national and independent system of wireless telegraphy. The system being worked in France at present is claimed by Messrs. Branly and Popp as their invention, and the company which is working the patents has stations in daily service transmitting messages 420 miles. The agreement which is now proposed to be entered into with the French Government, and which would give this company a monopoly of wireless telegraphy in France, provides for the establishment and maintenance at the company's own cost stations at every suitable point in France and the colonies and on every ocean-going French mail steamer, all other ships to be equipped for a certain annual subscription. The company would also undertake to establish and maintain all necessary schools of wireless telegraphy—marine and terrestrial—besides permitting the State to maintain, at the company's charge, an official at every station, and allotting to the State a percentage of the receipts. In return for these advantages, of course, the company's consideration would be a monopoly. With regard to the question of the interception of messages originating on other systems, Mr. Branly claims that quite recently he was able, with the aid of his new radio-conductors, to successfully tap and pass along to his own stations several Marconi messages between Liverpool and Crookhaven.

Municipal Trading.—The campaign started by certain interested supporters of private enterprise in this country against municipal trading of any description, is finding support among the editors of the provincial newspapers. Quite recently an article entitled "Municipal

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Gas" appeared almost simultaneously in eight different country papers, evidently gratuitously contributed by some energetic gentleman who is opposed to municipal trading. In addition to being unsigned, this article was given a prominent position in the newspapers which published it, in some cases appearing as a leading article. With the purely gas question we are not directly concerned, but in the course of this article the writer charged the Bristol Electricity Committee with having "apologised for the recent losses on the pathetic ground that they had to compete with the local gas company." Alderman Pearson, the chairman of the committee, naturally challenged the author of the article, through the columns of one of the papers, to produce his authority for the above statement. This he was unable to do, which is not surprising, and in a lame rejoinder to Alderman Pearson's enquiry he "regrets that he is unable to quote a reference in the report of the Bristol Electricity Committee to the competition of the gas company." Comment is needless, but it should in fairness be stated that the cause of the temporary loss in the trading of the Electrical Committee was the temporary rise in the price of coal. It only remains for us to deplore the hostile attitude towards legitimate trading by the municipalities taken up by certain influential provincial newspapers, which are willing to publish an article of the above description without first testing the veracity of the statements made by an interested writer.

The Pacific Cable.—The Postmaster-General, replying to Sir Edward Sassoon in the House of Commons on the 4th inst., was able to give a good account of the Pacific cable, which was opened for the transmission of public messages for the first time last Monday. He stated that the cable had been laid in perfect condition, and that the tests for insulation and conductivity were satisfactory. The consulting engineers of the Pacific Cable Board had conducted a series of speed trials over the Vancouver-to-Fanning section. These tests showed that the cable was capable of carrying 85 letters a minute with hand working, 100 letters a minute with automatic curb working, and approximately 168 letters a minute (84 letters each way) with duplex and curb automatic working. These tests Mr. Chamberlain added, exceeded the anticipations of the expert witnesses who gave evidence before the Pacific Cable Committee. The efficiency of the Canadian route of the new cable was further tested on Sunday. According to a *Times* message from Ottawa, dated Dec. 7, Sir S. Fleming, from Brisbane, sent a cable message to the Mayor of Ottawa, which accomplished the circuit of the globe in six hours three minutes. The time of transmission from the capital of Queensland to London, by way of the Pacific and Commercial cables, was only 18 minutes, while the time from London to Brisbane by the Eastern Extension lines was 5¾ hours. This performance speaks for itself, and reflects the greatest possible credit on all those who have been concerned in bringing the enterprise to a successful issue. A London morning paper also sent a message round the world by the "all-red" route on Sunday. The message started out from the offices of the Anglo-American Telegraph Company at the Throgmorton-street corner of Old Broad-street, and returned to the offices of the Eastern Telegraph Company on the opposite side of the street, having girdled the globe in exactly 7 hours 19 minutes.

Navigable Balloons.—At the opening meeting of the Aeronautical Society last Friday Major B. F. S. Baden-Powell gave an address on the events that have taken place in the aeronautical world during the last three years. Reviewing recent experiments with navigable balloons, he remarked that though we had learnt some useful practical lessons, and had obtained data of great value for future experimenting, the actual results attained carried us little beyond what was accomplished 20 years ago by Messrs. Renard and Kribs. It had, however, been shown to be practicable to build a navigable balloon to go 15 miles an hour. Having accomplished this much, it was probable that a balloon could be got to travel 20 or 25 miles an hour, which would be sufficient to stem the ordinary light breezes. He predicted that in the future larger balloons would have to be used on account of the power required to drive them, it having been proved that a cigar-shaped vessel some 20ft in diameter required more than 16 h.p. to propel it efficiently. The experiments of Mr. W. G. Walker of carefully testing the thrust and lifting power of various screws had clearly shown that it was possible to obtain a thrust of 25lb. per horse-power. As engines were now made weighing no more than 10lb. per horse-power, a machine on this principle could be constructed to lift itself, carrying some 15lb. per horse-power above the weight of the engines. Discussing the uses to which the navigable balloon or airship might be applied, primarily, it would form an incalculably valuable engine of war. One could scarcely imagine any invention which could have a greater effect on the conduct of warfare. Reconnaissance by captive balloon might be considered dangerous, but an apparatus travelling 150ft. a second ran an infinitely smaller chance of being hit by projectiles. Had we been in possession of such apparatus during the late war the operations would have been so greatly facilitated that the campaign would perhaps have been ended in a comparatively short time. Even in naval warfare the aerial machine should prove of infinitely more value than a submarine or a torpedo boat.

Electrometallurgy of Iron and Steel.—It is well known that many iron ores are to be found throughout the world which are too low in tenure to permit of smelting, and such ores have to depend on electrical methods for treatment. An entirely new method, which is said to have given most satisfactory results, was recently described before the American Electro-Chemical Society by Mr. Ruthenberg It consists in taking the concentrates cleaned up to the highest point of possible purity, and putting them through an electric furnace, the melting zone of which is a magnetic field. The ore being magnetic and the polar projections of this magnetic field being at the same time the electrodes of the smelting circuit, the magnetic field thus formed by the ore forms a high resistance in the smelting circuit. The heat of the smelting circuit is engendered within this bridge of ore itself. The electrodes are water-cooled. The moment the ore smelts it loses its magnetism, and, gathering weight from new molten material being added to it, falls out of the magnetic field, its place being taken by new ore from above. The result of this operation is agglomerated coherent masses, ranging in size from a bean to a walnut. These masses differ in no way from the ore prior to its agglomeration, except for the absence of moisture and the last traces of sulphur. The product is said to be an ideal fuel for use in the blast furnace. If reducing material, such as powdered coke dust, be added to the charge prior to its introduction to the electric furnace, a partial reduction takes place, and the fritted mass of carbonaceous dust and iron ore, partially reduced, is dropped into a soaking pit. If allowed to remain in this soaking pit a proper length of time, cementation takes place through the action of the heat left in the ore by the electric furnace and the action of the carbon fritted into the mass, which results in producing reduced metal, which may be properly termed steel. This material from the soaking pits is then melted in the

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open-hearth furnace. It thus becomes possible to produce first-class steel direct from the ore through the intermediation of the electric furnace and the soaking pit, producing spongy iron or steel ready for immediate melting in the open hearth without the intervention of the blast furnace in any part.

Superposed Magnetic Inductions in Iron.—Mr. James Russell recently read a paper on the subject of magnetic inductions before the Royal Society of Edinburgh, an abstract of which is now published in the society's *Proceedings*. The author first deals with the superposition of two magnetising forces at right angles to each other, and the co-ordination of the two components of the resultant magnetic induction, under the various conditions of field superposition; and, secondly, with the magnetic æolotropy of demagnetised iron. The same hollow iron cylinders were used in this investigation as in some shielding experiments previously carried out. With reference to the first of these propositions, the author presents the following case: Of the two magnetising forces at right angles to each other, let H_1 be the force first acting, H_2 the force superposed. Each force acting alone produces the normal B – H induction curve. Let B_1 and B_2 be the two components of the resultant induction in the directions of H_1 and H_2 respectively. When H_2 is superposed upon a pre-existing induction due to H_1, the B_1 component of the resultant induction always lies above the B_2 component. Repeated reversals of H_2 accentuate this result; B_1 is further increased, and concurrently with this B_2 is further lowered For low fields the B_1 component is considerably above the normal induction curve, but as the fields are increased a point is reached where the curves cross, the B_1 component then falling below the normal curve. Also the superposition of H_2 lowers the B_2 component below the normal induction curve, with this exception, that at low values of H_1 the superposition of the second force, H_2, increases the B_2 component above the normal induction curve. This is, however, a relatively small effect. When the superposed force, H_2, carries the B_2 component round a complete magnetic cycle, the B_1 component due to H_1, kept at a constant value, responds, and likewise passes through a complete magnetic cycle or series of cycles. A connection appears to exist between the change which takes place in the B_1 component and the permeability impressed upon the iron by the magnetising force which is superposed. This is especially well marked when H_1 is constant and the superposed force cyclic, the maximum and minimum values of B_1 corresponding to the maximum and minimum values of dB_2/dH_2 respectively. The whole phenomena, however, are exceedingly complicated—permeability, retentivity, coercive force, and vibration effects all contributing to the final result under the various conditions of field superpositions. Dealing with the magnetic æolotropy of demagnetised iron, the author states that during the early stages of induction the experiments described show that iron is more permeable to a reapplication of a magnetising force in the same direction (positive or negative) as that used in the immediately preceding process of demagnetising by decreasing reversals, than it is to force (positive or negative) at right angles to that used in the immediately preceding demagnetising process. The difference for the two qualities of iron used was found to be of the order of 30 per cent., but it vanishes as the magnetising force is increased. The paper closes with an explanation of this magnetic æolotropy of demagnetised iron based upon the molecular theory of induction.

Imperial Telegraphic Communications. — Mr. Chas. Bright delivered an address on this subject before the London Chamber of Commerce on Thursday afternoon, the 4th inst The author has written so often lately on the Imperial cable question, that his views are now fairly widely known. It was not to be expected, therefore, that he had anything new to say to the members of the London Chamber, although his address proved to be of considerable interest in connection with the completion of the "all-British" Pacific cable. Indeed, the greater part of Mr. Bright's remarks referred to the conclusion of this scheme. After giving a *résumé* of the history of the cable from its inception 15 years ago, he alluded to the expeditious manner in which the Telegraph Construction and Maintenance Company had made and laid the cable, but remarked that many considered the project should have been carried out in a different way. The lesson to be learned was that we should not in future put too much reliance on the arguments of those interested in existing cable systems. After enumerating the various political, commercial, strategic, and social benefits to be derived from the closer union, by telegraphy, of the British Empire, he observed that, owing to the great length of one of the sections, the Pacific cable was bound to be a slow-working line. To meet traffic congestion and the chances of breakdown, the line would require to be duplicated, and this, he thought, might well be effected by a link in the American Pacific cable in course of construction. Though the duplication might well be Anglo-American in character, he considered that the original scheme should be strictly "all-British" in every sense, to and from headquarters. Between England and Vancouver no single interest met that condition in a complete and truly satisfactory manner. The undefended state of the western ends of our Atlantic cables was also touched on by the author, and a fortified naval station and cable store were suggested for St. John's, as well as a new and complete link with the nearest end of the "all-British" Pacific cable. He next suggested that when concessions were sought the following points should be considered: guarantee of traffic instead of subsidy, sliding scale tariff, deferred rates, prohibition of "blocking" rates, indemnity for interruption, disallowment of amalgamation, absorption, or joint purses, unless agreed to, provision for taking over the line at an expert's valuation at any time, and a limited period for exclusive landing rights, forfeitable at any moment. On the question of rates he agreed that a reduction of tariff would probably, in many instances, lead to an increase of revenue, though this might take time. What we really wanted was a universal 1s. rate for all cables throughout the Empire. If the Government would guarantee the companies for a given period against loss, the experiment of lower rates might be tried. After suggesting various new cables to complete the "all-British" chain, the author referred to the question of the State absorbing the cables. Though there was much to be said in favour of the measure, there were also many objectionable features about any step which tended to check private enterprise. He concluded by recommending a complete telegraphic system round our coasts in communication with military stations, a piece of work which, he thought, wireless telegraphy was suitable for if kept under proper control.

King's College Engineering Society.—One of the most successful dinners in the annals of the King's College Engineering Society was given at the Hotel Cecil on Saturday night, at which Prof. Perry was the principal guest. Close on 120 members and their friends sat down to table under the genial presidency of Prof. Ernest Wilson, who was well supported by the professorial staff of King's College, including Profs. Thomson, Seeley, Simpson, Waynforth, Curry, Capper, Hudson, Elsey

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Smith, and Jackson. After a repast which left nothing to be desired, the company turned their attention to the toast list, which was kept commendably short in order to leave time for a musical programme afterwards. As should be the case on such occasions, the speeches were short, bright, and to the point, although Prof. Perry was allowed more license in this respect from the fact of his being the guest of the evening. Mr. H. S. Brailsford, in proposing "The College and Staff," paid a high compliment to the professors, who, he said, took such a great interest not only in the students' work, but also in their sports and social gatherings. The principal of the college, the Rev. Archibald Robertson, D.D., replied and congratulated all those who were instrumental in getting up this dinner on the splendid attendance that night. With regard to King's College, it was a very great satisfaction to him that in the reorganisation of the London University one of the professorships in engineering had been located at King's College, and had been given to their excellent dean, Prof. Capper. He also referred to the fact that the degree of B.Sc. was now open to all engineering students at the University of London, and enumerated the steps that were being taken to raise sufficient funds to endow King's College, remarking that a college like theirs ought to be able to secure the positions of its professoriate, and at the same time do something to lower the somewhat high fees they were now compelled to charge their students. It was not to the Government but to their friends to whom they must look to develop the college and enable it to do the splendid work in the future that it had done in the past. Mr. H. A. Lewis proposed "Our Guest," briefly remarking that Prof. Perry's name was a household name among engineers. In his usual humorous style Prof. Perry claimed to have a sort of connection with King's College, as he was president of five rifle clubs, one of which was King's College Rifle Club. He thought that when he was asked to make an extempore speech he ought to have at least two weeks' notice. In offering some advice to engineering students he held that everybody ought to be an electrical engineer at the present day. The aim of the professor should be to make the student think for himself, and he emphasised the importance of students debating matters among themselves and trying to help their professors in their duties. Prof. E. Wilson, in giving the toast of the "Engineering Society," offered congratulations to Mr. J. S. Highfield on his appointment as engineer-in-chief to the Metropolitan Electric Supply Company, one of the biggest undertakings, as he remarked, in London. With reference to the good work of the engineering section of King's College, he mentioned that out of 40 students sent out to Pittsburg by the Westinghouse Company to train for the Trafford Park Works, about one-fourth were King's College men. It would be a surprise to many to hear that there had been two engineering societies in connection with King's College. The old society was started in 1847, and the present one had been in existence for 45 years, having been founded in 1857. Mr. Mann, the president of the society, replied to the toast, and gave some cheerful news with regard to the progress of the society, which had now 75 members. A well-executed musical programme, to which both students and professors contributed, brought a highly successful evening to a happy conclusion.

Electricity in Modern Railmaking.—The introduction of electricity in railmaking and the substitution of the electric motor for the steam-engine in this work are of quite recent date, but they may be said to have truly revolutionised the steelmaking industry. The numerous and varied purposes to which electricity is put in a modern steelworks are well illustrated in an article which is contributed by Mr. J. Hays Smith to the current number of the *Engineering Magazine*. The author takes as a typical example of this development the case of the Edgar Thomson Steelworks, near Pittsburg, in the United States, which is the largest railmaking establishment in the world. The output of these works during the past five years has increased enormously, the enlarged production having been made possible by adopting electricity to operate the various metal saws, roll tables, cranes, rail conveyors, and machine tools. But to obtain a clear understanding of the part that electricity plays in the process of railmaking, the onward movement of the raw material, the metal, and, finally, the rail itself must be followed. The point of starting is the ore yard, and up the side of the blast furnaces, by an almost vertical incline, pass swiftly-moving cars carrying the ore, coke, and limestone in the exact proportions requisite for the production of iron. Electric motors hoist and dump the contents of these cars into the furnace top. The tanks containing the liquid metal are also tilted by an electric motor and their contents poured into other metal cars standing below. These cars, which are electrically operated, discharge into the mouth of the converter, which has been turned down to receive the white-hot metal, again by the aid of an electric motor. The preparation for the rolling process is almost as important as the rolling itself. Therefore, before rolling, the unevenly-cooled ingot is brought to a uniform temperature, which is accomplished in reheating furnaces. Above the bank of these furnaces are four monster electric tongs always busy in lowering or raising ingots. The tongs are suspended from a derrick-like car that travels back and forward on the bridge of an electric crane, which runs above the entire line of furnaces. Not only is the ingot hoisted electrically from the soaking pits, but also electrically conveyed to the blooming mill about 100ft. away. After a number of passes over the blooming rolls the metal becomes a bloom about 15ft. long and 9in. square. The next process is to cut the long bloom up into smaller blooms, in which electrically-driven bloom shears are brought into play. The rough ends—"crop heads"—are cut off and are placed by an electric crane in a car for shipment to any part of the works. Formerly eight to ten men were employed in wheeling the crop heads out from the bottom of the chute; now a boy and a helper dispose of them. Before the sheared bloom is finally rolled into rails, it is again placed in a reheating furnace. From this furnace it is drawn on the opposite side by an electric "drawer" and deposited on a buggy. It is then carried to the rail mill, where the transfer to the rolls is effected by a line of electrically-driven rollers. Here begins the final process of making the rail. Everything except the heavy rolls that shape the steel is electrically operated. The red-hot steel passes into the rolls, and, rushed back and forward on electrically-driven rollers, it lengthens with each pass, until finally it runs out a thick bar about 30ft long, when a set of transfer arms picks it up and throws it bodily to a second set of rolls. The steel bar quickly reaches a length of 100ft. under this process, and a third set of rolls finishes it off into its final and familiar T form. The long rail then passes to the hot saws, which, electrically driven, cut the rail in three pieces, each 30ft. long. Lastly, a motor-driven rail conveyor carries the finished rails out to the shipping skids, and they are ready for the market. The most remarkable feature of the manufacture of these rails is that from the beginning to the end man has not touched the metal, owing almost entirely to the extensive part played by electricity in the process.

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NUNEATON ELECTRICITY WORKS.

On Monday last, Dec. 8, the new electricity works for supplying electrical energy for Nuneaton were formally opened. The history of the electrical undertaking at Nuneaton is much more varied than is usually the case in a town of its size. For instance, the supply was only commenced in 1897, and now the whole of the then works

MR. S. CAMERON GIBSON, ELECTRICAL ENGINEER TO THE NUNEATON AND CHILVERS COTON URBAN DISTRICT COUNCIL.

have been superseded. The supply was first given by a private company, which erected its plant in some old buildings adjoining the present station. The electricity was distributed by overhead wires, and we believe we shall not offend against the truth when we state that in a good many cases the quarterly bills for the consumers were arrived at without the assistance of meters. The company commenced working without a provisional order, but afterwards obtained one, which was transferred with the undertaking to the Corporation in September, 1900. Under this order it became necessary to put the cables underground, and this entailed the scrapping of the overhead cables. It was also found that the old buildings were quite unsuitable for housing the plant, and the Corporation decided to entirely remodel the generating works The new buildings, illustrated in Fig. 1, together with the chimney, which is 120ft. high, were designed by Mr. J. S. Pickering, the borough surveyor, and carried out under his supervision. The general arrangement of these buildings is clearly shown in Fig. 2. The elevation of the buildings which is nearest the road, and which is shown in Fig. 1, is what may be called the permanent side of the works. In the other direction both the engine and boiler rooms have temporary ends, so that they can be readily extended towards the river.

The electrical plant for the new station was ordered while Mr. W. J. Proctor was the electrical engineer, but the erection of it and the moving of the old plant has been entirely carried out under the supervision of the present resident and consulting engineer, Mr. S. C. Gibson, A.M I.E.E. When Mr. Gibson took up his duties in September, 1901, the supply was being given by the old plant in the old station, and the condition of the plant made it no easy matter to carry on an uninterrupted supply during the transition period. These difficulties have now, however, been successfully overcome, but there remains a somewhat heavy capital charge on the undertaking. This was inevitable, as, although the company sold their undertaking for 15 per cent. under cost price, a good deal of the plant and mains had afterwards to be replaced.

The boiler-house equipment now consists of three Babcock and Wilcox boilers, each with 1,827 square feet of heating surface; the last of these to be added has a furnace specially designed for burning local slack, which can be obtained at 3s 3d. per ton. With this object the width of the furnace, and hence of the boiler setting, is increased, and the fire-brick sides of the furnace are arched in to meet the tubes. These, again, are placed higher up above the fire than is usually the case, in order to give a larger space for combustion. The increased height is about equal to the pitch of the lines of tubes—*i.e.*, it is as though the lower line of tubes was removed and placed on the top. The firebars are placed close together, and Mr. Gibson has also had constructed an extra door near the first baffle, so that the soot which usually collects there may be removed. The following interesting figures show what improvement has been made in the new boiler-house as compared with the old. In November, 1901, the coal burnt cost £52 In November, 1902, with 25 per cent. more units generated, the cost of coal was £13. The boilers work at 160lb., and a Babcock and Wilcox superheater has been added to the new boiler. The water from the river is used for feeding, and before being passed into the boiler it is heated up in an economiser. In order to prevent the sweating troubles which occur when cold water is passed in, a certain amount of the heated feed water is by-passed into the delivery side of the pump, so that a temperature of 90deg. F. is maintained on the water entering the economiser.

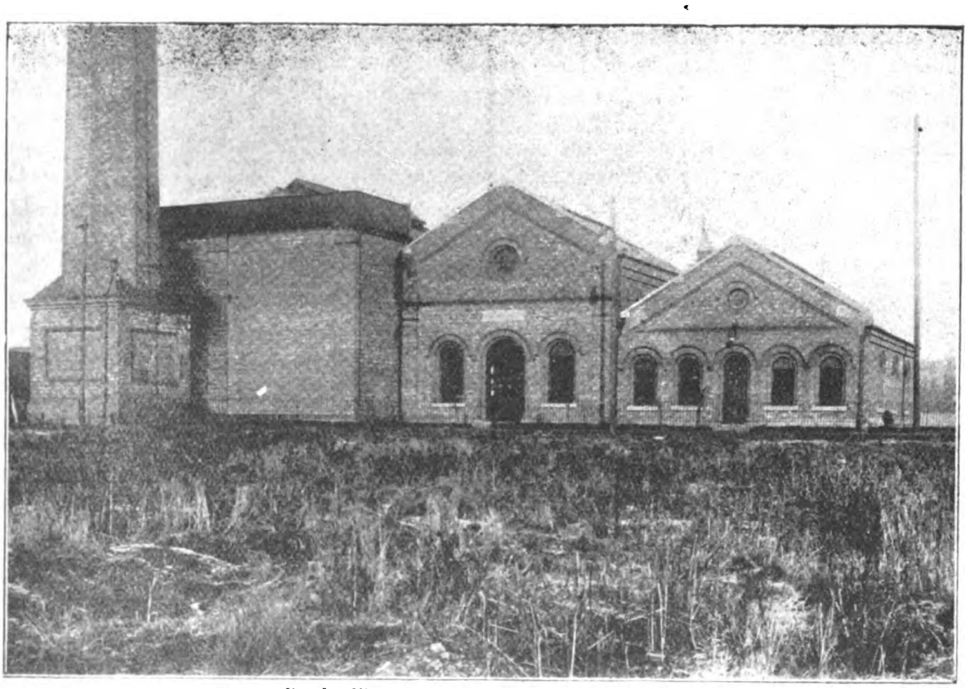

FIG. 1.—View of the Nuneaton Electricity Works.

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The engine-room plant consists of a 72-kw. Siemens-Willans steam dynamo, an 80-kw. Clarke-Chapman dynamo driven by an engine made by the same firm, and a 150-kw. Johnson and Phillips dynamo driven by a Willans engine. The two smaller dynamos are of the two-pole type, and they, with their engines, were taken over from the old company and rewound for the higher voltage. The larger set is a new one. The balancer and booster set, shown in the foreground of Fig. 3, was also supplied by Messrs. Johnson and Phillips. All the machines are now arranged to feed across the outers of the three-wire system at from 440 to 460 volts. These engines are now being worked condensing. The water for this purpose is obtained from the adjoining river, and is lifted into a 50,000-gallon tank, which can be seen in Fig. 1. This is done by means of a pump in the boiler-house, which is driven by a Johnson and Phillips semi-enclosed motor. The condensing water passes from this tank to the ejector condensers behind each engine. These are of the Ledward type. When we inspected the works at the time of the opening ceremony, the condenser on the large engine was providing a 27in. vacuum.

The accumulators are of the Hart type, of 250 ampere-hour capacity at the normal discharge rate. They are designed to give 88 amperes on emergencies, and have done this without trouble. They are placed in the accumulator-room behind the switchboard, and the regulating cells are connected by cables on to the accumulator switches. In the circuits of these two batteries of accumulators, Mr. Gibson has arranged two meters of the Chamberlain and Hookham type; a pawl and ratchet on the motor shaft allows one meter to run in one direction only, and the other can only rotate in the opposite direction. By this means the charge and discharge currents are independently recorded. The meter reading the charge is arranged to go 10 per cent. slow in order that the differences between the two meter readings may give directly a correct idea of the charge in the accumulators at any time.

The switchboard (Fig. 4) supplied by Mr. Edmund Charrington, of Ormond House, E.C., contains the various instruments and switches required for controlling the plant in the station. The meters are of the Kelvin type, and these include three large station voltmeters which enable the pressure at the end of the three feeders to be seen from any part of the engine-room. On swinging panels at each end of the switchboard, Mr. Gibson has arranged smaller voltmeters, which show the voltage on either side of the three-wire system at these feeding points. The three voltmeters for the negative side and the three connected to the positive side can, by means of these swinging panels, be watched while the regulating switches of the balancers or of the accumulators are being operated.

The cables originally ordered when the reorganisation of the undertaking was commenced were supplied by Messrs. Johnson and Phillips, and are of their paper-insulated type. The last feeder to be laid down was supplied by the Callender Cable and Construction Company. All the feeders are lead-covered and drawn into earthenware conduits of either the Doulton or the Sykes type. The distributing cables, on the other hand, are of the armoured class, and are laid direct in the ground. Pilot wires are used to connect the station to the feeding points for regulation purposes.

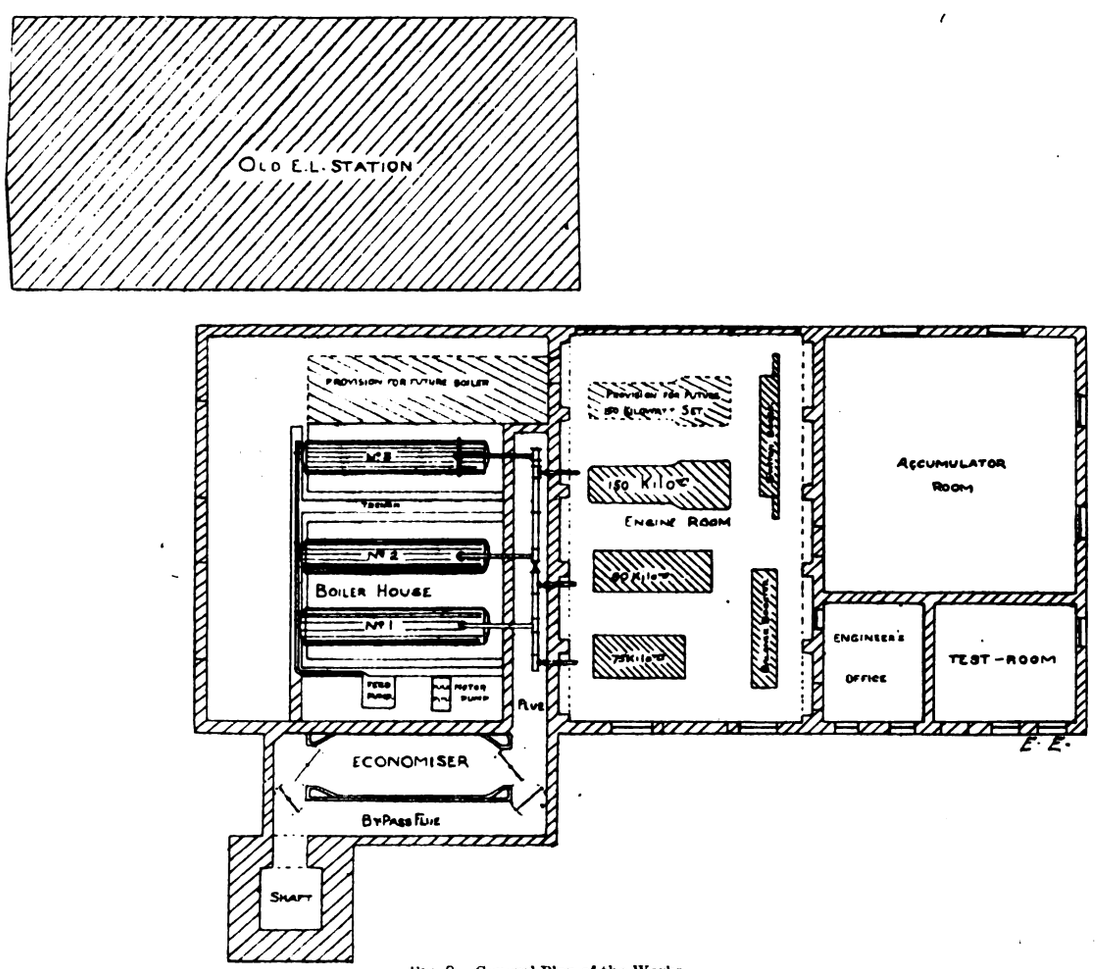

Fig. 2.—General Plan of the Works.

The street-lighting work at Nuneaton is entirely new, and the town has the honour of being the first to use the Bremner arc lights for this purpose in this country. At present 20 of these lamps have been supplied and erected on ornamental poles. They are connected in series of five between the middle wire and the outer, and supplied at 200 volts. There are two of such series on either side of the system, and the wiring is such that they can be switched on from the generating station. The lamps take 7½ amperes each. On the street-lighting panel there is also placed a pilot switch, which completes a circuit through the automatic gear in the base of each lamp pillar for cutting into circuit the two incandescent lamps which are used after 11 p.m. These lamps are also automatically cut in in event of either of the arc lamps failing. The Bremner arc lamps were supplied by the British Westinghouse Company, and are amongst the first to be manufactured by them at the Trafford Park Works.

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The light from these lamps is exceedingly rich in orange rays, and gave a most pleasing effect when we were passing through the streets after the opening ceremony. The regulation of one of the circuits had not been completed, but otherwise the lamps appeared to be working well in series.

With an undertaking such as briefly described above, which has been reconstructed throughout, the financial question becomes a most important one. In the old days the company succeeded in obtaining some 8,000 8-c.p. lamps connected to their mains, but, owing to irregularities in supply and exceedingly keen competition from the gas company, this number fell at one time to 5,000. Now that the works have been completely remodelled under municipal control, all the old customers are again taking a supply, and the equivalent number of 8-c.p. lamps which is now connected to the mains exceeds 10,000. Besides this, the department have now secured an order for a 60-h.p. motor for a Nuneaton wool factory, which will help the day load very much. The same people are also using a large number of arc lamps. Under the advice of their electrical engineer, Mr. S. Cameron Gibson, the charge for electrical energy for motors has been reduced. The rates are 3d. per unit for the first hour's average use of the maximum demand, and 1d. per unit for all in excess of this. In this way a bid is being made for a power load, which will be of great service to the undertaking and convenience to the public. It is to the economical working of the station that the financial success depends In order that a careful check may be kept on the same, Mr. Gibson has instituted a series of curves which are constructed from the figures obtained for each month's working. These curves, which are the most complete we have yet seen, enable the committee to see readily how the undertaking is progressing. They are equally useful to the electrical engineer, and they create a lively interest amongst the staff on the all-important question of cost. We are able to reproduce here two typical examples of these curves. The first of these (Fig. 5) gives the cost per Board of Trade unit generated for each month during the past 12 months. The upper curve is for the total works cost, while those underneath give the detail costs under the usual headings. The only uncertain part in this curve is that for November and December, 1901. The uncertainty is due to the fact that in the old works there were no meters in the station, and the output of the machines had to be estimated from the hourly records of the ammeters and voltmeters. The following exact figures for the month of October last will

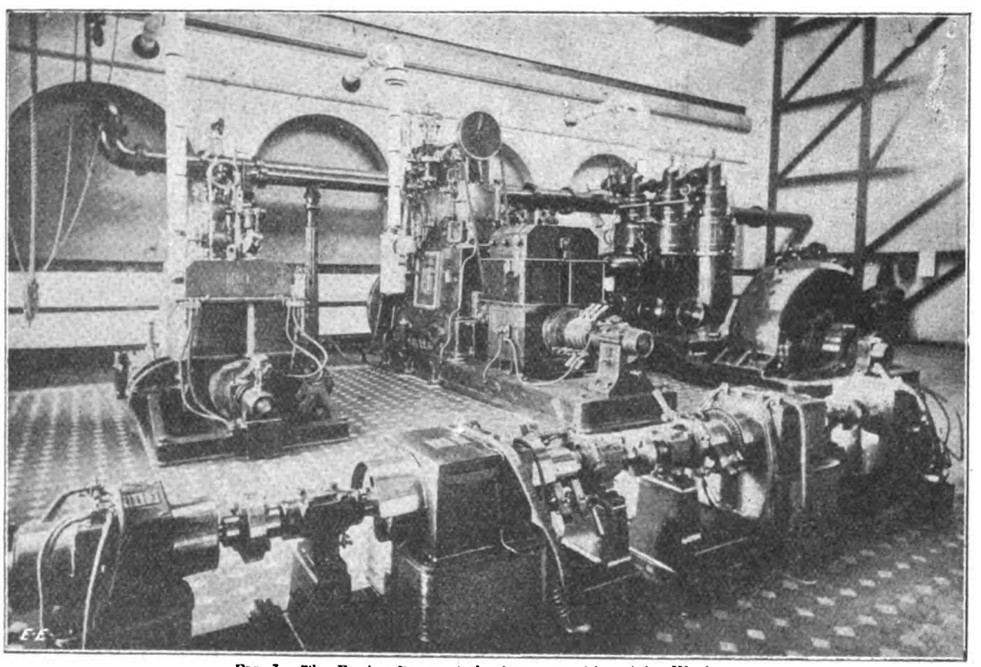

FIG. 3.—The Engine Room at the Nuneaton Electricity Works.

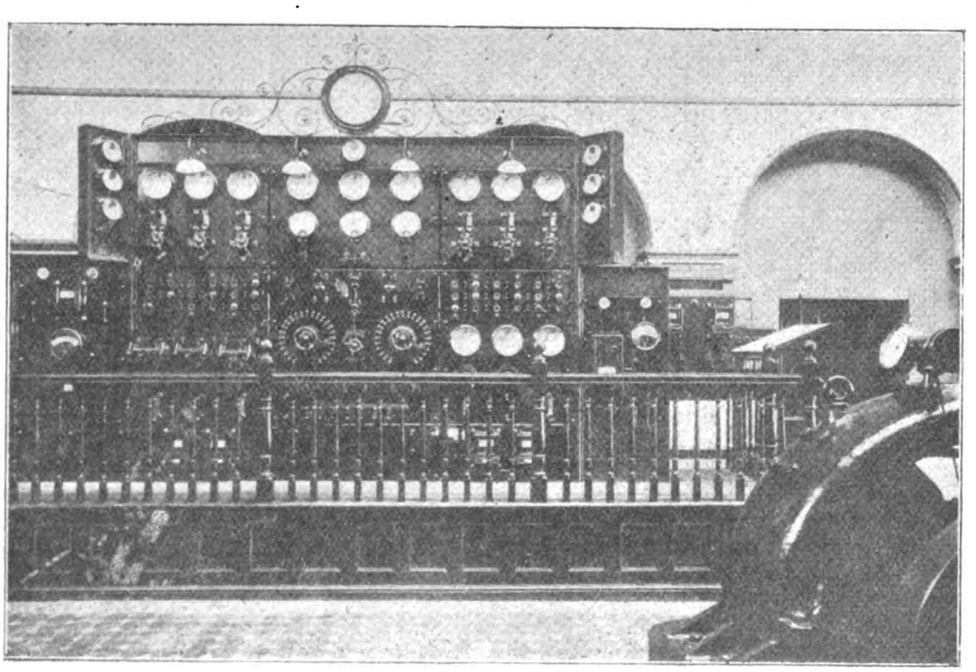

FIG. 4.—The Nuneaton Switchboard.

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be of interest. The costs per unit generated were for this month: coal, 0·273d.; oil, water, and stores, 0·043d.; wages, 0·465d.; and repairs, 0·016d. This brings the total works cost to 0·813d., which is an exceedingly creditable figure considering the output of these small works. For the same month the total cost per unit generated was 1·279d., or, including capital charges, 3·84d. The extension of the load caused by use of motors will soon reduce the great difference between these last two figures.

In Fig. 6 we give the curves of total expenditure for each month during the past year—*i.e.*, up to the present date. In this the interest and repayment of loan is

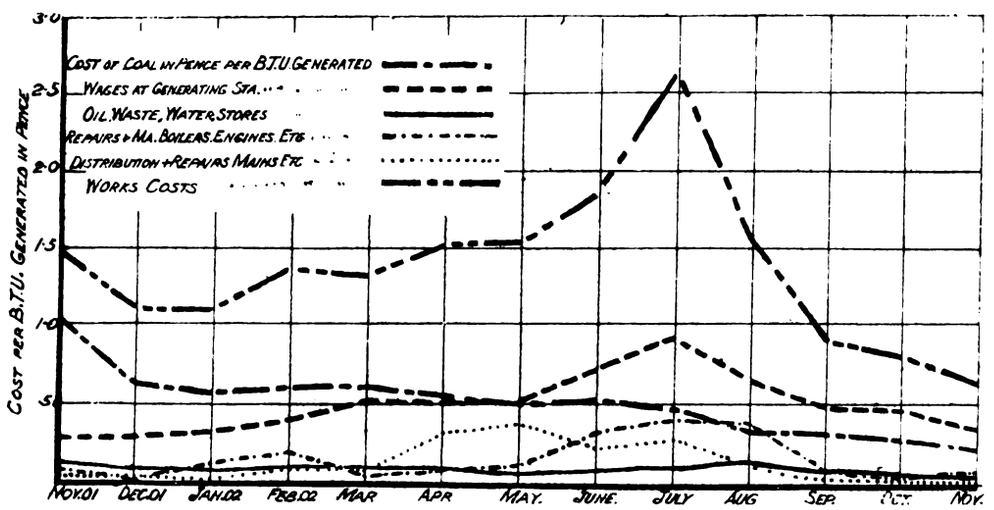

FIG. 5.—Curves of Monthly Costs of Production at Nuneaton.

included. Thus the increase in October this year is due to the last loan obtained. The area between this full line and the revenue curve clearly shows the financial state of the undertaking, and that during the summer months there has been insufficient revenue to meet the capital charges. About the middle of October this ceased to be the case, and during the winter months an effort will be made to wipe off the deficiency. If the undertaking was still in the hands of a company and not obliged to pay interest and repay capital, the profit each month would be represented by the difference between the two dotted lines. It must be remembered that these curves are for a period

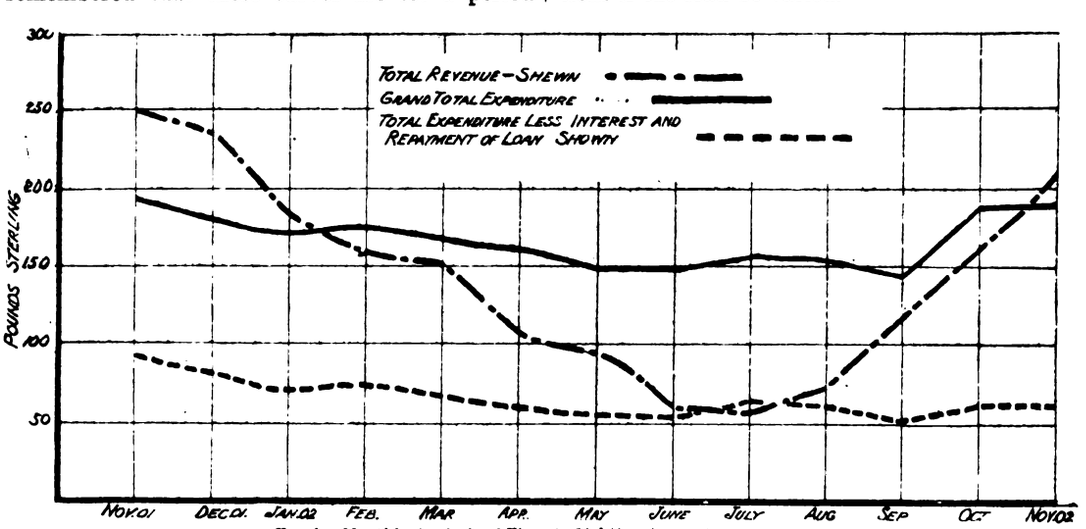

FIG. 6.—Monthly Analysis of Electric Lighting Accounts at Nuneaton.

when the works were being moved, and hence the returns for next year will be much more favourable to the undertaking. In fact, the results obtained in Fig. 5 fully warrant the expensive changes which have been made, and argue well for the future of the undertaking.

At the opening ceremony on Monday last only two toasts were given. The chairman of the Council, Mr. T. Horton, proposed "Success to the Electric Light Undertaking and the Electrical Engineer," which was replied to by Mr. Bates, the chairman of the Electricity Committee, and Mr. Gibson. The other toast was that of "The Contractors." After an inspection of the works Mr. Bates lighted the fires under the new boiler, and then the chairman of the Council switched on the street-lighting. This ended an enjoyable function, and we have only to conclude with our thanks to the electrical engineer for his kindness in showing us round the works.

THE DIFFERENTIALLY-COMPOUNDED MOTOR.

BY W. R. KELSEY, A.I.E.E.

For the majority of purposes the speed regulation of simple shunt or series wound motors is sufficiently within limits to render their adoption advisable; and of these types the shunt motor is well known to be by far the better for running at a fairly constant speed with varying load, the main advantage of the series winding being the large starting torque thereby obtainable. The ordinary cumulative compound winding, as is to be expected, presents an intermediate character, the similarity of its properties to those of a shunt or series winding being proportional to the smaller or greater number of its series turns. For a moderate compounding it possesses fair starting power under load, with rather poor speed regulations if the load be varied.

In general, as has been said, the use of motors of these types is advisable on account of their simplicity, and more particularly their economy in original and running costs. There are cases, however, where these points are subservient to the necessity for a very uniform speed under two or more loads, and this particularly with respect to motors used for driving textile machinery. For such purposes, where a 5 per cent. variation may mean much, shunt motors fail to meet the case, and differential windings may advantageously be employed. In such windings the series-turns carry current in a reverse direction to the shunt, so tending to reverse the magnetic flux.

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Such motors may then be regarded as shunt motors fitted with a number of demagnetising series-turns, and the determination of the windings is of some practical use and interest.

The points may, perhaps, be most clearly brought out by ascertaining the ampere-turns necessary in the shunt and series coils for a machine with a given armature and magnets.

If Z = the flux in C.G.S. lines per pole;
T = the number of armature bars;
N = the speed in revolutions per minute;
C = the current in amperes;
p = the number of pairs of poles;
n = the number of pairs of parallel circuits on armature;

then the horse-power developed is given by

$$\frac{1{\cdot}41\ Z\ T\ C\ p\ 10^{-8}}{12\ n} \times \frac{2\ \pi\ N}{33{,}000},$$

so that for a given output of power and speed the only quantities that can be varied are Z and C. Thus if any chosen value of C be inserted in the equation, the corresponding value of Z may be at once calculated.

If, then, the motor is required to run at two different horse-powers with the same speed, two curves may be plotted, showing for each load the corresponding values of current and flux at that speed, as in Fig. 1. Now, the

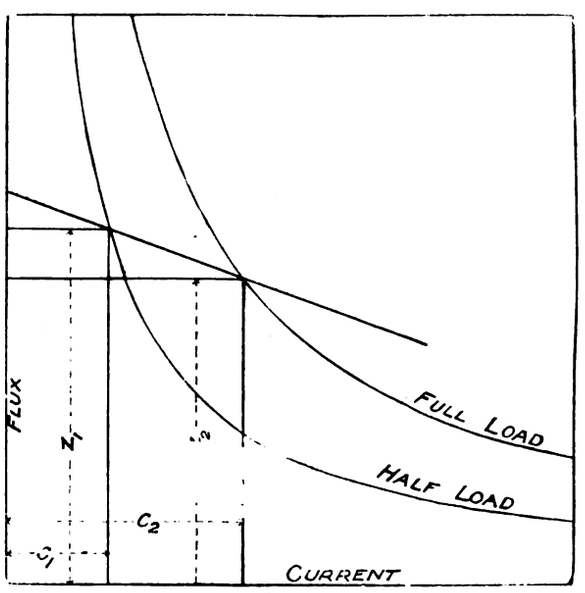

FIG. 1.

current and flux in the actual motor are not independent at a constant speed, but each value of the current corresponds to a particular flux. There is thus on each of the curves obtained only a single point giving the current and flux for that horse-power and speed.

To find these, it should be noted that no current flows through the armature when the flux, Z, is such that at the given speed the back pressure is equal to that of supply, E—that is, when

$$Z = \frac{60\ E\ n}{T\ N\ p} \times 10^8;$$

since the back voltage equals $\frac{Z\ T\ N\ p}{60\ n} \times 10^{-8}$.

On the other hand, if the flux is altogether removed, the current through the armature is simply equal to the supply pressure divided by the combined resistance of the armature and series coils. Hence, if from a point on the flux scale representing the value of Z so found a straight line be drawn to a point on the current scale representing this maximum current, this will cut the two curves in the required points. As this current is generally too large to be conveniently set off, it is preferable to draw from the point on the flux scale a line inclined to the axis at an angle $\tan^{-1}\left(\frac{n\ q\ 60 \times 10^8}{T\ N\ p\ R}\right)$, where R denotes the motor resistance, and q the ratio of the length on the flux scale, representing one C.G.S. line to the length on the current scale of one ampere. In this latter way it is possible to draw only so much of the line as may be necessary to cut the curves. By either method the current and flux which must coexist for each load is found, no other values being possible.

To determine the windings, the induction curve (Fig. 2) showing armature flux and exciting ampere-turns is plotted in the usual manner, and the ampere-turns necessary for the production of each of the two values of flux given by Fig. 1 are ascertained. If these be denoted by X_1 and X_2, the currents by C_1 and C_2, the number of turns in the series coils must evidently be

$$\frac{X_1 - X_2}{C_2 - C_1},$$

and the ampere-turns in the shunt must be made equal to

$$X_1 + C_2 \text{ (series-turns)}.$$

The actual section of the conductor of each may be settled in the ordinary way, though it is to be noted that the less the resistance of the series-turns the smaller is the difference of flux necessary between the given loads. This winding is the only possible one satisfying the given conditions, and even thus it is not practicable to ensure uniformity of speed at intermediate loads. Were the induction curve a straight line between the two flux points, this constancy would naturally follow, but inasmuch as in the region of the curve available for practical working it is

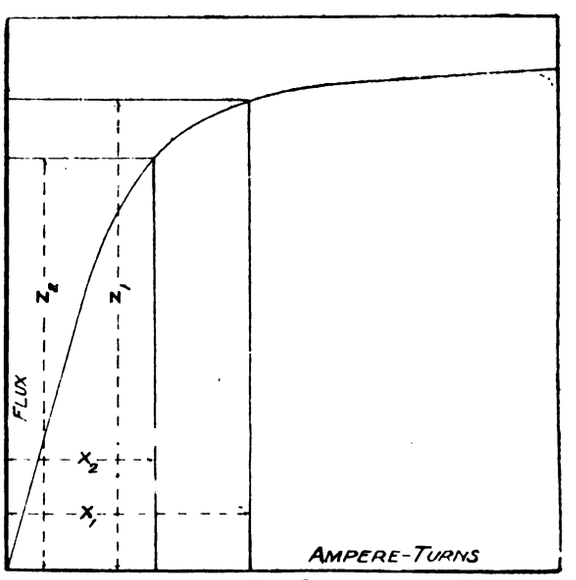

FIG. 2.

convex upwards, a fall of speed occurs between the two positions. The variation per cent. is the same as that of the flux from straight line values. Where a given special variation is permissible between the low and full load values, it is only necessary to draw in Fig. 1, instead of a single straight line, two, one for each speed, and to take the intersection of each with its particular load curve.

It is obvious that since the series coils act in opposition to those of the shunt, the energy expended in them is wasted so far as conversion into mechanical work is concerned, and that they should, therefore, be as few as possible. On this account it is not advisable to work the iron at the high inductions usually employed. A glance, indeed, at the induction curve will show how many times more greatly the exciting ampere-turns must be reduced to produce a given fall of flux, if the working point be on the upper region than if below the knee. The magnets of the machine must, therefore, be of larger section, and so heavier, than in other types. The weight of copper also is augmented.

The efficiency is necessarily somewhat reduced by the increase of turns in the field—viz., series turns, increase of shunt turns, and the greater length of each per turn due to the larger magnets. These losses may, of course, be minimised by greater original outlay on copper, provided this does not entail a lengthening of the iron cores, and, as against it, must be set off a lessening of the iron loss due to the smaller induction. The redistribution of the wasted

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energy, as compared with the shunt motor, is thus an increase of the variable and a reduction of the fixed losses, the greatest value of the efficiency being thus brought down to a smaller value of the load.

The conclusions are, then, that the differential motor has good speed regulation, but is heavy and expensive in cost and working. Its speed should be high and its resistance low, that a moderate difference in flux may be sufficient. Its shunt should be connected across the terminals that its power may not be reduced with large currents by any drop in the series coils. And, lastly, it may be advantageous to shunt some part of the main current from the field through a resistance having a high temperature coefficient.

NOTES ON POLYPHASE MOTORS.

(Continued from page 805.)

A circuit may possess both inductance and capacity. In this case we proceed in the same way by setting out a line, A B, to represent the ohmic resistance, R, at right angles to this and to the same scale. Above the line is drawn the line B C, to represent the reactance due to the induction, $2 \pi n$ L. Off the top of this line is set a part, C D, of such a length that C D represents to the same scale the reactance $-1/(2 \pi n$ K), due to the effects of capacity. If, then, the points A and C are joined, the line A D will represent to the scale the total impedance of the circuit. If the inductance is (as is shown in Fig. 8) greater than the capacity, D will be above the line. If, on the other hand, the capacity is greater than the inductance, then to get D, the line B C must be continued below the line A B, and A D will also be drawn below A B. This will show that the current will lead in phase.

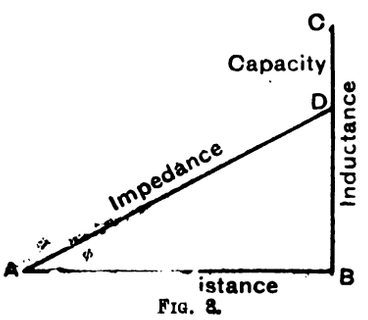

FIG. 8.

In the case of direct-current work the power in any circuit in watts is found by multiplying the volts by the amperes; this is not the case, however, with alternating currents. As we have seen, part of the tension is required to overcome the back E.M.F. due to the induction; this portion, then, of the voltage is doing no useful work, and even when E represents the virtual volts and C the virtual amperes, it is not sufficient to multiply the two together to obtain the power in watts. The product of these two must be further multiplied by the cosine of the angle of lag. So that the equation for the power in any alternating circuit will be

$$E \times C \times \cos \phi = \text{watts.}$$

In the case of three-phase circuits the power in each phase must be obtained in this way, and the three products added together for the total power. The true watts in a circuit can be found from calculation if the coefficient of induction is known, for we have seen that, from Fig. 5, the tangent of the angle of lag is equal to the reactance divided by the ohmic resistance. Hence, if the angle of lag is required, and we know the value of L, we can deduce from the equation $\tan \phi = 2 \pi n$ L/R.

The more usual method of finding the angle of lag is by inserting a wattmeter in circuit. This instrument reads the true watts, and as the apparent watts are found by multiplying the apparent volts and amperes as given by the voltmeter and ampere-meter, the ratio between the two is easily obtained. For instance, if the wattmeter gives the value of the energy in the line as 8,000 watts, and the apparent volts are 100, and the apparent amperes 90, we can readily find the value of ϕ. We know that $E \times C \times \cos \phi$ = true watts, where E are the virtual volts and C the virtual amperes given by the instruments. We also know that the true watts given by the wattmeter are 8,000; hence

$$E \times C \times \cos \phi = 8{,}000;$$

or $$100 \times 90 \times \cos \phi = 8{,}000;$$

that is, $$\cos \phi = \cdot 888.$$

Upon referring to a table of sines, we find that the cosine of an angle of 27·5 is ·887, so that we may write ϕ as 27·5.

On the left-hand side of our equation we have three factors which we multiply together. The question arises, which of the two first do we multiply by cos ϕ; we may consider that we multiply either. If we multiply the volts, we are then multiplying the amperes into the resolved part of the volts in phase with the current, and have the other component of the E.M F.—viz., sine E—as being required to overcome the counter E.M.F. due to the induction. The more usual way of looking at the matter is to consider that we multiply the amperes by cos ϕ; we then resolve the current into an energy current in phase with the E.M.F., and a wattless current in quadrature with the volts As in the working of any alternating generator this wattless current is of the utmost importance, because of its heating effect, this latter way of regarding the subject is the one more generally adopted.

The ratio of the true watts to the apparent watts is called the "power factor." This is always less than unity. In the example given above the power factor is 0 888, and is then equal to the cosine of the angle of lag. The value of the sine of the angle of lag will give a factor which is sometimes called the induction factor. Thus in the above example we have seen that the energy current is 90 cos 27·5 = 79·2 amperes, while the wattless current will be 90 sin 27·5, or 90 × ·461 = 41·49 amperes.

In alternating-current circuits it is not advisable to use conductors of large diameter; far better results are obtained when the conductors are made to consist of a number of small wires instead of one large one. The reason of this is apparent if we remember that the counter E.M.F. is due to the lines of force set up by the alterations in the direction and value of the current flowing. The current creates a magnetic field round the wire, the lines of force forming closed rings concentric to the axis of the wire. Now, the extent to which these rings will extend in the surrounding medium depends entirely upon the strength of the current. If the current is small, the lines will not extend far; also any alteration in the value of the current will first affect the lines nearest to the axis. We have only to consider the effect on a conductor of abnormal dimensions to see that it is quite possible to have the outer layers of it lying quite outside the field due to the self-induction. In actual practice it is, therefore, best to use small conductors, or else to make use of a conductor with a hollow core. Mr. Oudin states in his book on "Standard Polyphase Apparatus and Systems" that with a large conductor the centre may not only be absolutely useless, but may even convey a current, due to self-induction, which is flowing in the reverse direction.

For similar reasons it is not advisable in the case of three-phase transmission to use a triple-concentric cable, but to employ a three-core cable. It is easily seen that in the former case the central conductor will be subject to the influence of the magnetic field due to the other two conductors in a greater degree than will the intermediate conductor, while this will be worse placed than the outer conductor. It must also be remembered that with a three-phase current, whether the conductor be concentric or three-core, that the wires must never be run in an iron pipe. If attention is not paid to this point, owing to induction a current will be induced in the pipe, and as no current can be generated without the expenditure of energy, the result will be a corresponding drop in the tension of the current in the conductors. With a two-wire monophase distribution it may be that the fluctuations in one wire will counterbalance the fluctuations in the other, but this result will not obtain with three-phase currents, as if one balances the other there is a third wire unbalanced

Designers of direct-current generators know that the current is first of all generated as an alternating current

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and then commutated into a direct current at the commutator. If the winding were put on without any connection to the commutator, either as a ring or drum winding, and the two ends of the winding were connected to slip-rings, we should get an alternating current. Similarly in any direct-current machine, if connections are made from two commutator sections to slip-rings (across the diameter in the case of a bipolar machine, and across a quadrant for a four-polar), we should obtain a direct current from the brushes resting on the commutator and an alternating current from the brushes resting on the slip-rings. The virtual volts of this latter current would be $x \div \sqrt{2}$, where x is the voltage of the direct current; the periodicity of the alternating current would be $N \times P \div 2$, where N is the number of revolutions per second, and P the number of poles.

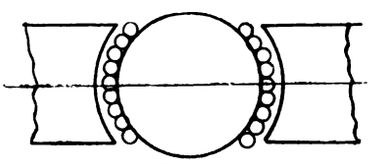

FIG. 9.

Let us consider for a moment this method of generating an alternating current. Take first of all a bipolar generator. We know that all the inductors on the periphery of the armature core serve a useful purpose in the case of the direct current, those lying between the poles being required for commutating purposes, but for the alternating current these wires which are not in the magnetic field are idle, and equally good results would be obtained were all the inductors grouped under the poles, as shown in Fig. 9. This would leave a large portion of

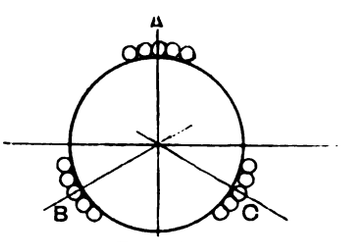

FIG. 10.

the armature core bare. We might then wind a different set of coils at right angles to the first, and if this set were treated as an independent winding it would give birth to a second alternating current, which would attain its minimum and maximum values 90deg after the first current had attained its maximum and minimum values. The two currents obtained in this manner might be treated as entirely separate both in their generation and in regard to the circuits they fed, or in the outer circuit they could be arranged to work in parallel. This arrangement of the generator gives us a two-phase current. In place of only putting on two independent windings, we could group the inductors of the various sets close together and put on

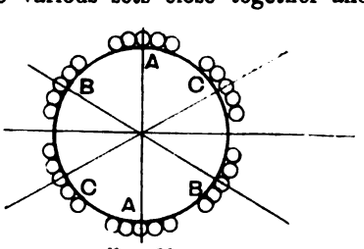

FIG. 11.

three windings, as in Fig. 10, the centre of each winding being 120deg. behind the preceding one. This arrangement would give us a three-phase generator. In place of putting on only three sets of coils, we can, as in Fig. 11, put on six, opposite coils being in series with each other. This shows that the method is equally adapted for either ring or drum windings. Now let the three sets of coils be denoted by the letters A, B, and C respectively. If, then, at any instant the tension in coil A has its maximum value, V, the tension in the winding B will be equal to $\frac{1}{2}$ V, but will be in the opposite direction to the tension in coil A; the tension in coil C will be equal in value and sense to the tension in coil B. An instant later the tension in the first phase will have a value equal to $\frac{\sqrt{3}}{2}$ V; the tension in winding B will then be equal to zero, and the tension in winding C equal to $-\frac{\sqrt{3}}{2}$ V. In order to see what will be the respective values of the tensions in the various phases at any instant, all that is necessary is to draw a clock diagram and calculate the sines of the angles through which the various lines representing the tensions in the windings have moved from the starting point.

In the case given above we have considered that we have only to deal with bipolar machines: in actual practice we shall find that alternating generators are always multipolar; this, however, presents no difficulty. With a bipolar generator the original state of things recurs after any point on the periphery of the armature has revolved through 360deg., with a four-polar a complete cycle is made when the point has swept through an angle of 180deg., with a six-polar when the point has moved through an angle of 120deg., and so on. The method adopted, then, is to consider the smaller angle, whatever it may be, as an angle of 360deg. For instance, suppose that we are dealing with a 20-pole machine, and that we desire to set out in the form of a clock diagram the E.M.F.'s generated instantaneously during a complete cycle. We can set this out in a complete circle, provided we multiply every angle under consideration by 10, and shall obtain by this method in a simple manner perfectly correct results.

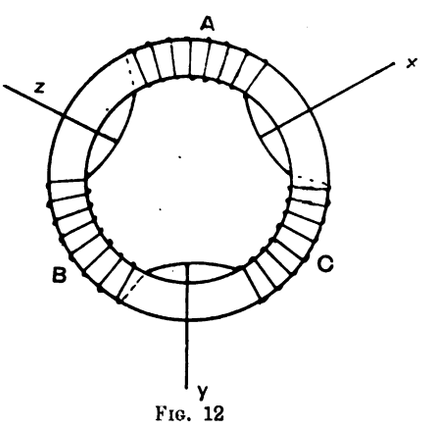

FIG. 12

The next question to consider is how are the various phases to be connected. There are various ways of doing this. In the first case we can adopt the method suggested in the case of a two-phase generator and run three pairs of leads. In this way we should treat each current as being entirely independent of the others in the generator, and in the outer circuit they might also be independent. Although this method would be feasible, it is not one which is usually adopted, the more general method being to connect the three phases in either mesh or star connection. The latter is now the more prevalent, although the former is used at times, while occasionally we utilise a combined star and mesh connection.

Fig. 12 shows the connections between the phases in a mesh formation. It is clear that with such a connection the voltage between the outgoing leads, X and Y, is simply that due to winding A, which has a maximum value, V. Now consider Fig. 13. Here we have joined the neutral points of the three windings, and can, if we choose, run three separate wires from the generator, making the one from the neutral point, P, the common return for all three circuits. It is evident that the tension between X, Y, or Z, and the wire, W, from the neutral point, P, will be the tension due to one winding which we have assumed has a maximum value, V, but we may omit, as is the usual practice in motor installations, the wire from the neutral point: we then require to know the tension between any two of the leads. This is necessarily more than V when at its maximum value, for, as will be seen from the figure, any two coils are in series. It is not, however, equal to

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twice V, as the two windings A and B are not in phase, and therefore do not attain their maximum and minimum values at the same instants, the angle of lag between them being equal to 120deg. Now, we know that the voltage follows a sine law; hence, if we take any instant when the tension is that due to the winding having taken up a position θ degrees from the datum line, the E.M.F. will have a value such that it is equal to $v \sin \theta$. Now, the tension in winding B follows the same law, but is 120deg. behind the tension in coil A; consequently in combining the tensions in A and B we get $\sin \theta - v \sin (\theta - 120) = \sqrt{3}\, v \sin (\theta - 30)$.

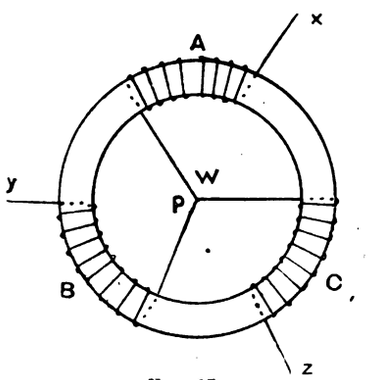

FIG. 13.

In other words, if V is the tension due to the winding A the tension between the lines A and B will be $\sqrt{3}$ V.

(To be continued.)

SOME LIMITS IN HEAVY ELECTRICAL ENGINEERING.*

BY JAMES SWINBURNE, PRESIDENT.

ARGUMENT.—Two kinds of limit—Electrical means scientific engineering—Engineering is science—Unapplied and applied science complementary—Engineering includes both raw and finished science—Raw science important—Unfortunate attitude of raw towards finished science—Development of tidal power not practical—Fictitious value attributed to water powers—Electrical energy direct from coal a dream—Limits of efficiency of steam-engine—Steam and SO_2—(Notes: units; entropy)—Limits of gas-engine—Large margin for improvement—Dynamos and transformers near limit—Secondary battery progress limited chemically—Little chance of great improvement—Cables made empirically: room for advance in insulation, but not in conductor—Condensers not wanted—Electromagnetic condenser—Enormous unavoidable waste of light—Arc capable of improvement—Not studied from all standpoints—(Note: back E.M.F. of arc)—More refractory conductors for incandescent lamps—Carbides—Metals—Electrolytic lamp—Possibility of direct radiation—Cooper-Hewitt lamp—Electric heating—Want of variable speed gear for electromotives—Application of electrolysis limited by ignorance of those interested.

It is customary for a presidential address to be a review of the development of the science with which the Institution is particularly concerned. Such a review is especially beneficial in the case of such a rapidly growing industry as electrical engineering, as the outlook changes considerably during a year. But other forms are open—for instance, I might have devoted our time to the discussion of the work of this Institution, and gone fully into its growth and its doings, and we might have considered what the Institution has done for the industry, and what it ought to do in the future.

Instead of a review of the past, a dream of the future may take the form of a presidential address. This form has great attractions for me for several reasons. In the first place, this kind of prophecy is easy and pleasant. I might draw a rosy picture of the future when everything conceivable is done electrically. We will have electrical energy developed direct from carbon at the coal-pits. Not only all our lighting, but all our domestic heating will be done electrically. There will be no smoke in our cities, or in what will correspond to them. Most of the dirt of our houses will have vanished. Large and crowded towns will have disappeared, because the telegraph will have given way to its wireless rival, and that will have given way to the wireless telephone, with no exchanges and no subscriptions. There will thus be no need for people to go and see one another to transact business. Even when matters must be written to preserve a record no office will be necessary. You will dictate by wireless telephony to your shorthand clerk at his distant house. Perhaps we will all learn shorthand instead of our present cumbersome system of writing, and all books and letters will be in one language, written and printed phonetically at speaking speed, or faster. The horse will have gone, leaving clean and odourless streets, with smooth surfaces on which people travel in rapid electric automobiles. The railways with very rapid long-distance service will be entirely electric. It is very easy to prophesy in this sort of way, not only in a general way, but in considerable detail; and it is an amusement that brings much credit to the prophet. If any of his prophecies seem unlikely to come true he merely has to say, "Wait a little!" While if anything like what he foretells comes into existence, say 20 years hence, all he has to do is to refer back to an address to claim that he has foretold it, and the future inventor will have half his credit taken from him and given to the prophet. If the prophecies are sufficiently vague, there is certain to be some sort of fulfilment of some of them sooner or later, and it is always well to have a good many past publications of this sort in stock waiting for future development.

Great though the temptation is I will resist it, and try to look into the future from quite a different point of view. We have been going ahead so very fast lately—even our acceleration itself increasing—that we may be a little apt to have vague views of what we can and what we cannot do electrically. It may be well, therefore, to try and look over some of the branches of our great and diverse industry, and see what obstacles are now opposing us, and what are likely to oppose us shortly, and whether the obstacles are insuperable or not. This sort of prophecy is much more difficult than the other, for there can be no credit 20 years hence in having said something could not be done, even if it has not, while if it has been accomplished the position is still more difficult. Negative prophecy is thus unattractive. But the discussion of our limits may not only have a beneficial effect in making us modest, but it may be a much greater benefit if by focussing our attention on a limit of any development, we find either that the obstacle is theoretically insurmountable—in which case we must go round it—or that it has to be scaled in a particular way.

There are clearly at least two kinds of obstacles. For instance, it is obviously impossible to get more than 746 watts out of a dynamo taking 1 h.p. to drive it. But the limit of possible speed on an electric railway belongs to quite a different category. I will therefore discuss various branches of electrical technology to see what may prevent, or is preventing, further advance.

An address is usually taken without discussion. When it deals with views or facts which are generally accepted no difficulty arises, but in this address I must touch on many points which may be controversial. It must be remembered, therefore, that though I do not insert "I am of opinion" or "I think" before every proposition, that is all my statement, however definitely made, amounts to; and I will ask that what is for shortness stated dogmatically should only be taken as personal opinion, and be accepted or rejected on the grounds given or understood, and not in any way on authority.

Twenty years ago this Institution was chiefly concerned with the development of the telegraph. We can get but few telegraph papers now. This is not because telegraphy is dead; it is because most of its problems are solved, so there is little to discuss. The fact that there is little to discuss in telegraph is the proof of its vitality. It has passed out of the childhood of technical difficulties into the manhood of commercial development. Ten years ago we were in the thick of the evolution of the dynamo and the transformer. Now there is little but detail to discuss about electrical generating machinery. This is because heavy electrical machinery has got through its difficult infancy, and is now a trade, which is the highest compliment that can be paid to it. But we electrical engineers

* Inaugural address delivered before the Institution of Electrical Engineers.

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have also developed through our difficult training into being the scientific branch of the engineering profession. Our exactness of calculation and measurement has leavened the steam engineers, and the other manufacturers with whom we have to work in concert. But this must enlarge our mental view and move out our horizon. We must not say that because we can buy efficient dynamos and order accurate instruments that we need have no technical knowledge. Quite otherwise. We must understand dynamos as before, also measuring instruments, but we must also understand steam-engines, gas-engines, fuel questions, financial matters, parliamentary matters, tramway matters, railway engineering, and, very soon, railway management. All these are the work of the electrical engineer. No one man can be a complete electrical engineer, but each of us ought to know one subject well and a large number of allied subjects fairly well.

As a basis of technical knowledge, which I am alone dealing with to-night, we must have a fairly all-round knowledge of "theoretical" physics and chemistry. Physics is merely unapplied engineering. Science is split—unfortunately the split is very difficult to heal—into two parts, generally wrongly called the theory and the practice, or pure and applied science. This fissure is not so deep in our branch of engineering, but it is there. Science, to be worthy of the name, is knowledge of nature utilised by man. Engineering is science, and science is engineering. You can cut off a part and call it unapplied science. This is what is generally known as theory, or pure science. It is not purer than any other science, and the term theory is misapplied. To be an engineer you must know both branches. There is nothing superior about knowledge which is not yet applied. It is mere raw material; it may be useful when worked up, and it is valuable before it is worked up, but only because it may be worked up. The so-called practical man who works at applications without understanding the generalised principles is ignorant. He only understands a part of science. The so-called scientific man who only understands what is called pure science is just as ignorant. Each understands part of his subject only. Specialisation demands sacrifice of general knowledge to gain particular, but the "theorist" and the "practical man" are both ignorant of half science. Very sinister is the influence of the "practical man" who despises "theory" and thinks everything abstract, or mathematical, or chemical is better left unlearnt, and who glories in his so-called "practical knowledge"; but just as sinister is the attitude of the half-scientific "theorist" who thinks his own kind of knowledge includes of necessity that of the "practical man." The, may I say, somewhat supercilious attitude of the (from this point of view) half-educated scientific man, who only deals with the raw material of knowledge, has done more to increase the gap between applied and unapplied science than any action of uneducated manufacturers. The sort of tacit assumption that an engineer can never be a "scientific man," while a "scientific man" can teach the engineer his business, cannot fail to annoy the engineer, and this feeling of annoyance is largely the cause of a great deal of opposition to techical, that is to say, really scientific education.

Perhaps the votary of unapplied science sometimes feels that it is hard that people who only possess, in his opinion, a kind of knowledge which is unworthy of the name of science should be able to secure more fishes and more loaves. He must remember that he gets more kudos. Moreover, unapplied science is pleasanter to acquire. Most of us would rather read chemistry or mathematical physics or study, say, the eccentric little ways of radio-active bodies than design coal conveyors or tabulate meter charges. But the great work of the world and the making of character depend on people doing what they dislike, not what they like. The world will requite with cereal and marine produce the man who does what the world wants. If he has to spend his earlier years over the applied half of science, and has little time to indulge in the pleasures of the other half, because as a young man he only gets very little black bread and the meagrest kind of kippered fish, he is enabled to give the world more useful work later in life, and eventually earns more amylaceous and brain-forming material; and the man who has preferred to indulge in the more interesting but less useful half of science should respect his knowledge, and should not cast envious eyes on the enormous income of starchy and phosphoric material the practician has to pretend he makes. The raw science man has his own reward. He has pleasanter work, that most would like, and he has in proportion a much better position. Each branch has its own peculiar advantages, and there ought to be no sort of antagonism. I would plead for more mutual respect and a better understanding among scientific men, and closer fellowship among those who study raw science and those who deal with it in its finished form.

We as electrical engineers ought especially to heal the split between the two halves of science; a split which is much deeper in other branches of engineering, such as chemical and purely mechanical. We ought to unite knowledge of both branches of science in one individual as much as possible. The electrical engineer must not be only an overgrown wireman, a mechanical engineer with a little electrical knowledge, a mathematician, a financier, a lacquered brass and sealing-wax varnish instrument maker, a physicist, or a manager of men. He must be all of these, in different proportions in different people. Our Institution should equally deal with all parts of our knowledge. We ought to have papers on the value and cost of fuel and on electrons; on the best way of arranging piece-work, and on the thermo-dynamics of the dissociation theory; on the "skin" effect and cylinder condensation; on the relation of e to borrowing powers; on Wien's law and the proper charge for lamps on variable circuits; on the relation of the refractive index and specific inductive capacity and the electromagnetic theory of light, with special reference to the waste of power in alternating rubber cables; on thermo-dynamic potential applied to making manure by fixing nitrogen; Guldberg and Waage's law and gas-engine combustion; on tube railways, Hertz waves, wireless telegraphy, strikes, blast-furnace gas, submarine telephony, automobiles, standard cells, tramway cars, and everything that concerns electrical engineers. This session the Council hopes to deal with a varied assortment of such questions, holding as even a hand as possible between the various branches of our subject. No excuse is, therefore, needed for ranging over a fairly large area in an address. To keep within reasonable limits of space our attention will be confined to heavy electrical engineering, thus omitting the electrical transmission of messages. Even then each subject can only be treated very shortly indeed.

Tides.—The tides are often referred to as a possible source of energy even to this day, and it is urged that in places where the tide rises abnormally—for instance, in the estuary of the Severn—it would pay to make a dam with turbines. The sort of argument is that if you have an area of, say, 1,000 square metres, and a total rise of 15m., you have 15,000 cubic metres of water, and as this runs in twice and out twice a day, you have 15,000 cubic metres of water falling the equivalent of 60m. a day, or approximately 100 kw. This statement contains many fallacies. In the first place, in order to get the full advantage of the difference of level, the water must be let in and out at high and low tide only. Even then the equivalent, or average head during discharge or charge, is only 7½m. But a system which gave an enormous power for a very short time four times a day would be of no use. The plant would be expensive and the result of no value. With a single tank it is impossible to get a continuous output. If the tide is coming in and you get power by letting the tide fill the tank, the power will decrease to zero as the tide begins to fall and comes to the same level as the water in the tank. It is, therefore, necessary to have more than one tank. To make the plant practical you want fairly constant pressure available on the turbines, though you may waste head by sluices or valves. Then the tank may be divided up into three, one of 200, and two of 400 square metres. The small one is emptied at each low tide and filled at each high tide. Starting at half tide, with the tide rising, and the 200m and one 400m. vat empty, and the other 400m. quite full, the small tank takes in water at such a rate that at high tide it is half full. It thus takes in 1,500 cubic metres of

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water with a useful head of 7½m. for three hours. This gives 10 kw. At full tide the large empty tank is allowed to fill through a turbine working on 3¾m., but taking twice as much water per minute, and this goes on till half ebb tide. The small tank is rapidly filled to high-tide level. At half tide the large tank has 3¾m. of water, and the head is getting too small, so the small tank is now allowed to empty for three hours with 7½m. fall, until low tide. From low tide to half tide the second large tank is emptying from the 15m. to the 11¼m. level. By means of these tanks, of total area of 1,000m., and two turbines and one dynamo we thus get 10 kw. going into the turbines. If the tide—and the neap tide must be taken—is only, say, 4m., we only get 700 watts! No doubt the tanks and turbines might be worked somewhat more profitably than I have sketched, but there can be little margin. Turbines to work on variable pressures, or any sort of storage, mean more capital expenditure, and it is the great capital expenditure that wrecks tide schemes. It is often said that a Norwegian fiord or a Scotch loch could be easily dammed and utilised, but it would be impossible to find three lochs all opening out together. The need for more than one reservoir does not seem to have been recognised. In addition, the demand for electrical energy on Scotch lochs or Norwegian fiords is rather minute.

Water Power.—Some years ago there was a great deal of excitement about the development of water powers. The possibility of "harnessing Niagara" and utilising waterfalls all over the world was hailed as a great triumph over Nature, and the idea was that power could be got for nothing, and industries would all migrate from coal districts to the neighbourhood of water powers. The daily press and the magazines took the matter up, and there is something in the idea of saving some of the colossal waste of natural energy that appealed especially to the half scientific or unpractical reader. At the time of the excitement it was pointed out, largely in vain, that water power did not cost nothing, because the development of a fall demanded a good deal of capital, whose interest and depreciation had to be paid. But further than this, Ricardo's theory of rent is applicable to water powers as well as to arable land. If steam power costs a farthing a unit, and if water power at the same place can be produced for half a farthing, after paying working expenses and interest, the owner of the water power will claim the odd half farthing as rent, or will just allow the water power enough to encourage the production of a new thing. As a rule, however, a water power is not where it is wanted industrially. In the nature of things water powers are generally in hilly countries, and are seldom near the sea. The result is that a water power, as a rule, cannot command the same price as steam or gas, because it is not where it is wanted. The idea in starting many of the water-power stations also was that works which needed power would come and settle near. As a matter of fact the cost of power is a much smaller item in most industries than is generally supposed, and it does not pay to start a works in an otherwise not perfectly suitable locality simply for the sake of the cheap water power. In such industries as engine building, flour milling, spinning and weaving, and so on, the chance of reducing the expense for power is not enough to overcome other considerations. It may be said that in electro-metallurgical processes the whole cost is practically the electrical energy, and so carbides, aluminium, and electrolytic soda, and chlorate of potash will be made at water powers. Even this, however, is misleading. Carbides and aluminium are generally made at water-falls, and chlorate nearly always is. Electrolytic soda and bleach are made at water powers, but are also made extensively by steam-driven plant. Against the cheaper power we have to put extra carriage for materials and for coal, which is often needed in addition, and extra carriage for finished products, and very often extra cost of labour, as labour is often dear and bad in water-power districts. Let us take as an example calcium carbide. The general idea is that the electrical energy is practically the whole cost of the carbide. Taking present practice, however, a kilowatt makes about two tonnes, or, say, two tons of carbide a year. The difference between water at, say, £2. 10s. and £5 a kilowatt year is thus £1. 5s. a ton in cost. The price of carbide may be taken at £13. 10s. a ton, so doubling the cost of power instead of nearly doubling the price of the carbide would increase it a little more than 10 per cent. Difference in local cost of coke, lime, and labour, coupled with cost of carriage, may thus easily be of more importance than cheap power, even in such a case as calcium carbide, which is an electrical furnace product in which, at first sight, the power seems to be the main element of cost. In the case of electrolytic caustic and bleach, for one ton of caustic and the corresponding bleaching powder, the electrical energy, taken at £2. 10s. per kilowatt year, a low water-power cost, comes to about 17s. 6d. The caustic and bleach sell for about £20 according to a varying market. Doubling the price of power therefore increases the price some 5 per cent. It may thus easily pay to use much more expensive power if the other conditions are more favourable. Steam power, for instance, will cost three or 3⅓ times as much, and yet it pays to make electrolytic caustic and bleach in England where the other conditions are all favourable. It is not, therefore, the want of water power that has kept the electrolytic industry back in this country. For a water power to be really valuable, it should be near a source of material, on the sea, and should have a great head of water, so that the capital cost of development is small. Such a water power is very valuable—to the landlord. A blast furnace is more valuable than a water power. There are plenty in England. But the owners, who have been wasting the gas up to now, will not give it away; they will want rent, so that it will only just pay to use this gas rather than make it. The electrical industry thus does not gain, but the ironmasters do.

Carbon Cells.—For many years "electrical energy direct from coal" has been the dream of the electro-chemist—that is to say, he has dreamed of an electrolytic cell in which the consumed electrode is carbon. The best way to realise the difficulties of this problem is to consider it solved and see what it means. The carbon must be in contact with an electrolyte, and that electrolyte must either be in contact with a second electrolyte which wets the other electrode, or must itself be in contact with that electrode. This second electrode must almost certainly be metal, as there are no other non-metallic conductors available. The electrolyte in contact with the carbon must be a salt of carbon, or must contain a salt of carbon, or it must contain another salt whose positive radicle can be replaced by carbon. Such compounds as the hydrides, nitride, oxides, chloride, bromide, or the sulphide, or silicide, of carbon are not salts in the electrolytic sense. Carbon forms part of the electro-positive radicle in the organic radicles, and part of the electro-negative radicle in the cyanogen compounds, but it is never a radicle by itself. To sum up the matter shortly in the light of modern theory, carbon never forms ions, and has therefore no solution pressure, and can therefore give no E.M.F. At ordinary or moderate temperatures carbon is practically inert. Oxidising agents will attack some forms slightly, and sulphuric acid will attack it. In this latter case the formation of water and its combination with the acid is the determining factor. At high temperatures, oxygen, sulphur, silicon, and to some extent nitrogen, and many of the metals combine with carbon, but there is no dissociable salt of carbon formed. The carbon cell thus seems impossible. Such schemes as Mr. Reed's, ingenious as it is, is not a solution of the problem. It would be simpler to reduce zinc oxide with the carbon and then put it in a zinc cell. It is hardly necessary to discuss thermopiles or thermo-magnetic engines as possible economical producers of electric power.

(To be continued.)

TUNBRIDGE WELLS ELECTRICITY WORKS.

On Wednesday evening last we had an opportunity of again inspecting these interesting works at a time when Alderman Elvy Robb, the chairman of the Lighting Committee, was entertaining the Corporation in the same. A large number of prominent townspeople were also present to inspect the plant, which, it was explained to us, was not

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for sale. We found it well to refrain from mentioning the telephone question and to confine our attention to the electrical work on view. Mr. H. L. P. Boot, the consulting and resident engineer for the works, has made large extensions and improvements since the supply was inaugurated in 1895. A list of the plant extensions would be a long one, but it suffices to say that there is now in the engine-room plant of nearly 2,500 h.p. The largest generators are a Ferranti alternator driven by a 1,000-h.p. engine, and another alternator of the same make driven by a Willans three-crank engine of 800 h.p. The new switchboard for controlling the whole of the generators is of the Ferranti type, but the feeders are still controlled from the original switchboard. The greatest improvements made since the works were first started are in connection with the condensing of the exhaust steam from the engines and in the boiler-house. With the extension of the boiler plant, two Lancashire boilers have been installed, each capable of evaporating 9,000lb. of water per hour with a working pressure of 200lb. The steam is also superheated. The condensing plant was most desirable at Tunbridge Wells, owing to the high price which had to be paid for coal. The engineer has found that with the high cost of transport it pays to get the best coal and to economise it by using most efficient plant. The condensing water is cooled in a large Klein cooler constructed over a storage reservoir holding 140,000 gallons of water. The cooling tower is able to deal with circulating water equivalent to 3 000 h.p. developed in the engine. The air and circulating pumps are of the well-known Edwards type, and these were working exceedingly well at the time of our inspection.

On Wednesday last the offices in the station were turned for the evening into museums, in which various apparatus was on view, and the chairman of the Electricity Committee had also provided exhibits which appealed to the ordinary consumer. Some interesting experiments were made in the engine-room on 3,000-volt arcs, which we believe were more appreciated than understood by most present. As regards the financial position of the Tunbridge Wells undertaking, the total expenditure on it to date is £70,000. The gross profits since the supply was commenced approach £20,000, and after the payment of interest and sinking fund, a net profit of £6,154 has been earned.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on Nov. 27 the following were the candidates balloted for:

Members.—K. O. A. Gulstad, Great Northern Telegraph Company, Copenhagen; E. G. Jones, Town Hall, East London, South Africa; W. J. Lineham, 2, Leyland-road, Lee, S.E.; D. Reid, 18, Cambridge-street, Glasgow; A. W. Whieldon, Sutton, co. Dublin, Ireland.

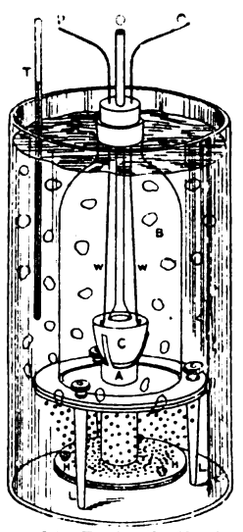
Associate Members.—S. E. Britton, Electricity Works, Motherwell, N.B.; W. C. Brown, New Primrose Gold Mining Company, Germiston, South Africa; W. W. Buckton, Messrs. Harland and Wolff, Belfast; W. E. B. Dove, Crown-street, Darlington; A. L. Forster, Chance Bros. and Co., Limited, near Birmingham; G. E. Heyl-Dia, Warrington; W. Mannox, Electric Light Station, City-road, E.C.; C. W. Nicholl, the Calcutta Electric Supply Corporation, Calcutta: H. W. J Peterson, 30, Braxfield-road, Brockley, S E.; P. E. Rycroft, Rosedale Villa, Cameron-road, Seven Kings; W. H. Smith, 35, High-street, Bedford; G. R. Spurr, Electricity Works, Ley-street, Ilford; W. Wharam, Claypit-lane, Leeds; H. L. T. Wolff, 52, Carson-road, West Dulwich, S.E.

Associates.—H. Bailey, Sunnybank, Shear Bank-road, Blackburn; A. W. Bennis, 28, Victoria-street, Westminster; E. F. Boult, 111, Hatton-garden, E C.; C. B. Chartres, Akeld House, Wooler; H. de Pinna, Corporation Electrical Department, Cape Town; G. Dixon, Brotton Hall, Brotton, R.S.O., Yorks; H. B. Dorrell, Electricity Works, Buxton; J. F. Edmunds, St. Margarets, Duncombe-hill, Honor Oak Park, S.E.; A. Eve, Uralite Works, Higham, Kent; J. Gilligan, Witwatersrand Gold Mining Company, Knights, Transvaal; A. Gray, Birkdale District Electric Supply Company, Birkdale; S. B. Griffith, 8, John-street, Adelphi, W.C.; L. T. Healy, 20, Linton-street, Islington, N.; F. C. Heritage, 22, Windsor-road, Forest Gate; A. Johnston, St. Helens Tramway Depôt, Swansea; L. J. Lawless, 27, Castlewood-avenue, Rathmines, Dublin; G. C. Leach, Birchill Lodge, Hasland, Chesterfield; A. B. Longden, British Westinghouse Company, Trafford Park, Manchester; W. McDonald, Electric Supply Department, Commercial-street, Sheffield; J. McLachlan, 33, Agamemnon-road, West Hampstead, N.W.; W. Makinson, Roundthorn, Sale, Cheshire; W. H. Merrett, Royal College of Science, South Kensington, S.W.; E. H. Mottram, Te Aroha, Ashley-road, Upper Parkstone, Dorset; E. H. Owtram, 6, Roeland-street, Cape Town; P. C. Parker, 6, Percy-terrace, Newcastle-upon-Tyne; R. Rigg, 50, Springfield-place, Leeds; E. C Roche, 8A, Durham-place, Campden Hill-road, W.; J. W. P. Scott, Erkinholm, Langholme, N.B.; W. B. Scott, Eversley Cottage, Middleton, near Manchester; C. H. Shanan, 142, Great Mersey-street, Liverpool; E. V. F. Shaw, 3, Queen's-road-villas, Plymouth; H. C. Silver, 23, Radcliffe-square, S.W.; A. Smith, 81, Canal-street, Nottingham; T. Smith, Electricity Mains Department, Horsley Fields, Wolverhampton; J. D. Stevens, 2, Down-terrace, Maynard-street, Cape Town; W. W. Wakley, 177, Maida-vale, W.; F. Walker, Telegraph Department, Brisbane, Queensland; H. West, Cyclops Steel and Iron Works, Sheffield; C. H. Williams, No. 4 Residence, Royal Naval Hospital, Haslar; J. C. Wilson, 152, Oxford-street, Manchester; R. E Workman, 5, Woodside-terrace, Glasgow.

Students.—N. Barr, Electrical Department, Midland Railway, Derby; W. Blathwayt, Faraday House, Charing Cross-road, W.C.: J. Bollands, jun., The Fox Inn, Melton Mowbray; R. E. Brooke, School Field, Rugby; E. Fisher, 6, Chesham-villas, Sudbury, Middlesex; V. W. Gill, Faraday House, Charing Cross-road, W.C.: J. Hague, 71, Acres-lane, Stalybridge; R. Hardy, Faraday House, Charing Cross-road, W.C.; R. P. Hulton, Willisford, Northallerton: P. V. Hunter, 10, North Danes-road, Great Yarmouth; P. H. Keeling, Faraday House, Charing Cross-road, W.C.; R. Line, 4, Cardigan-terrace, Melton Mowbray; T. Mason, Faraday House, Charing Cross-road, W.C.; W. H. Mayston, 106, Western-road, Brighton; W. G. Perry, 6, Warndon-street, Rotherhithe New-road, S.E.; E. W. Porter, Weston-on-Trent, Derby; E. B. Thomas, Faraday House, Charing Cross-road, W.C.; E. J. Ward, 58, Regent-road, Salford, Manchester; R. C. C. Yates, Febina House, Bushbury-lane, near Wolverhampton.

FOGS AND SMOKE.

At a meeting of the Sanitary Inspectors' Association on Dec. 6, Mr. I. Young, president of the council, in the chair, Mr. Charles R. Darling, A.R.C.S. (Ire.), Wh.Ex., A.I.C., etc., demonstrator and lecturer in the electrical engineering department, City and Guilds Technical College, Finsbury, demonstrated a number of experiments and read a most interesting paper on fogs and smoke, in the course of which he introduced the apparatus given in our illustration, by which the tendency of a coal to smoke on burning was clearly demonstrated, and which may be shortly described as follows: The coal is burnt in a crucible, C, which is placed in the interior of a glass bell-jar,



Fuel Calorimeter used for Testing the Heating Power of Fuels, and also the tendency to Smoke Production.

B, which is fastened down upon a brass plate so as to make an air-tight joint. For gaseous coal, or liquid fuels, a copper bell-jar, fitted with a window, is used instead of B. Oxygen, to burn the fuel, is admitted by the tube, O, and the gases produced by the combustion pass down the pipe, A, and escape through the water by a number of small holes in the top of the chamber, H. Wires, W W, serve to start the ignition by electrical means, being connected in the crucible by a piece of fine platinum wire embedded in the coal, which is heated to redness on passing a current of electricity through the circuit.

Mr. Darling started by burning in this contrivance a sample of anthracite, when no black smoke or sooty matter was visible. A sample of bituminous coal followed, and in spite of the presence of excess of oxygen dense black clouds of smoke were produced. This black smoke consisted of a form of carbon, distilled from the gaseous portions of the coal, and ejected from the crucible before it became hot enough to burn. This is what would occur with this specimen on the large scale in a furnace. A mixture of the smoky coal and coke gave a burning comparable to that of anthracite. The intermingling with the coke prevented the formation of any large quantity of smoke in one locality, and all was burnt before escaping. On this principle

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much smoke may be prevented, with economic results, by mixing a very gaseous fuel with coke. Such procedure, however, is only admissible in cases where the rate of steam production—taking the case of a boiler—is not reduced below the desired limit by thus diminishing the rate of burning of the fuel. But the application of some simple test, such as the foregoing, cannot fail to be of service to a consumer, who would be forewarned as to the behaviour of the coal in his furnaces.

Before concluding, he showed a pretty experiment by dissipating entirely, by electricity, a heavy fog caused by burning magnesium wire under a glass bell. He inserted a brass rod connected with a generator and furnished with an induction coil. The presence of a charge of electricity in the flask caused the small dust spheres to cohere and fall, and the fog was dispersed. The particles joined together to form flakes resembling snow, which fell to the bottom of the jar. To produce this effect on a sufficiently large scale, the lecturer stated, would be difficult, and possibly dangerous; nevertheless, the suggestion might yet have a practical outcome. Of course, the remedy, even if successful, would be purely local in its application; yet if they could keep busy places, such as that between the Bank and Mansion House, free from fog, the result would be a great public convenience.

FORTHCOMING EVENTS.

FRIDAY, DEC. 12.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "A New Automatic Railway Coupling compared with the Existing System on British Railways," by Mr. A. T. Swaine.

Institution of Electrical Engineers (Dublin Section).—Ordinary meeting.

North-East Coast Institution of Engineers.—At 7.30 p.m., general meeting. Paper: "Large Stop-Valves for High-Pressure Steam," by Mr. J. Hamilton Gibson.

SATURDAY, DEC. 13.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Advancement of Machine Tools," by Mr. J. H. Davey.

MONDAY, DEC. 15.

Society of Arts.—At 8 p.m., Prof. V. B. Lewes on "The Future of Coal Gas and Allied Illuminants." (Lecture IV.)

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "Railway Block Signalling," by Mr. J. Pigg.

TUESDAY, DEC. 16.

Royal Statistical Society.—At 5 p.m., ordinary meeting. Paper: "English Railway Statistics," by Mr. W. M. Acworth.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "The Rupnaragan Bridge, Bengal-Nagpur Railway," by Mr. S. Martin-Leake.

Institution of Electrical Engineers (Manchester Section).—Ordinary meeting. Paper: "Electrical Haulage on Canals," by Dr. E. W. Marchant.

WEDNESDAY, DEC. 17.

Royal Meteorological Society.—At 7.30 p.m., ordinary meeting.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "The South Russian Iron Industry," by Mr. A. P. Head.

Institution of Electrical Engineers.—At 7 for 7.30 p.m., annual dinner, Hotel Cecil.

Chemical Society.—At 8 p.m., ordinary meeting.

THURSDAY, DEC. 18.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper: "Notes of Recent Electrical Designs," by Mr. W. B. Esson.

Petroleum Institute.—Lecture on "The Development of Petroleum Fields in Texas," by Principal Dvarkoritz.

FRIDAY, DEC. 19.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "Recent Practice in the Design, Construction, and Operation of Raw Cane Sugar Factories in the Hawaiian Islands," by Mr. J. N. S. Williams. If time permit, committee's report on "Standardisation of Flanges."

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "Electricity Supply from Double-current Generators," by Mr. P. R. Wray.

SATURDAY, DEC. 20.

Glasgow Scientific Society.—Eleventh anniversary dinner.

CHELTENHAM ELECTRICITY ACCOUNTS.

The accounts of the Cheltenham electricity department for the year ended March 31, 1902, have just been issued, and show a total expenditure on capital account to that date of £141,544. The number of private customers was 491 at the beginning of the year and 573 at the end of the year. The corresponding equivalents in 8 c.p. lamps of load connected were 35,002 and 35,897 respectively. The public lighting load was equivalent to 5,882 and 8,038 8-c.p. lamps at beginning and end of year respectively. Abstracts of the revenue account, balance-sheet, etc., are given herewith.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel	£2,668	3	3			
Oil, waste, stores, etc.	438	0	7			
Salaries and wages	1,459	15	9			
Repairs and maintenance of building	5	15	10			
Ditto machinery	511	0	11			
Carbons and miscellaneous	28	9	9			
				5,111	6	1
Distribution of Electricity.						
Salaries and wages	261	5	1			
Repairs and maintenance—mains and services	52	12	10			
Ditto house connections	309	9	9			
Ditto sub-stations	13	4	9			
				636	12	5
Public Lamps.						
Salaries and wages	665	0	7			
Carbons, renewals, &c.	507	3	6			
				1,172	4	1
Rents, Rates, and Taxes.						
Rents	66	7	0			
Rates and taxes	130	9	9			
				204	16	9
Management Expenses.						
Salaries and wages—engineer	299	9	0			
Ditto clerks	297	12	5			
Ditto collector	10	0	0			
Stationery and printing	78	3	11			
General charges	145	4	4			
				830	9	8
Special charges—insurances				51	13	9
				8,007	2	9
Less goods sold, etc.				47	19	5
				7,959	3	4
Amount carried to net revenue account				5,109	4	11
				13,068	8	3

Cr.	REVENUE ACCOUNT.	£	s.	d.
Electric energy at 6d. per unit, less discounts		1,548	4	5
Ditto at 5½d. per unit, less discounts		5,144	1	5
Ditto at 4d. per unit, less discounts		755	18	9
Ditto at 3d. per unit		151	1	5
Ditto at 2d. per unit		0	13	4
Ditto sold by contract		48	0	0
Ditto tramways at 1·9d. per unit		712	19	6
		8 360	18	10
Less rebates		577	12	3
		7,783	6	7
Public lighting		5,278	0	5
Meter rents		7	1	3
		£13,068	8	3

GENERAL BALANCE-SHEET.

Dr.	Liabilities.	£	s.	d.
Capital account—loans raised		89,468	8	4
Sundry creditors		1,996	12	3
Interest on debentures		611	4	1
Loan repayment (£17,200 loan) provision account		216	19	2
Sinking fund provision account		2,234	19	0
Cash due to treasurer		63,721	16	0
Outstanding accounts		132	16	10
Balance—amount of loan repaid		997	11	8
Amount of sinking fund		10,054	0	3
		£169,434	7	7

Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		141,544	15	1
Stores in hand		1,272	8	11
Sundry debtors for electric energy		2,678	16	11
Ditto collector		17	13	4
Other debtors		308	9	1
Balance at debit of net revenue account		13,422	12	5
Electrical engineer's advance account		135	11	7
Sinking fund investments and cash at bank		10,054	0	3
		£169,434	7	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated (including exciters), units			1,286,558
Quantity sold	Public lamps	514,391	970,333
	Private customers by contract	5,338	
	Private customers by meter	360,544	
	Traction	90,060	
Quantity used on works			154,523
Total quantity accounted for			1,124,856
Quantity not accounted for			161,702
Total maximum demand (kilowatts)			937

Number of public lamps: arcs, 361; incandescents, 20.

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THE

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CONTENTS.

Notes	829	Appointments Vacant	853
Nuneaton Electricity Works.	834	Legal Intelligence	853
The Differentially - Compounded Motor	837	Companies' Meetings and Reports	854
Notes on Polyphase Motors...	839	New Companies Registered ...	855
Some Limits in Heavy Electrical Engineering	841	Contracts for Electrical Supplies	855
Tunbridge Wells Electricity Works	843	Traction Notes	856
Institution of Electrical Engineers	844	Lighting Notes	859
Fogs and Smoke	844	Provisional Patents, 1902 ...	862
Forthcoming Events	845	Companies' Stock and Share List	863
Cheltenham Accounts	845	Traffic Returns	864
Commercial Expansion	846	Supplement:	
Correspondence	847	The Electric Nitrification of the Atmosphere	1
Questions and Answers	848	Some Notes on Air-Pump Design	5
Trade Notices and Novelties.	852	Stirling Accounts	8
New Committees	853		

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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COMMERCIAL EXPANSION.

The mere devotee to pure science is a dreamer of very little value to himself or the world in general if considered without his surroundings His intrinsic value, however, becomes almost too great for the powers of calculation when the combination of himself with the devotees of applied science is considered. He delves into the secrets of nature merely to know; he piles fact upon fact till he deduces a general law dealing with all these facts; then, having satisfied his curiosity in the one field, he turns his investigations into another field. All this is exceedingly interesting, but becomes valuable only when the man devoted to applied science comes along and utilises the facts and laws for the benefit of poor humanity. Commercial men put no value upon a scientific fact till that fact finds an application in the working industrial hive. The connection, however, in these early days of the twentieth century between pure and applied science is so close, that hardly any fact observed in pure science passes without a great many attempts being made to apply that fact. The application of a fact either increases the number of industrial operations or increases the economy of production in existing operations. Hence the more widely the results of scientific investigations can be made known, the easier it is for the applied workers to glean what may assist them in their work.

Commercial relations are now world wide. The increased facilities for intercommunication have made it as easy to-day to do business with South Africa as a century ago to do business with the North of Scotland. Months in distance have become weeks, and weeks have become days, so the borders of business have become extended, and so the resources of the earth till lately unknown will be developed. In all this, pure and applied science must go hand in hand. It is too often the cue of uninformed or misinformed writers to attribute to English business men ignorance of the first principles of business, to point to foreign competition as a proof of such ignorance. The fact is that such writing and speaking shows nothing, except the absolute ignorance of those who give currency to those views. It would be a great gain for business in this country and for the world in general if all the men who promulgate these doctrines were euthanasied. Consider for a moment the increased demands of the world with the increase of so-called civilisation; and, further, consider the possibility of one small area of the earth's surface such as Great Britain supplying the whole of such demands. It could not be done; hence, in the nature of things, other areas come into competition to supply the demand. A careful examination of this subject will prove that Great Britain cannot supply the demand, and, accepting that conclusion, is it not better for us to assist the development of outlying parts of the Empire rather than to assist foreign competitors? How can we assist the development of outlying parts of the Empire? There are many ways, only one of which concerns us at the present juncture, and that refers to the mutual assistance between pure and applied science. The perambulating society known as the British Association is something of a hybrid between these sciences, but in its time has done magnificent work. Perhaps the rubbing of shoulders has done more even than the reading of papers. We do not say or wish to infer that the British Association has done more for mankind than the Iron and Steel Institute, because in our opinion the latter stands head and shoulders above all associations for the magnificent work done in disseminating information. It is an international association in the widest sense of the term, and almost all we know about iron and steel, either from the pure or the applied scientific standpoint, is due to its labours and its initiation. The

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British Association is less international. It has, indeed, visited America, and may do so again, but we wish to see it become Imperial first, and an opportunity has arisen in that it is suggested a visit should be paid to South Africa in 1905. According to the Central News, "The suggestion that the British Association for the Advancement of Science should be invited to hold their annual meeting in 1905 in South Africa first came from the Chartered Company, and it is being cordially supported by the various Colonial Governments. The Cape Government has offered £3,000 towards the expenses, and the Transvaal and Natal between them will provide a similar amount. If the association should accept, an elaborate programme will be prepared, and the itinerary will in all probability include meetings at Victoria Falls, Johannesburg, Kimberley, Cape Town, and Durban."

The Exchange Telegraph Company has interviewed Sir H. M. Stanley on the subject. "He regarded the proposal as an admirable one. No doubt it would resolve itself into a huge picnic, such as took place on the occasion of the opening of the Bulawayo Railway a few years ago. The Victoria Falls were only some 300 miles further on, and it was hoped that the railway thither would be completed by the end of next year. Given a year after the completion of the railway, and there would be a town built up as big as Bulawayo itself. Apart from the magnificent falls which everyone would want to see, there would be many other inducements calculated to bring in visitors. Naturally, like Brighton, Birmingham, Sheffield, Glasgow, Swansea, and other cities and towns, Rhodesia would like to have the kudos of having entertained the British Association. Just as each year particular attention was paid to the archæological features of the district in which the association met, so would these scientific people, and more particularly the geologists, have a splendid object lesson before them in the remarkable subsidence—of no less than 350ft.—which was responsible for the division of the Zambesi into its upper and lower courses."

Putting aside for a moment the purely commercial aspect of such a visit, which we contend would be of immense value, let us consider the sentimental aspect. Later-day investigations have proved almost beyond the shadow of doubt that "the gold of Ophir" of the Old Testament was obtained from Rhodesia. The ruined cities of Mashonaland bear eloquent testimony to a past civilisation, and the "old workings" prove that the ancient inhabitants were a gold-seeking race. Prof. Keane sums up the matter in a terse paragraph: "Havilah was the auriferous land whence came the 'gold of Ophir,' and Havilah is here identified with Rhodesia, the mineralised region between the Lower Zambesi and the Limpopo, Mashona, Matabele, and Manica lands." If the mineral wealth of these lands was not exhausted in the time of Solomon, that wealth has again to be redeveloped, and the land should teem with workers whose demands at first would have to be satisfied from the outside—preferably this country. Commercial men should join scientific men in promoting a visit which ought to have wide-reaching results.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TAUNTON ELECTRICAL ENGINEER'S TRIAL.

SIR,—My attention has been drawn to paragraphs which recently appeared in your paper, and as you have attacked me I must, in justice to myself, ask you to grant me a small space in your next issue to contradict your misleading assertions. You state: "The father of this particular assistant was formerly employed under *the then* electrical engineer, and also left." Allow me to state I was never under an electrical engineer here or elsewhere, but I was in the employ of the old Taunton Electric Light Company as an accountant when the Corporation took over the electric light works. I remained with them for some little time, and was the means of detecting a case of forgery and fraud. So the present irregularities, or whatever other phrase you may term them, is not the first case. But I am at a loss to understand what my connection with the electric light works has to do with the present case, seeing I resigned about eight years since. But perhaps it is best known to your informer, who is well known.

Again, you say: "The father seems to have come across memoranda which, without explanation, might be used to disparage the position, etc." This is absolutely false. Before any person, other than myself, knew anything respecting the written instructions to my son, I communicated with the chairman of the Electric Light Committee that I wished for an opportunity of making what I deemed to be an important communication (he previously refused to see me). I then stated: "Under the circumstances you must not blame me for any course I may see fit to adopt after this date." Nothing more was done until Aug. 29, when I had an interview with Mr. Thornhill in my office. I then pointed out the slips to him, and I told him I wanted to know the meaning of these written orders, but he did not satisfy me. After this I had an interview with two gentlemen—large consumers. Next day I wrote Mr. Thornhill a letter—and for your information I enclose copy—when I was again treated with contempt. I solemnly declare that no one was "approached and induced to take the matter up," as you state, but a meeting of several gentlemen took place and adjourned. Another meeting was held, and it was then suggested that a meeting of all consumers whose names appeared on the written instructions should be asked to attend a meeting. These numbered something like 80, and although the chairman of the Electric Light Committee was invited to attend, did he do so? Oh, no! but in his place an accountant put in an appearance, partly I may say in justice to himself on his own behalf. This accountant, I should add was not an official of the Corporation. He had a statement with him, together with some of the electric light books. Although contradicting the statements made by me when challenged by some of the consumers, he had to admit several of the consumers' meters were *put on*.

When Mr. Wansbrough, the prosecuting solicitor, sent instructions to a local gentleman (a solicitor who is highly respected and who has taken great interest in this case, and a consumer) to take out a summons against the borough electrical engineer, the town clerk requested him not to do so, adding the Electric Light Committee would like to have an interview with Mr. Wansbrough. This was arranged for Tuesday, Oct. 14. He (Mr. Wansbrough) informed the committee he was prepared to take the case into a civil court providing they, as a committee, would promise to defend the action. Why did not the committee accept the offer?

I could say much more, but I fear that I have already trespassed too much. I will, therefore, conclude by thanking you in anticipation.—Yours, etc.,

THE FATHER OF THE ASSISTANT.

[Every man is entitled to give his own view of a case, and especially so in a case in which he is interested. We, therefore, rather welcome the above correspondence, which, to our benighted mind, seems to strengthen the view propounded in our issue of Nov. 28 last; hence we are still recalcitrant, and hold that the proceedings taken against Mr. Thornhill were wrong both in conception and execution. Mr. Thornhill has presented a further explanation of his action to the Council, which, however, we cannot find space for in this issue. The matter ought to be left to the decision of the Council.—ED. *E. E.*]

Bucharest.—The Postal Telegraph Department invite tenders for 50,000 kilos. of 2mm. galvanised steel wire. Tenders by Dec. 24.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

541. Is it true, as sometimes stated, that more energy can be got from coal by means of gas-retorts and a gas-engine than from it by means of boilers and a steam-engine? If so, why is it not more widely adopted for the purpose of electric lighting where the possibility of storing the energy as gas would be so useful?—T. P. S.

542. The *tandem* compound, three-crank engine is supposed to give the most uniform angular velocity. What is the reason that the *tandem* arrangement of the cylinders should give such a uniform angular velocity?—P. C. E. W.

ANSWERS.

Question No. 535.—A 5-h.p. enclosed motor is satisfactory in every respect except that it makes a loud humming noise when running, similar to a small steam horn. In this case the noise is very inconvenient, and it is important that it should be stopped. In some books it is stated that the trouble can be overcome by filing away the ends of the pole-pieces, but this method has been tried and makes no appreciable difference. I should be glad if some of your readers would suggest some method of overcoming the difficulty. Would an increased number of slots in the armature make any difference?

Best Answer to No. 535 (*awarded* 10*s.*).—The humming of a continuous-current motor is a phenomenon of some interest, and one which has been to a large extent neglected by designers of electrical machinery. Most modern motors hum more or less, and it is unfortunate that this fault mars otherwise excellent designs of machines which are at present on the market. The writer has a case in point at the present time in which a 4-h.p. semi-enclosed motor running in a lecture-room of a college has been condemned because the lecturer can barely hear himself speak when the motor is running. There is a remedy, but not in the direction in which "W. F. S." has sought it. The remedy must be looked for mainly in the armature, and rounding the pole-pieces, as your querist has found out, will not make any appreciable difference to the humming of the motor.

A series of experiments with the object of reducing the noise of a running toothed armature has led the writer to the following conclusions: (1) If in a toothed armature, with an even number of slots, the length of air-gap at each side of the core is *greater than* the width of slot, then the machine will run silently (see Fig. 1). (2) If the air-gap

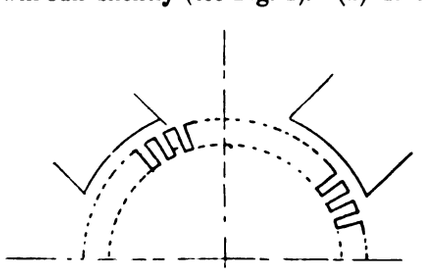

Fig. 1

be reduced until the clearance is *less than* the width of slot, the machine will hum, and the less clearance allowed the greater will be the noise, but the note emitted will remain the same with the same core running at the same speed (see Fig. 2). In fact, it is easy to predetermine the note any given armature will emit if the number of slots and the speed is known, it becoming merely a question of vibrations per second. (3) An armature with closed slots will run silently.

It is probable the motor complained of is a modern machine having a short air-space and few, but wide, slots in the armature core, and the writer can imagine "W. F. S." being tempted to use his motor as a siren or a town fire alarm. But let him not despair. There are two courses open. The first course is to procure a new armature with

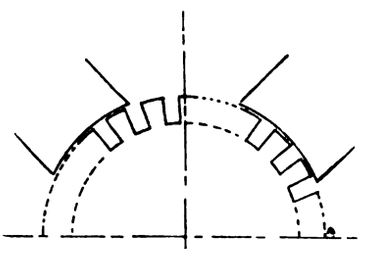

Fig. 2.

more teeth in the core and the width of each slot less than the clearance between armature core and pole-face, or to have a new armature with an odd number of slots, so that when one tooth is leaving a pole-piece another tooth will be partially under another pole-piece (see Fig. 3). This latter suggestion is not a perfect cure, but will materially reduce any objectionable noise. The second course is to wind the armature from end to end of the core, after removing the bands, with iron wire so as to close the slots. The magnets must then be bored out to give the same air-space as at

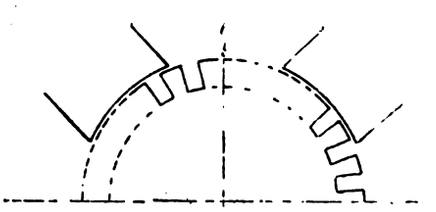

Fig. 3.

present. To this method there is the objection that the whole of this wire must be taken off if any fault occurs in one of the grooves. It is, however, worth trying before going to the expense of a new armature, and the writer has found it to work well in more than one case.—M. K. R.

Answer to No. 535 (*awarded* 5*s.*).—The cause of the trouble is most probably a want of tightness in the armature core discs, especially in the teeth, and is of the same nature as that producing the well-known hum of transformers whose core stampings are not securely bolted together. Whilst a given tooth is under a pole, and is carrying its share of the flux, each separate disc forming the tooth may be considered as a magnet, all the poles of similar size being side by side. Under these circumstances, a definite magnetic repulsion will occur between tops of all the discs forming the tooth, tending to open out the core in the direction parallel to the shaft. As soon as the tooth passes from under the pole into the neutral space this repulsion ceases, and the discs spring together again. If, therefore, the core has not been tightly built up, or if the thick end discs, used for clamping purposes, are not provided with stiff projections, extending all or most of the way up the teeth, a little play will take place and a decided hum may be expected. This opening out of the teeth occurs once under each pole, so that the number of complete vibrations per second, counting all the separate teeth, will be:

$$\frac{\text{Number of}}{\text{teeth in the core}} \times \text{Number of poles} \times \frac{\text{Revolutions}}{\text{per second}}$$

so that if the machine has, say, four poles and 40 slots and runs at 1,200 revolutions per minute, the number of vibrations per second will be $40 \times 4 \times \frac{1,200}{60} = 3,200$, which is equivalent to a very shrill note. If, however, the poles are exactly equally spaced and the number of slots is exactly divisible by the number of poles, a tooth will be leaving or entering each of the poles at the same instant, and although the note will be louder, it will be of lower pitch than that given above in the ratio of 1 : number of poles.

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With regard to a cure, the best method would be to provide the core with stiff end nuts and by their means to thoroughly tighten up the discs. This is, however, difficult and often impossible without completely rewinding the armature, and in such cases the necessary tightness can often be obtained by driving a small metal wedge into each tooth, keeping the wedges in position by means of an extra binding band wound over them. If the above is the correct cause of the hum, altering the number of slots would not, in itself, prevent the trouble; it would only alter the pitch of the note given out. In some machines the vibration which causes the hum is not in the core discs at all, but in the pole tips or horns. This is especially the case in machines having thin horns projecting a considerable distance from the body of the pole. When a tooth is opposite the tip of such a horn a definite magnetic pull exists, tending to drag the horn down on to the armature. When the tooth is replaced by a slot, the net pull on the horn is greatly reduced and the horn springs out again. The periodicity of this fluctuating pull on each horn is: number of slots × revolutions per second; and when this approximately equals the natural periodicity of swing of the horn, which depends on its weight, length, etc., a hum is sure to result, and on touching the horn, whilst the machine is running, the vibration will easily be felt. When the hum is due to this cause it can usually be stopped by filing away the edges of the horns, so as to

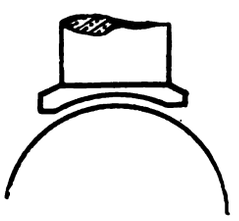

FIG. 1.

decidedly increase the length of air-gap between the horn tip and the armature (Fig. 1). This has the effect of reducing the density in the tooth under the tip, and so greatly reducing the maximum pull, which is proportional to the square of the flux density in the teeth, at the point at which the pull is most effective and most liable to do harm. Another way of stopping the vibration of the horns is to give their edges a slope relatively to the teeth (Fig 2), so that each tooth passes gradually instead of suddenly from under the pole. This prevents the occurrence of large changes in pull on the pole-pieces from

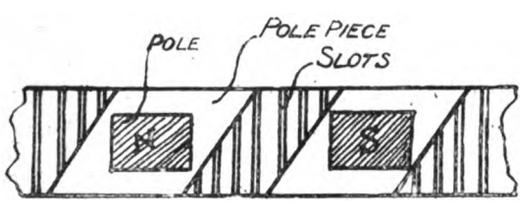

FIG. 2.

moment to moment. Increasing the number of slots in the armature, in the case of vibration in the horns, would also probably prevent or, at least, greatly reduce the hum, since the teeth would be smaller and carry less flux, and so produce less pull individually, and also the periodicity of the impulses would be increased and is not likely to again synchronise with the natural period of vibration of the horn.—Q.

Answer to No. 535 (*awarded* 5*s.*).—The humming noise is due to one or several of the following causes: (1) reversal of magnetism—iron when magnetised or demagnetised gives out a sharp clicking sound; (2) pulsations given to the air by commutator lugs or irregularities due to winding and connections; (3) brushes; (4) vibration from too slack-fitting bearings; (5) the pulley.

1. The humming caused by reversal of magnetic polarity can be prevented by winding a layer of soft-iron wire, say No. 16 B.W.G., over the whole of the armature, forming a broad band (Fig. 1). It will be quite easy to fasten this iron wire by means of a few clips, using hydrochloric acid as a flux when soldering. Resin will answer for a flux if the wire is *clean*, but hydrochloric acid will make the more reliable job. Any acid may be removed with a dilute solution of ammonia. The poles will now in all probability have to be bored out larger, as, allowing for a layer of tape below the iron wire, there will be an increase of about $\frac{3}{16}$in.

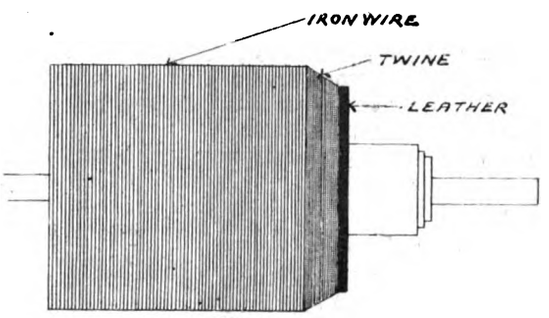

FIG. 1

in the diameter of the armature. They should be bored out as shown in Fig. 2. By so shaping the poles there will be less saturation of the teeth when reversal takes place, and thus the *amplitude* of the vibrations causing the humming will be less. Even if "W. F. S." leaves the armature as it is, giving the poles this form will effect

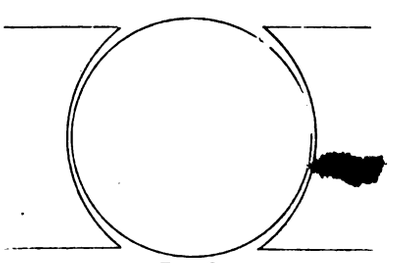

FIG. 2.

an improvement. Some engineers might object to the iron wire, because in making practically a tunnelled core the self-induction due to the winding is somewhat increased, but it is hardly probable that the increase in this case would be observable.

2. To prevent noise from commutator lugs, fit a leather cup (Fig. 3). This can very readily be pressed into shape

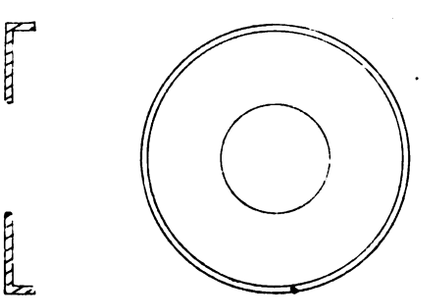

FIG. 3.

while wet in an iron or wooden mould; it may be fastened by tying in three or four places to the commutator lugs. (It is, of course, obvious that if the commutator lugs are cast in one piece with the sections and mica is fitted to top of lug, there will be no need for this leather cup.) From end of core, where iron wire finishes, to commutator lugs wind on a layer of twine; this will form a good surface, and can be arranged to hold down the leather cup. If the other end of armature is uneven, a wooden block should be fitted; thus the armature will have a regular form and a complete surface. Any heating due to curtailment of the ventilation will be balanced by the better conducting power of the layer of iron wire.

3. Carbon brushes, as a rule, are more noisy than the ordinary metallic ones, therefore copper brushes should be employed. If by replacing carbon with copper brushes increased sparking is observed, this may be attributed to the lower contact resistance of the copper; it will then be advisable to use brushes made of brass wire gauze.

4. Bearings should be overhauled. No doubt many of our readers have noticed the quieting effect of pouring

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some thick oil on a slack dynamo bearing. See that there is not too much end play between the bearings.

5. Although not a general cause of trouble in this respect, a turned webbed pulley will sometimes mend matters.

By increasing the number of slots—slots being kept of the same width—the teeth would be thinner; thus matters would be made worse. The consensus of opinion with regard to slotted cores is that the slots should be narrow and deep, and the teeth wide. To fulfil these conditions is not always easy for the designer; general practice tends to making width of slot equal to the thickness of top of teeth.—M. M.

Answer to No. 535 (*awarded* 5*s.*).—Humming in small motors, such as the 5-h.p. machine which "W. F. S." mentions, is usually caused by the flux density in the teeth of the armature (and also in the pole-face) being very high, and to the magnetic field at the pole-tips being not properly graduated (see Fig. 1A). If there is very little or

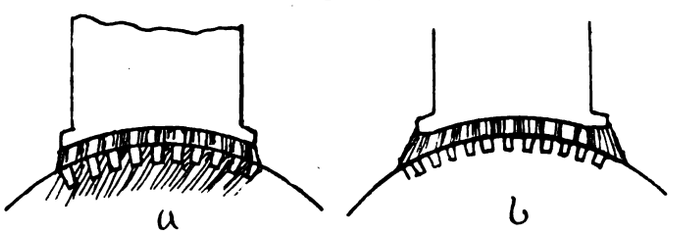

FIG. 1.

no fringe of flux at the pole tips, the teeth enter and leave the magnetic field very suddenly, which causes them to vibrate. This vibration is sometimes increased by the armature being loosely built—*i.e.*, the discs have not been properly pressed together. Increasing the number of slots

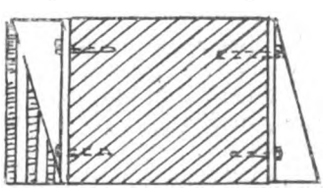

FIG. 2.

might do good, inasmuch as a greater number of slots and teeth would tend to make the magnetic lines more evenly distributed over the surface of the core, so that fewer lines would be broken as each tooth left the field. On the other hand, increasing the slots always increases the flux density in the teeth, as the total section of the latter has to be smaller to allow of getting in the extra insulation. This is obvious, as each slot must have a given

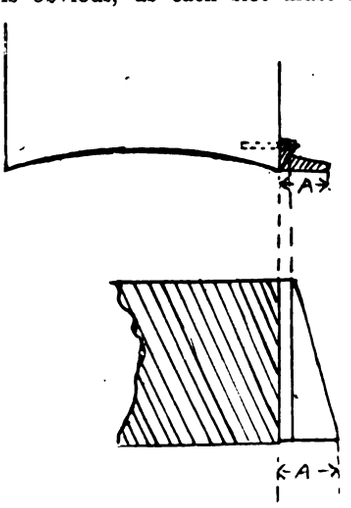

FIG. 3.

amount of insulation, and therefore the more the slots the more insulation required and the more room wasted, which might otherwise be occupied by iron. And, as mentioned above, high density in the teeth increases the tendency to hum, so that it will be seen that increasing the number of slots will not be likely to do very much good.

The best and easiest way out of the difficulty is to fit slanting pole-tips on your motor, as shown in Fig. 2. If the motor has already got fairly long pole-tips, say an inch or so long, these may easily be filed away in such a manner as to completely do away with them at one end and sloping them off so that they remain the same length as before at the other end (see Fig. 2). As "W. F. S." says he has already tried filing away the pole-tips (presumably filing them off parallel with the pole), there may not be enough material left to treat in the way mentioned above. If this is the case, he should take them off completely, and fit in their place angle-iron pole-tips of the shape shown in Fig. 3, making dimension "A" equal to the original length of his old pole-tips. As may be easily seen, the above arrangement causes the teeth to enter and leave the magnetic field gradually instead of suddenly, thus doing away with vibration (see Fig. 2). The writer has found this an almost

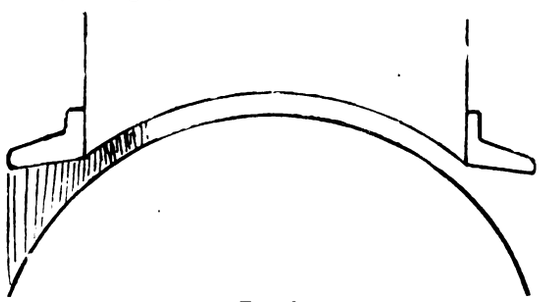

FIG. 4.

infallible cure. Another good thing is to chamfer off the pole-tips, as in Fig. 4, thus causing a well-graduated fringe Yet a third way of improving the motor, as far as noiseless running is concerned, is to increase the bore of the magnets; but as this would entail considerably more field copper, it is not to be recommended in this case.—R.

Question No. 536.—After running on full load for about five hours the collecting rings of a single-phase alternator are found to be distinctly shaded in sections, corresponding in number to the poles on field magnets—the shadings being alternately of a dull and of a polished appearance. Can any reader explain this phenomenon? It may be mentioned that the rings are quite cool after the run.

Best Answer to No. 536 (*awarded* 10*s.*).—The statement of this question is rather ambiguous. The *shadings* are said to correspond to the number of poles on the field magnets, and as both bright and dull sections are said to be shaded, we may take the question to mean either (*a*) that the *shadings* on one ring are equal in number to the total number of pole-pieces on the machine or (*b*) that the *shadings* on one ring are equal in number to the number of poles on one side of the armature. Suppose the machine to be somewhat after the type of the Kapp, Siemens, or Ferranti alternators, in which there is a row of field magnets on each side of the armature, and the number of complete cycles per revolution is equal to $\frac{1}{2}p$, where p is the number of poles on one side of the armature.

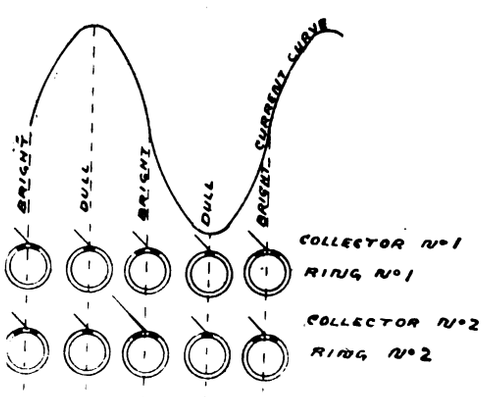

FIG. 1.

(*a*) In this case the number of dull sections is equal to half the total number of poles that is equal to p, so that we require to find some cause which occurs twice every cycle, and as the current reaches a maximum value, irrespective of direction, twice in each cycle, we are led to conclude that whenever the current reaches a certain

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value its heating effect is sufficient to oxidise the copper contained in the brass ring. There is thus produced a layer of copper oxide on those portions of the ring which carry a current above that certain value, as shown in Fig. 1. This local heating may not be sufficient to raise the temperature of the ring to any great extent. (*b*) In this case we require to find some cause which occurs only once every cycle—that is, with either a positive or a negative current. Suppose that no lubricant is used, but that there is a film of water with a trace of acid in it on the surface of the ring. A current passing from ring to collector will liberate oxygen on the ring and hydrogen on the collector. The oxygen, being in a nascent state, will at once combine with the copper of the ring, forming a layer of copper oxide on that portion of the ring from which the current is passing; but when the current direction is reversed the oxygen is liberated at and combines with the collector, leaving the surface of the ring bright, as shown in Fig. 2.

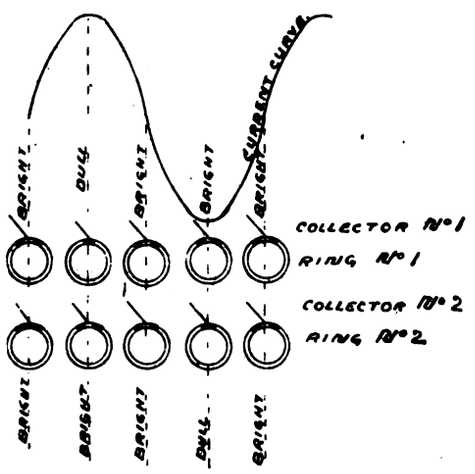

FIG. 2.

In the foregoing we have assumed that the collectors bear on a small portion of the ring, and that if there are more than one collector to each ring they are set at distances apart which are some fraction of the number of poles. Thus with a Ferranti alternator we would not get this effect, because the collector bears on half of the ring. If "C. S." employs an electrolytic lubricant which happens to liberate oxygen when electrolysed, this, of course, will account for the formation of oxide on the ring.—D. R.

Answer to No. 536 (*awarded* 5*s.*).—The shading is due to the differences in current collected at the different points of the slip-ring. Suppose there is only one brush rubbing on each ring; then when this brush is touching certain definite points of the ring, the number of these points being equal to the number of poles, the current passing through the brush contact is at its maximum value. At other points, midway between the first-mentioned ones, the current is zero, and its value varies gradually between zero and the maximum value at intermediate points. Even if there are more brushes than one on each ring, so long as they are spaced out at regular distances which are some exact multiple of the angular distance between two poles, the effect would be the same. It is, of course, understood that the power factor of the load remains fairly constant during the run, for any considerable change in this respect would mean a corresponding change in the actual positions on the ring of the points of maximum current.

Though the primary cause of the shading is almost certainly the difference in current density at different points of the ring, yet the actual manner in which the shading is produced is not so clear. Experiment has shown that the coefficient of friction between certain conductors is greatly changed whilst a current is passing across the surface of contact between them. It may be that in this case the composition of the ring and of the brush are such that this effect is obtained, and sufficient difference in the friction exists between points of low current density and those of high density to cause some parts of the ring to become appreciably more polished than others. Or, again, the differences in current density may themselves give rise to slight local heating sufficient to cause some oxidation, if not of the ring itself, at least of any oil or other lubricant which may have been used on it. The fact that this shading is not more often noticed is probably due to the common use of several brushes on each slip-ring arranged close together and collectively covering at least as great an angular breadth as that between two poles, and thus screening the effect.—Q.

Answer to No. 536 (*awarded* 5*s.*).—It is certainly a very curious problem that "C. S." has set. It reminds me of

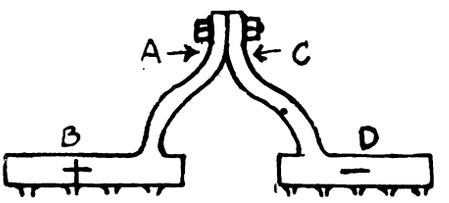

FIG. 1.

a problem I have come across in battery work. Shortly after a battery has been erected the lead lugs connecting the positive plates turn brown and are always moist, whilst the negative connecting lugs are dry and remain the ordinary colour of lead. The connecting lugs are shown in Fig. 1, and from B to A is brown and moist, whilst from D to C is always comparatively dry and unaffected in colour. A rough sketch of an alternator having eight

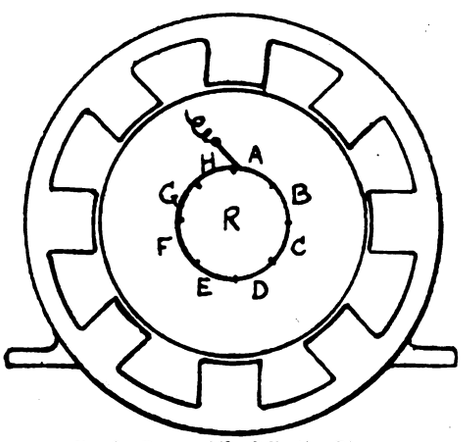

FIG. 2.—R, one of the Collecting Rings.

poles is shown at Fig. 2. In Fig. 3 is shown the number of alternations of the current during one revolution of the armature. Let us suppose that the line in Fig 3 represents the circumference of the collecting ring. It will be seen that the portion of the ring marked A is positive, and when the current has changed its sign and become negative, the portion of the ring marked B will be under the brush.

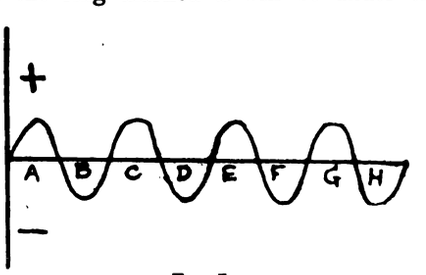

FIG. 3

The current has again changed its sign when the portion C is under the brush, and so on. The portion A will always be positive whilst the machine is running, and the portion B always negative. It may be that moisture is attracted to the positive portions and the negative portions remain dry, and this causes the positive portions to have a polished appearance whilst the negative portions remain dull. Or perhaps for some reason the positive portions are subjected to a greater heating effect, and are thus burnished.—W. A. S.

[N.B.—Will the author of the above reply to No. 536, initial "W. A. S.," kindly send his full name and address?—ED. *E. E.*]

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TRADE NOTICES AND NOVELTIES.

"Street-Lighting."

From the Improved Electric Glow Lamp Company, Limited, 7, Great Newport-street, London, W.C., we have received a copy of the third edition of their "Street-Lighting," which is an admirably compiled and illustrated catalogue of the street-lighting apparatus specialised by this firm. The considerable experience which the Improved Electric Glow Lamp Company

FIG. 1.—Nernst Lamp Street-Lighting Fitting—Wrought-Iron Type.

FIG. 2.—Nernst Lamp Street-Lighting Fitting—Cast-Iron Type.

have had with street-lighting work renders them peculiarly competent to speak authoritatively on the subject, and in their claim to prove that every class of street-lighting can be more efficiently and economically effected by means of arc and incandescent electric light than by any system of gas lighting we have cause, therefore, for no little satisfaction. For convenience of reference the catalogue is divided into three parts: (1) electric street-lighting by incandescent lamps; (2) electric street-lighting by arc lamps; (3) useful notes relating to street-lighting. Some new forms of fittings are illustrated, and the edition otherwise brought up to date. We reproduce herewith illustrations of three of the many interesting specialities shown. The Nernst lamp fittings (Figs. 1 and 2) are designed for

FIG. 3. King Enclosed Arc Lamp complete.

attaching to existing lamp-posts. It is claimed that they combine the following advantages: (1) the burners and resistances of the lamps are easily accessible for renewal; (2) the lamps are readily detached when replacements are required to be made; (3) no shadows are cast on the road or pavement. The remaining illustration, Fig. 3, shows the King enclosed arc lamp complete. This lamp is chiefly remarkable for its extreme simplicity, great steadiness of burning being a further attribute claimed. There being no break mechanism the carbons are fed together continuously, and not at intervals, as is the case with brake-type lamps. Moreover, the sensitive and even working of the lamp is not affected by corrosion or dirt. The lamp consists of a fixed upper carbon and a lower carbon attached to a specially shaped elongated iron core, to the lower end of which is attached a float, which is immersed in a tube containing mercury. This tube also acts as a guide. The carbon-holder is so weighted that the float is sunk and the carbons are normally apart. The shunt coil, which is wound round the top end of the tube when the current is switched on, attracts the core upwards, and causes the carbons to come together. The pressure across the coil thus being reduced, the core and carbon drop again until the current increases in the coil, and the weight of the moving parts is held in equilibrium. This is when at a pressure of 80 volts. It will thus be seen that should the pressure vary either up or down, the position of the core will move, and maintain the pressure across the arc constant. The functions of the mercury in the tube are four in number: (1) to counterbalance the weight of the moving part; (2) to prevent all sudden movement and obviate flickering or pumping; (3) to prevent extraneous matter getting into the guide of the moving part; (4) to act as a conductor between the fixed and moving part. The method of clamping, which is the second feature of the mercury, is very ingenious. The core is perforated with a small zig-zag hole, through which the mercury passes when any movement takes place, and by reason of the high specific gravity of the mercury, and, therefore, large inertia, it passes slowly, and thus prevents any rapid movement in the part of the float, core, and carbon. The arc is burnt in a single globe which is practically airtight. The consumption of current is small, and the lamps can be made to burn from 30 to 40 hours without requiring recarboning, which operation is carried out with great ease. These lamps can be fixed on the top of posts without any special carrier or bracket. They are made to burn in parallel on a 100-volt circuit, two in series on a 200-volt circuit, and three in series on a 230-volt circuit, and can be made to take any current from three amperes upwards. The simplicity of their construction ensures a low cost. It would occupy more space than we have at our disposal to fully enumerate the contents of the catalogue under notice; suffice it to say that artistic fittings and some interesting switching devices are included.

Automatic Inter-Communication Telephone.

We have received from the General Electric Company, Limited, Queen Victoria-street, London, E.C., a copy of their

"S. R." Inter-Communication Telephone Wall Set.

circular No. K. 1,021, describing a new automatic inter-communication telephone, which they have named the "S. R."

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system. A notable feature of this telephone is the introduction of special push-button line selectors, whose automatic action is quite different to anything previously put on the market, and claimed to be a great improvement on existing forms having radial arms or levers. The illustration herewith shows a wall set, consisting of hand combination with switch in handle, buzzer, induction coil, automatic switch-hook, and special push-button line selectors. In using the instrument, all that it is necessary to do to ring up a number is simply to push the corresponding button; this action rings the bell, and sends the calling current to the line. When the pressure is removed the button partly regains its normal position, disconnects the battery, and puts the telephone instrument in connection with the station selected. The moment the telephone is replaced on the hook the button automatically regains its normal position. The same happens if a second button is pushed. The simplicity of the instrument and its compactness speak for themselves, and there is no reason to suppose that its working should not be equally satisfactory. Everything is interchangeable, and the workmanship and material, we are informed, are of the best British-made quality.

Catalogues.

REGULATORS AND MOTOR-STARTING RHEOSTATS.—From the Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C., we have received a copy of their new price-list (No. 3) of regulators and motor-starting rheostats. As is usual with the publications of the above firm, this list is well arranged, and contains illustrations of many interesting and useful pieces of apparatus, with descriptions and prices.

EDISON LAMPS.—The British Thomson-Houston Company, Limited, Rugby, England, have sent us a copy of their pamphlet No. 135 (superseding No. 112, issued Oct. 11, 1902), descriptive of their various types of Edison incandescent electric lamps. The high standard of excellence attained by these lamps is well known.

RECORDING INSTRUMENTS.—From Messrs. Nalder Bros. and Thompson, Limited, 34, Queen-street, Cheapside, E.C., we have a copy of Section III. of their price-list dealing with recording ammeters and voltmeters for direct and alternating currents. A number of instruments are illustrated, and some views of the company's Dalston works are also given, showing the up-to-date equipment.

NEW COMMITTEES.

RAMSGATE.—*Electricity*—Councillor Gwyn, chairman.

YARMOUTH.—*Electric Lighting*—Mr. R. Nudd, chairman.

BACUP.—*Electric Lighting*—The Mayor (Alderman J. H. Maden), chairman; Alderman Astley, vice-chairman.

HARROGATE—*Lighting*—Councillor Davidson, chairman. *Lighting Sub-Committee*—The Mayor; Aldermen Chippindale, Hudson, Simpson; Councillors Davidson, Houfe, and Turner.

NEWPORT (MON.).—*Electric Light and Tramways*—Alderman J. Moses, chairman; Councillor Brown, vice-chairman; Councillors Liscombe, F. Phillips, T. S. Gower, and J. H. Williams.

APPOINTMENTS VACANT.

Winder, accustomed to former-winding. See advertisement.

Shift Engineer, to take charge of 8 hours' shift. See advertisement.

Fitter-Driver, Falkirk Town Council, 35s. per week. See advertisement.

Lamp Trimmer, Falkirk Town Council, 25s. per week. See advertisement.

Designer, with good experience in up-to-date transformer work. See advertisement.

Meter Tester and Reader, Falkirk Town Council, 30s. per week, Dec. 19. See advertisement.

City Electrical Engineer, Dundee Town Council. £400 per annum, Dec. 27. See advertisement.

Clerk and Canvasser, Bermondsey Borough Council Electricity Department, £2 per week, Dec. 21. See advertisement.

Switchboard Attendants, Falkirk Town Council, 25s. per week, Dec. 19; Peterborough Corporation, 25s. per week, Dec. 20.

Junior Assistant Engineer. The Electrical Engineer of the Bolton Corporation will shortly advertise for a junior engineer.

Assistant Electrical Engineer, London County Council Tramway Department, £500 per annum, Jan. 5, 1903. See advertisement.

Electrician-in-Charge. Must be conversant with H.T. direct-current motor-transformer system, 35s. per week, Shoreditch Electricity Supply Dept. See advertisement.

Electrical Engineers. Eiland Urban District Council, Dec. 22. Fulham Borough Council, £400 per annum, rising by £25 per annum to £600 per annum, Dec. 15. Morley Town Council, Dec. 27. See advertisements.

LEGAL INTELLIGENCE.

GALVANIC BATTERIES—ALLEGED INFRINGEMENT.

On Tuesday in the Court of Appeal, composed of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, the arguments were concluded in the case of the Patent Exploitation Company, Limited, *v.* Siemens Bros. and Co., Limited, in which the plaintiffs appealed from a judgment of Mr. Justice Buckley. The action was one brought to restrain the alleged infringement of letters patent No. 1,110 of 1890, and there was an alternative claim for damages.

According to the plaintiffs' case, they were the owners of the patent in question granted on Jan. 21, 1890, to Mr. Charles Addison Hitchcock for an invention for an improvement in galvanic batteries, and the defendants were alleged to have infringed the patent by manufacturing shortly before December, 1890, and by the sale in that month to different persons of batteries and cells made in accordance with the complete specification of the plaintiffs' patent.

The defendants denied that they had infringed the patent, and they also pleaded that the plaintiffs were not the legal owners of the patent, and that the patent was invalid. The objections set out that the alleged invention was not new by reason of a prior publication of the invention, prior user of the invention, and prior public knowledge. It was also said that the invention had been published in certain passages of Prof. S. P. Thompson's book, "Elementary Lessons in Electricity and Magnetism," issued in 1882, and in Delahaye's "L'Année Electrique; Deuxieme, Année," published in France in 1886. Further, it was said the invention had been used in this country prior to the date of the letters patent by the defendants themselves, who purchased in 1889, and used in the same year at their works at Woolwich, Gassner dry cells, which were constructed substantially as described in the plaintiffs' specification. There had been a further prior use of the invention by the common general use of sawdust, plaster, and other suitable material for fixing the liquids used in galvanic batteries, and by the common general use of a depolarising agent in mixture with the exciting agent in contact with the magnetic electrode. The defendants further pleaded that the alleged invention was not proper subject-matter of letters patent. In the Court below, Mr. Justice Buckley found against the plaintiffs, substantially on the ground of anticipation, and he entered judgment for the defendants with costs. Hence the present appeal.

Mr. Astbury, K.C., Mr. Shaw, and Mr. Paget appeared for the appellants; and Mr. Fletcher Moulton, K.C., and Mr. A J. Walter for the respondents.

Mr. Astbury for the appellants contended that the invention related to batteries constructed and arranged as described in the plaintiffs' specification. There was to be a cylinder of zinc or equivalent metal, and it was to be lined with an exciting agent, consisting preferably of five parts, but, whatever change might be made in the ingredients, the mixture must be damp and setting, not subsiding. When it was pointed out that the mixture was to be solid or semi-plastic, those terms were not introduced as alternatives, but plastic was used as the opposite of elastic. In conclusion, he asked the Court to reverse the judgment of the Court below.

Counsel for the respondent submitted that this was a patent for a class, and not for a particular form, of cell; that the class was defined by two semi-solid layers, one only of which contained a depolariser, and that beyond that limitation there was no limitation at all. Pulverisation was not described on the specification as an essential. If the question came to one of infringement, he admitted at once that the defendants infringed, if the specification was to be interpreted in the broad sense; but the only evidence given on the issue of infringement was not as to manufacture or process of manufacture, but was directed to analysis, and as this was a patent for construction, and not for materials, analysis was of no value at all.

On the conclusion of the lengthy arguments of counsel, their Lordships reserved judgment.

RIVER PLATE ELECTRIC LIGHT AND TRACTION COMPANY.

In the High Court on Tuesday Mr. Justice Byrne had before him the petition of the River Plate Electric Light and Traction Company, Limited, and its liquidator, for the Court's sanction to a scheme of arrangement between the Company and its unsecured creditors.

The scheme, as stated by **Counsel,** was that each unsecured creditor should receive, in full satisfaction of all his claims and demands as an unpaid creditor, fully paid ordinary shares (omitting fractions of a £) for the amount of the debt. The scheme did not affect the secured creditors, who had been otherwise dealt with. The agreement had been sanctioned by the Court whereby Mr. Weston, as receiver and manager, sold the whole of the assets to the City Safe Deposit and Agency Company, Limited, partly for debenture stock in a company proposed to be formed.

His Lordship adjourned the petition for a week, and directed a meeting of shareholders to be held next Monday, in order to get their approval.

ALLEGED BREACH OF CONTRACT.

In the Westminster County Court on Monday his Honour Judge Woodfall tried the case of Russell and Russell *v.* Scrivener, in which the plaintiffs, a firm of electrical engineers carrying on business at 49, Victoria-street, Westminster, sued the defendant to recover payment of an account in respect of an electrical installation at his house, 34, Gladstone-road, South Kensington. The defence was that the work was not carried out according to contract, inasmuch as the electric light wires were not carried through steel piping, as agreed upon.

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The plaintiff's case was that he took the order for the work on the distinct understanding that he was to have a free hand, and do it in the way he thought best. With regard to the question of steel tubes, he had used them where necessary, and the work generally was carried out in the very best manner.

After a somewhat lengthy hearing his **Honour** said he thought the justice of the case would be met if he gave judgment for the plaintiffs for the reduced sum of £8. 7s. 6d. and costs.

DAMAGES FOR DELAY.

In the Shoreditch County Court on Friday the Sales Company, Limited, of 39, Wilson street, made a claim of £20 against the County of London and Brush Provincial Electric Lighting Company, Limited, for breach of contract in not installing the electric light.

The defendants, it appeared, entered into an undertaking to supply the plaintiffs with electric current. The plaintiffs had the fittings put in, but, it was alleged, could not get the current until so many weeks after that the gas had to be laid on. It was for the cost of the gas fittings that the plaintiffs now sued.

The defendants said they had to obtain the permission of the Shoreditch Borough Council before they could do the work, and that took a long time.

The **Judge** thought that the defendants had been guilty of unreasonable delay, and gave judgment for the plaintiffs for 10 guineas, with costs. Leave to appeal was refused.

DAMAGE TO GAS-MAINS.

A case of special interest to electric light and gas companies was heard last week in the Isle of Wight County Court before his Honour Judge Percy Gye. The claim was that of the Sandown Gas Company for £22 odd, the price of gas which was estimated to have escaped from the company's mains consequent on the fracture of a service pipe by a blow from a pickaxe which, it was alleged, was being used in road excavation work for cable-laying by the Isle of Wight Electric Light and Power Company, the defendants in the action. The case for the plaintiffs was that some time after the electric cable had been laid it was discovered by plaintiffs' manager that the gas-pipe had been fractured. No notice of the damage had been given, and it was estimated that the gas had been leaking away for about six months. The electric light company admitted having paid the claim for damage to the pipe. They, however, repudiated liability in regard to the claim for loss of gas.

His Honour, in giving judgment, said that, having regard to the defendants' action in paying for damaged pipe and the other circumstances of the case, he had come to the conclusion, though not without some doubt, that the electric light company were responsible for the damage and loss through the negligence of those in their employ. He therefore gave judgment for the gas company for £15, with costs.

Notice of appeal was given.

COMPANIES' MEETINGS AND REPORTS.

MARCONI'S INTERNATIONAL MARINE COMMUNICATION.

The ordinary general meeting of this Company was held on Tuesday at the offices, 18, Finch-lane, Colonel Sir Charles Euan Smith presiding.

The **Chairman**, in moving the adoption of the report, observed that the Company's business was at present only in an early stage of its existence. An extensive agency business for assisting the international organisation of the business was being carefully built up, and in this matter the Company were greatly assisted by men of high standing on the Board, who had special influence in the countries which they represented. The development of the Company's system of shore stations was also proceeding satisfactorily, and further arrangements, particulars of which it was not desirable to disclose, were practically completed for additional shore stations commanding important shipping routes. A school and depôt was about to be opened at Liverpool to facilitate the transaction of the large business which the Company already had with vessels running to and from that port. Referring to the proposed international conference at Berlin in connection with wireless telegraphy, he said that the Board believed that if there was to be any practical outcome of the conference, it could only be by certain regulations being made binding on all ships carrying wireless telegraphic apparatus similar to those which had already been put in force by this Company from the start for the organisation of their shipping business—regulations which, it was felt, could only be enforced by one central organisation controlling such an international system as that which this Company had had developed for the benefit of all nations alike. The Board had just received the following gratifying cablegram from the Congo Free State: "Succès complet entre les postes des télégraphie sans fil de Banana et Ambrizette." This was in pursuance of the arrangement concluded with the Congo Free State for an overland wireless telegraphic connection between that State and the Portuguese colony of Angola by the erection of two Marconi stations at the places named in the cablegram.

Colonel H. M. Hozier seconded the motion, which was adopted *nem. con.*

NERNST ELECTRIC LIGHT.

The annual general meeting of the shareholders of this Company was held at the Westminster Palace Hotel on Wednesday afternoon.

Mr. Bernard M. Drake presided, and moved the adoption of the report, which appeared in our last issue. Having referred to the retirement from the Board of Sir Henry Mance, under medical advice, he went on to say that the profit and loss account showed a debit balance, but the shareholders would be pleased to note that some substantial sums had accrued from the genuine sales of lamps, and, taken as a whole, the result of the past year's operations showed an improvement as compared with former years. The largest item under the heading of income was in respect of royalties, which amounted to £1,115 on lamps sold in England, and there was little doubt that this would rapidly increase. The most important business of the period under review had been the settlement and working arrangement effected with the Allgemeine Elektricitäts-Gesellschaft in regard to legal proceedings which were pending at the date of the last report. It would be remembered that the directors had decided to apply for a compulsory license to manufacture in Great Britain. Previous to the hearing of the case, however, they received a visit from representatives of the Allgemeine Elektricitäts-Gesellschaft, and in consequence of this Mr. Hirst (a director) and he visited Berlin, and, after difficult negotiations, were able to make an arrangement which not only avoided further legal outlay, but enabled the Board at once to decide on a definite policy and to commence obtaining an income for the Company. At the same time, it overcame the difficulty which stood in the way of the Company's manufacturing except in foreign countries. At first sight it might appear that the Board had for a time sacrificed manufacturing profits, but the fact was that no one could make lamps at the price which this Company were getting them at without providing a factory quite beyond their means. If the invention should develop in the future to an extent that would warrant manufacturing being started in different countries, there would be nothing to prevent their adopting that course. In spite of adverse criticism in the past, the Nernst lamp was now beginning to take its place as a serious factor in all new schemes for electric lighting. He suggested that the time was now come for considering the question of reducing the capital of the Company to a proper working basis. With the present capital it would be some years before the ordinary shareholders could hope to obtain any dividend, as the preference dividend would absorb over £9,000 per annum. The Board would be glad to hear the views of the shareholders on this matter.

Mr. J. G. Dalzell seconded the adoption of the report.

A discussion followed with regard to the expenses and the directors' fees.

Mr. Hugo Hirst, in reply, stated that the expenses had been reduced all round, and that the Company started the current year in a very different position from the state of things at the beginning of the period under review.

Several shareholders spoke in favour of writing down the capital.

The **Chairman** said that the Board would communicate with the shareholders by circular prior to convening a meeting to deal with the subject. The directors, he further stated, would agree to their fees being reduced to £720 per annum, and they were also willing to forego all arrears.

The motion was then agreed to.

ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING.

The report of the directors from April 4, 1901, to Sept. 30 last, to be submitted to the meeting on the 16th inst., states that the balance of net revenue for that period is £22,815. Out of this sum debenture interest to June 30, 1902, £3,000, and preference dividend to Sept. 1, 1902, £4,862. have been paid, leaving a sum of £14,953. After making provision for three months' debenture interest and one month's preference dividend accrued up to Sept. 30, there remains a balance of £12,828. From this balance the directors have written off the whole of the preliminary expenses, £1,023, and £1,000 from the special car account, and it is proposed to carry forward £10,804 to the credit of revenue account. While the revenue account is made up to Sept. 30, the balance-sheet has been brought up to Nov. 29 so as to include some outstanding liabilities which were unsettled at the former date. The Broadstairs lighting was not commenced till last August. The sale of current included in the accounts up to Sept. 30 produced £129 Protracted negotiations with the Corporation of Margate (not yet definitely concluded) regarding the terms on which public lighting should be supplied have delayed the inauguration of the electric supply in this district, but the Company are now engaged in laying down the distributing cables, and will soon be able to commence supplying private consumers in Margate. Ten additional cars were delivered early this year, and 10 more have been ordered, which will be ready for next summer season's traffic.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The report of the directors for the year ended Sept. 30 last states that the accounts show, after provision for doubtful debts, a net profit for the past 12 months of £57,554. Adding £54,807 brought forward, and deducting £12,500, interim dividend paid in June, there remains a disposable balance of £99,861. The directors recommend the distribution of a dividend of 15s. a share, free of income tax, amounting to £37,500, making, with the interim dividend paid in June, a total payment of 10 per cent. for the year, and leaving £62,361 to be carried forward. The general business shows a falling off when compared with last year. To a great extent this is due to a lowering of selling prices, the quantity of goods sold being about the same in the two years. The cost of raw material has, on the whole, been less. A cable to connect San Francisco with the Sandwich Islands has been manufactured for the Commercial Pacific Cable Company, and was dispatched in the cable steamer "Silvertown" on Sept. 20 last. This vessel is expected to

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arrive shortly at San Francisco, and will proceed with the laying. The "Dacia" has been employed by the Spanish Government in cable-repairing work, and by the Western Telegraph Company in cable-laying on the coast of Brazil. The "Buccaneer" has had three short charters for cable-repairing work in the English Channel. The works at Silvertown and Persan have been maintained in their usual state of efficiency, and extensions continue to be made.

POWER GAS.

Presiding over the meeting of shareholders in the above Corporation on the 4th inst., **Sir Henry H. Fowler, M.P.**, explained that the Company had been formed for the purpose of manufacturing engines and plant which could be driven by the Mond gas. It was too early yet to give any detailed results, but during the last 12 months they had received a number of good orders, and they had some still in hand which would keep the works busy for some time to come. The South Staffordshire Mond Gas Company, which obtained its Act of Parliament in 1901 was now formed, its capital subscribed, and was busy erecting its large plant for the purpose of distributing Mond gas. This Company were shareholders in that company to a small extent, and had secured the contract for the plant which the Mond gas would require. The Mond gas had excited the attention of the manufacturing and engineering world, which was much concentrated on the supply of cheap motive power for generating electricity, and gas-engines, which could now be made up to 2,000 h.p., had an important bearing on the industry. He and his colleagues were quite satisfied with the progress already made, and there were good prospects for the future.

The report was adopted.

NEW COMPANIES REGISTERED.

County Electric Traction Company, Limited.—Capital, £3,000. Objects: to lay down and maintain electric and other tram and rail roads, electrical undertakings, etc.

Dynamotor, Limited.—Capital, £6,000. Objects: to acquire from S. Frost certain patents relating to improvements in electrical apparatus; to develop the same; as producers and suppliers of gas and electricity, etc.

Motor Power Company, Limited.—Capital, £100. Objects: to carry on in all or any of their respective branches the businesses of cycle makers, motor and motorcar builders and engineers, in particular as producers of gas, electricity, etc.

River Plate Electricity Company, Limited.—Capital, £250,000. Objects: to adopt an agreement with the City Safe Deposit and Agency Company, Limited; to acquire any electrical undertakings; to establish and maintain electric and other rail and tram roads in the Argentine Republic or elsewhere in America, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Wigan.—The Corporation invite tenders for a supply of cable. Tenders by Dec. 29. See advertisement.

Swindon. The Corporation invite tenders for the wiring of the town hall for the electric light. Tenders by Dec. 29. See advertisement.

Harrogate.—Tenders are invited by the Corporation for the supply of carbon rods for arc lamps during the ensuing 12 months. See advertisement.

Wigan.—The Corporation invite tenders for an extension to the switchboard at their central electric supply station. Tenders by Dec. 29. See advertisement.

Messina.—Tenders will be called by the Italian Government Railways Department shortly for the electric lighting of the railway station, estimated at about £4,500.

Glasgow.—The Corporation invite tenders for the supply of 100 electric motor equipments and spare parts for same. Tenders by 11 a.m. on Jan. 5, 1903. See advertisement.

Lowestoft.—The Corporation invite tenders for motorcars, trucks, motors, and equipments, and track sweeping and watering car. Tenders by Jan. 7, 1903. See advertisement.

Sunderland.—The Corporation invite tenders for the supply of a Lancashire boiler, 28ft. by 8ft. 6in. diameter, with fittings, etc., complete. Tenders by 12 noon on Jan. 2, 1903. See advertisement.

Blackpool.—The Electricity and Tramways Committee invite tenders for the supply and delivery at the electricity works of overhead tramway equipment and cable. Tenders by Dec. 24. See advertisement.

Swansea.—Tenders are invited for electrical work required to be done at the Swansea Hospital. Specifications may be had of Mr. W. D. Hughes, secretary, to whom tenders must be delivered by 15th inst.

Wallasey.—The Urban District Council invite tenders for engine and dynamo for traction purposes, Lancashire boiler, condensing plant, and water-cooling tower. Tenders by Jan. 15, 1903. See advertisement.

Cardiff.—The Tramways Committee invite tenders for the supply of tools necessary at their main car depôt. Specifications, etc., can be obtained on application to Mr. Arthur Ellis, The Hayes, Cardiff. Tenders by 18th inst.

Burnley.—The Health Committee invite tenders for the supply and delivery of steel steam-piping required for conveying steam from the refuse destructor boiler to the electricity station. Tenders by Dec. 20. See advertisement.

Salford.—The Tramways Committee invite tenders for the supply of 50 electric tramcars. Full particulars may be obtained upon application to Mr. Ernest Hatton, general manager, Tramway Offices, 32, Blackfriars-street, Salford. Tenders by 4 p.m. on 15th inst.

Hebden Bridge.—The Urban District Council invite tenders for gas-engines for direct coupling to dynamos; dynamos, booster, and balancers; storage battery, switchboard, travelling crane, and supply and laying of cables. Tenders by Dec. 22. See advertisement.

Blackpool.—The Tramways Committee invite tenders for laying about one and a quarter miles of double line at Lytham-road South. Specification, etc., can be obtained from Mr. John S. Brodie, borough engineer and surveyor, Town Hall, Blackpool. Tenders by Dec. 22.

Sidmouth.—The Urban District Council invite tenders from electrical engineers and others for the lease for a period of 42 years of a provisional order for the supply of electricity for lighting, heating, and power throughout their district. Tenders by Dec. 20. See advertisement.

Manchester.—The Tramways Committee invite tenders for supply of about 100 cast-iron bases for tramway poles. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by 1 p.m. on 13th inst.

Rotherham.—The Corporation invite tenders for 2,000 yards of ·1, 1,000 yards of ·95, 500 yards of ·035, 1,000 yards of ·022 1,000 yards of ·012 square inch single vulcanised-bitumen cable. Tenders to be sent to Mr. H. Hampton Copnall, town clerk, Town Hall, Rotherham, by 15th inst.

Newport (Mon.). Messrs. G. F. Lovell and Co. invite tenders for extension of the electric light installation at their Monmouth confectionery works, Crindau, Newport. Specifications, etc., can be obtained from Mr. C. D. Copland, M.I.E.E., Westgate-chambers, Newport. Tenders by Dec. 16.

Manchester.—The Trafford Park Estates Company, Limited, invite tenders for permanent way, roadmaking, draining, etc., overhead equipment, and steel poles, etc. Specification, etc., can be obtained from Messrs Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Dec. 13.

Stoke-upon-Trent.—The Corporation invite tenders for the supply and erection of boiler-house plant, steam dynamos (single-acting engines), balancer, reversible boosters (hand-regulated), switchboard, battery, street mains and accessories, travelling crane, and workshop machinery. Tenders by Jan. 14. See advertisement.

Brighton.—The Council invite tenders for the construction of the permanent way of the tramroads in London-road, St. Peter's-parade, and Old steine, etc., including the bonding and all contingent works, and paving with wood the whole of the area of such roads, including the tramway tracks. Tenders by Dec. 23. See advertisement.

La Valette.—The Municipality invite tenders for the establishment and working for 99 years of a tramway between La Valette and Senglea Cospiena, Vettoriosa and Casal Zebbug. Deposit £300. Tenders by Nov. 25 to Wm. Casolani, receiver-general and director of contracts, La Valette. Plans and particulars will be ready by March 1, 1903.

Clacton.—The Urban District Council invite tenders for the supply and erection of boiler-house plant, two Economic boilers with fittings and accessories, steam and exhaust piping, two high-speed engines, two 100-kw. dynamos, balancer and boosters, switchboard, street work, underground cables, switch pillars, etc., accumulators, travelling crane, and rails. Tenders by Dec. 22. See advertisement.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply, delivery, laying, erection, and connecting-up, etc., of high-tension cables, low-tension cables, telephone, and test wires, etc., extra high-tension switchboards for main generating station and four sub-stations, and low-tension switchboards. Tenders by Jan. 5. See advertisement.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 2,245 tons of steel girder tramway rails, 1,470 tons of slot rails, 580 tons of conductor tee rails, together with the fishplates, and bolts and nuts required in connection with the reconstruction (for electrical traction) of the County Council tramways. Specifications, etc., may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on 22nd inst.

Devonport.—The Corporation invite tenders for the supply of materials in connection with and the execution complete of the overhead equipment of about 2 miles 4 furlongs 3 chains of double trolley line, together with incidental works. Specification, etc., may be obtained on application to Mr. C. Chadwell, 20, Victoria-street, Westminster. Copies of the drawings may be inspected daily between 11 a.m. and 5 p.m. on application being made to the Resident Engineer, 40, St. Aubyn-street, Devonport. Tenders by 9 a.m. on 29th inst.

Bulawayo (Rhodesia).—Tenders are invited by the Municipal Council for the establishment and working of an electric tramway system for that municipality. A limited number of copies of a draft agreement upon which the Council is prepared to grant the right, together with plan of township, suggested route, and other details, can be obtained upon application to Messrs. Davis and Soper, 54, St. Mary's-axe, London, E.C., London agents of the municipality, by whom sealed tenders, endorsed "Tramways," will be received up to noon on Feb. 26.

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Wellington (New Zealand).—The City Council invite tenders for the complete supply and installation of electrical tramways, other than buildings; the supply, delivery, and erection of certain tramcars and electrical equipment; plant and materials for the power station; supplies and the erection of plant for the power station; materials for the permanent way; supplies and the construction of the permanent way; material and fittings for the overhead equipment and feeders; and erection and maintenance of all materials, etc., for the overhead equipment and feeders. Tenders by Jan. 21. See advertisement.

Sydney (N.S.W.).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on Wednesday, Feb. 4, 1903, from persons desirous of contracting for the supply and delivery of an additional subscriber's section of the present metallic circuit branching system multiple telephone switchboard at the Central Exchange, General Post Office, Sydney, New South Wales. Sealed samples, specification, and general conditions may be seen at the office of the Chief Electrician, General Post Office, Sydney. Specification and general conditions may also be seen at the General Post Office, Melbourne, Brisbane, Adelaide, Perth, and Hobart. The tenderers must state the shortest time within which the switchboard can be delivered at the Central Exchange, General Post Office, Sydney.

RESULTS OF TENDERS.

Londonderry.—The Corporation have accepted the tender of Messrs. Hugo Lorenz and Co. for the supply of carbons for the year 1903.

Malvern.—Messrs. Dick, Kerr, and Co., Limited, have let the sub-contract for two 150-h.p. engines to Messrs. Belliss and Morcom, Limited.

Darwen.—The Town Council have accepted the tender of Messrs. G. F. Milnes and Co., Limited, for covering one of the cars on the Hoddlesden route.

Sheffield.—The Tramways Committee have accepted an offer by Milnes, Voss, and Co., Limited, Birkenhead, to fit up one of their cars with the patent top-deck covering.

Burton.—The Town Council have accepted the tender of the British Insulated and Helsby Cables, Limited, for the electric light mains for the tramway service, at £1,183.

Newport (I.W.).—The Town Council have accepted the tender of Mr. A. Wood for the erection of an electrical water-level apparatus to gauge the water at the reservoir, at £96. 9s. 6d.

Walton-on-Naze.—The Urban District Council have accepted the tender of the Coast Development Company for supplying the public lamps of the town with electric light, at £2. 15s. per annum for each 16-c.p. electric lamp.

Norwich.—The Norwich Electric Supply Company have decided to instal an 850-h.p. Willans engine for direct coupling to a dynamo of Siemens Bros.' make.

London County Council.—The following tenders have been received for the execution of the roadwork and platelaying in connection with the reconstruction for electrical traction of the New Cross to Greenwich, etc., section of the Council's tramways:

With Askham special work.			
W. Griffiths	£213,279	12	11
With Lorain special work.			
Dick, Kerr, and Co.	208,219	19	5
W. Griffiths	221,724	6	2
E. Nuttall	215,151	9	11
J. G. White and Co.	218,005	12	4
With Hadfield special work.			
Dick, Kerr, and Co.	211,985	11	0
W. Griffiths	227,295	14	7
E. Nuttall	219,151	9	11
J. G. White and Co.	216,630	10	4
Other tenders received.			
S. Pearson and Son	259,895	4	6
R. C. Brebner and Co.	279,082	2	4
J. Smith and Co.	303,638	12	6

Erith.—The Electric Lighting and Tramways Committee have received the following tenders for the wiring and supply of fittings for a complete installation of electric light at the Council offices and Council chamber:

Cramer and Co., 13, Queen Anne's-gate, Westminster, S.W. (irregular)	£93	0	0
Ward Bros., 28A, Basinghall-street, London, E.C. (accepted)	136	17	9
S. W. Gibson and Co., Dartford, Kent	149	18	0
R. Dawson and Co., Hartley Works, Stalybridge	164	0	0
W. Simmons, Martin Works, Frederick-street, 134, The Grove, Stratford, E.	196	0	0
J. P. Lemmon, Canterbury-street, New Brompton, Kent	208	19	6
Handley and Shanks, Newton-chambers, Cannon-street, Birmingham	210	0	0
Jackson Bros., Broadway, Plaistow, E.	214	16	7
F. J. Coleby and Co., 7, Thayer-street, Manchester-square, W.	222	10	0
W. Mossop and Co., 52, Queen Victoria-street, London, E.C.	224	3	0
H. J. Ede, 6, Ormonde-buildings, Station-road, Epsom	225	0	0
H. E. Keen and Co., 22, College-parade, Kilburn, N.W.	240	10	0
Gardner and Co., 156, Milton-road, Gravesend	271	15	0
Tamplin and Makovski, Redhill	288	0	0
J. P. Child and Co., 130, Powis-street, Woolwich	300	0	0
L. G. Tate, Mansion House-chambers, 20, Bucklersbury, E.C	310	0	0

Bradford.—The Corporation have accepted the tender of Messrs. G. F. Milnes and Co., for fitting six of the car bodies, now being made by them, with car top covers, similar to those in use at Liverpool, at £50 per car.

South Wales.—The South Wales Electrical Power Distribution Company have placed an order for extensions with Willans and Robinson, Limited, of Rugby, for four 600-h.p. engines for direct coupling to dynamos of the Westinghouse Company's make.

Finchley, N.—The Urban District Council have accepted the following tenders: R. Hornsby and Sons, Grantham, boilers, £1,295; Sunderland Forge and Engineering Company, Pallion, Sunderland, steam balancer sets with Belliss engine, £2,264; Callender's Cable and Construction Company, London, cable, £10,107. 4s. 2d.

Dialite Cable.—The St. Helens Cable Company, Limited, Warrington, have received orders for waterproof dialite cable from John Brown and Co., Sheffield; Ernest Scott and Mountain, Limited, Newcastle-on-Tyne; the Norwich Electricity Company; the Notting Hill Electric Light Company; the Corporations of Bootle and Oldham, etc.

BUSINESS NOTES.

TRACTION.

Stretford.—It is hoped to have the electric tramways running here in six weeks' time.

Whitefield.—It is resolved to apply for powers to borrow £14,000 for tramway construction.

New Forest.—A scheme is being promoted for an electric light railway from Totton to Fawley.

Hyde.—The construction of the permanent way of the new tramways in Hyde was commenced last Monday.

Willenhall.—The British Electric Traction Company have opened the tramway service between Willenhall and Darlaston.

Paignton.—The local ratepayers' association has passed a resolution in favour of a general scheme of tramways in the district.

Maidstone.—The adjourned sitting of the Light Railway Commissioners on the local tramway scheme took place on Tuesday.

Broughty Ferry.—The negotiations regarding the Broughty and Dundee tramways are reported to be in a satisfactory condition.

Llanelly.—The tramways company are now taking steps to secure specific performance from the British Insulated Wire Company of their contract.

Brighton.—Under a new arrangement the Electric Lighting Committee are supplying current for tramway purposes at a flat rate of 1·5d. per unit.

Plymouth.—The Board of Trade have sanctioned the borrowing of £10,750 for the reconstruction and electrical equipment of the tramways in Union-street.

Linthwaite.—The District Council are taking steps to get a reduction of the tram fares at present enforced by the Huddersfield Tramways Committee.

Willington Quay.—The tramway company have promised to run workmen's cars at an early date. The District Council are pressing for further concessions with regard to fares.

Portsmouth.—The tramway receipts for the week ending Dec 6 totalled £1,165. 18s. 9d., as compared with £820. 3s. 10d. for the corresponding week last year, an increase of £345. 14s. 11d.

Darlington.—It is proposed to use scoriæ bricks for paving the tramway tracks. The Light Railway Committee have been authorised to obtain tenders for constructing the proposed light railways.

Paris Motorcar Show.—The fifth International Automobile and Cycle Exhibition was opened in the Grand Palais, Paris, on Wednesday. The show is likely to prove the most successful of its kind yet held.

Lower Bebington.—The promoters of the proposed electric tramway from New Ferry to Chester have deposited the plans of the same with the District Council, who have referred them to the Parliamentary Committee.

Colchester.—The local debating society have passed a resolution that a system of tramways is essential for the welfare of the town, and that the same should be owned and controlled by the municipal authorities.

Bacup.—The tramways company have promised to ensure the efficient state of the roads in future, in consequence of numerous complaints which have been made of late as to the slippery condition of the thoroughfares in question.

Leeds.—On the report of Mr. Hamilton, general manager, the Tramways Committee have approved the adoption of "overlapping" fares on the cars. A sub-committee has been appointed to report upon the question of ½d. fares.

Hastings.—Mr. Murphy is proceeding with his "front-line" scheme of tramways, and will promote a Bill next session to authorise the construction of the lines. He also proposes to lay down tramways in London-road.

Eastbourne.—In a letter to the editor of one of the local newspapers the Mayor of Eastbourne expresses his disapproval of trams for the town, but his approval of an electric motor-omnibus service, which in his opinion, would pay in the summer.

Gomersal.—The District Council have appointed representatives in connection with the Bill which is being promoted by the British Electric Traction Company for obtaining powers for the reconstruction for electric traction of the local tramways.

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Eastwood.—Sir Bache Cunard has informed the District Council that he does not propose to proceed with his light railway scheme. The Council have, therefore, given their consent to the scheme of the Notts and Derbyshire Tramways Company.

Provincial Tramways Co.—The accounts for the year ended Sept. 30 admit, after setting aside sums for reconstruction of permanent way, of a final dividend on the ordinary shares of 3s. per share, making 3 per cent. for the year. The balance carried forward will be about £1,100.

Automobile Cup.—The Automobile Club of America will compete for the Gordon Bennett Automobile Cup, at present held by the Automobile Club of Great Britain, through the victory of Mr. S. F. Edge in last year's contest. This year's race will probably be held in Ireland.

Bury.—A special meeting of the Town Council has approved the intended application to the Board of Trade for a provisional order to enable the Corporation to construct additional tramways along Heywood-street, Spring-street, Cecil-street, Frederick-street, and Market-street.

Ayr.—The Town Council have decided to continue the present charge for current supplied to the tramways department—*i.e.*, 1½d. per unit up to 200,000 units, and 1d. per unit beyond that amount—and have rejected a proposal to charge a flat rate of 1½d. per unit right through.

Northampton.—The Tramways Committee have prepared a report showing that in the first 12 months' working of the tramways by the Corporation the receipts from traffics were £11,008. 2s., and that after paying all expenses, including interest, there was a net profit of £916. 12s. 10d.

Blackpool.—The borough surveyor has been instructed to carry out the requisite repairs to the tramway permanent way in Warbreck-road and Dickson-road. The doubling of the line and the installation of electric traction on the Lytham route will be completed, it is estimated, by June next.

Wirral.—The proposal to run a line of electric tramways through this place has given rise to extensive discussion in the district, but no decision has yet been arrived at by the Council. The proposed tramway is part of the scheme for a tramway between New Ferry, Birkenhead, and Chester.

South Africa.—It is stated that a complete system of electric tramways is to be laid down by the Westinghouse Company, of Pittsburg, at the De Beers Mines, Kimberley. The Salisbury (Rhodesia) Town Council have practically decided upon an electric light and traction scheme for the town.

Birmingham.—Under the Bill which the Birmingham Tramways Company are promoting in the next session powers are sought to construct new tramways along the Birmingham and Stratford and Birmingham and Warwick main roads, in the parish of Yardley, as extensions of the existing system.

Halifax.—The Tramways Committee have arranged with Mr. Campbell, of Sunderland, to give a trial of his patent tram cover. It is a contrivance formed of lattice work, after the style of the Bellamy cover in use at Liverpool, and if it answers expectations its use will become general on the Halifax cars.

Merthyr.—Mr. John Morgan, who recently retired from the office of traffic superintendent of the Merthyr Electric Traction Company, is to be presented by the employés with a handsome illuminated address framed. Mr. A. J. L Plunkett is now in responsible charge of the local arrangements as managing engineer.

Oxford.—A committee of the City Council is to be appointed "to furnish information as to the results of municipal and private electric tramway services, and (1) to report upon the most desirable system as suitable to Oxford, and (2) to advise the Council as to necessary improvements (if any) for the efficient working of the same."

West Bromwich.—The work of equipping the tramways running through the borough of West Bromwich in readiness for the introduction of the service of electric cars has now been completed, and on Tuesday the Board of Trade inspectors inspected the line between Carter's Green, West Bromwich, and the Handsworth boundary.

Poole.—Sir Herbert Jekyll, one of the Board of Trade inspectors, has, as a result of the enquiry held last week, confirmed the decision of the Light Railway Commissioners granting powers to the Poole and District Electric Traction Company to construct a tramway through Parkstone. This line is included in the proposed purchase powers of the Bournemouth Corporation.

Littlehampton.—The proposed Hove and Littlehampton tramway was discussed at the last meeting of the local ratepayers' association, and it was unanimously resolved: "That this association gives its support to the tramway scheme, providing that favourable conditions can be arranged by the Urban Council, and that, *inter alia*, at least the tramways should run to Wick."

Traction Engine Owners' Association.—The ninth annual report of the National Engine Owners' and Users' Association states that the organisation of the traction engine industry during the year has made satisfactory progress. The number of members has grown, the increased subscriptions have been willingly paid, and greater interest has been taken in the work of the association.

Cardiff.—A sub-committee has been appointed with plenary powers to negotiate (*a*) on the claim of the Provincial Tramways Company for £23,500 in respect of depôts, for which the Council have offered £22 000; and (*b*) on the question of the purchase of the undertaking of the Cardiff District and Penarth Harbour Company, for which the company ask £13,000, and the Corporation offer £10,000.

Huddersfield.—Owing to the slippery state of the metals, caused by snow, an eight-wheeled bogie car got beyond control when descending an incline at Paddock and collided with an ascending car on Friday last. The fronts of both cars were smashed, and the driver of the runaway car was badly injured. Many of the passengers jumped off when they saw a collision probable, and only two received injuries.

Kirkcaldy.—Prof. Kennedy, consulting engineer for the Kirkcaldy tramway and electric lighting schemes, has made an inspection of the works, visiting the whole of the tramway route and also the generating station. The Electric Lighting and Tramway Committee are considering the applications received for the appointment of engineer and manager. It is expected that within two months the tramways will be running.

Bradford.—With reference to the tramway employés' grievances, the formation of a Conciliation Board, consisting of six members of the Tramways Committee and six representatives of the tramway employés, is suggested. It is intended that the proposed Board shall be competent to deal with all matters now in dispute between the Tramways Committee and their employés, and also with any further difficulties that may arise in the future.

Swansea.—The Swansea Tramways Committee met on Monday to discuss the merits of the various systems of electric traction for adoption on the extensions about to be undertaken. It was eventually decided that the deputy town clerk should prepare a report on the Dolter surface-contact system, which a deputation of the Council recently inspected at Paris, and embody therein the opinion of the deputation as to the practicability of the system.

Rochester.—On Tuesday night a largely-attended meeting of owners and ratepayers authorised the City Council to promote a Bill in Parliament for constructing municipal tramways in that borough, and for carrying out an extensive scheme of street widenings in connection therewith. The resolution was carried by a practically unanimous vote. It was stated that two companies are also promoting Bills in Parliament to lay down tramways in Rochester.

Walsall.—On Tuesday Colonel Yorke, R.E., on behalf of the Board of Trade, inspected an extension of the Corporation tramways which has been carried out at Bloxwich. The new line, which is a continuation of the tramway affording communication between Bloxwich and the centre of the borough, is about a mile in length, and is the first of a general scheme of tramway extensions. It is hoped that the line will be opened to traffic in the course of a few days.

Derby.—A resolution was unanimously passed at the last Town Council meeting empowering the Parliamentary Committee to take steps to oppose the Nottinghamshire and Derbyshire Tramways Bill. The Chairman of the Parliamentary Committee said that, having regard to the fact that the Council were on the point of embarking on a scheme for electric tramways in the borough, they were determined to oppose the introduction of foreign electric traction into the town.

Aberdeen.—A movement is on foot among the principal cab proprietors, carting contractors, and others concerned, with a view to taking action in the way of having more limitation put on what is considered the excessive rate of speed at which electric cars are propelled on some parts of the Corporation tramway system. Recently several accidents have been reported, resulting in a good deal of damage to vehicles. Four new cars are being built for the Corporation in Manchester, and it is expected they may be running before Christmas.

Adelaide.—According to a paragraph in the *New Zealand Mining, Engineering, and Building Journal* of Oct. 16, Mr. H. Noyes, of Messrs. Noyes and Bros., should now be in England with full plans of the proposed electric tramways for Adelaide. The work will be started as soon as possible, but not before March, or more probably May next. The trams will be completed in two years from date. The estimated cost of the whole work is £1,400,000, and the company, when formed, will do the work themselves without calling for tenders. The Westinghouse Company will supply the machinery.

Competition.—In order to meet the severe competition of the Glasgow Corporation electric tramways, the railway companies running into Glasgow have this week announced that a reduction in the price of season tickets will come into force at the beginning of next year. Under the new arrangement monthly season tickets will be procurable from any of the suburban stations into the city on the basis of 5s. for third-class and 7s. 6d. for first-class. The new tariff is only 1s. above the special rates granted to workmen, who, however, are restricted to travel by certain trains, whereas season tickets will be available by all trains.

Additional Traffic Returns.—Anglo-Argentine, £583 increase; Barcelona Ensanche y Gracia, £37 increase; Barcelona, £63 increase; Brisbane, £202 increase (month of November, £10,291, increase £552); Buenos Ayres and Belgrano Electric, £10 increase (month of November, £13,698, increase £925); Calcutta, £579 increase; Cape Town (month of October), receipts £16,507, expenditure £8,727; Isle of Thanet Electric, £82 decrease; Mexico Electric (month of November), receipts £42,800, expenditure £24,800; Perth Electric, £28 increase; Port Elizabeth (month of October), receipts £3,832, expenditure £2,095.

Glasgow.—The Parliamentary Bills Committee of the Corporation recommend, subject to the approval of the Tramways Committee, that the amount of additional borrowing powers to be applied for tramway purposes should be £200,000. This sum is required to meet the cost of various tramway extensions, the proposal being to carry the service from Dumbarton-road to the Clydeside. The route of the new line has not definitely been decided, but it is understood it will be either by Stobcross-street or Kelvinhaugh-street. The Town Council this week approved the provisional order to authorise the new lines proposed.

Lowestoft.—A representative deputation of ratepayers has met the Tramways Committee, and presented a petition protesting against the use of granite in the construction of the roadway beside the tramlines. Eleven double-deck and five single-deck cars and one track-sweeper are

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to be obtained, and the engineer has been authorised to appoint a clerk of works for the construction of the permanent way at a salary not exceeding £4 per week. The Corporation's offer of £500 for the purchase of the Drake and Gorham Syndicate's order for the construction of a light railway to Kessingland has been accepted provisionally upon terms being arranged.

Manchester.—In consequence of the opening of several new routes on the south side of the city the tramway receipts have increased in one week from £5,013 to £7,434. The snapping of an overhead trolley wire was the cause of a stoppage of tramway traffic in the centre of the city on Thursday last week. The official explanation is that when the car that caused the accident reached the corner of Liverpool-road the frog was put in operation, so that the car could proceed past the junction of the wires. The driver allowed the car to run a little too quickly when passing the junction, with the result that the head of the trolley pole caught the wire and brought it down.

Leigh (Lancs.).—The Town Council have refused to accede to the application of the South Lancashire Tramways Company for their consent to the extension by one year of the period of four years allowed by the company's Act for the construction of tramways within the borough. The company's further application for the consent of the Council to the construction of the tramways in the east and west parts of the borough has also been refused. The Corporation are themselves promoting a Bill in the ensuing session of Parliament for the construction of tramways within the borough, and will oppose the Bill now being promoted by the South Lancashire Tramways Company.

Christchurch (N.Z.).—We understand that the advisability of utilising the Waimakariri River for purposes of municipal traction is being urged with great emphasis in Christchurch. An address on the subject has been delivered to the City Council by Mr. T. E. Taylor, who recently returned from a visit to Europe. During his stay on the Continent Mr. Taylor consulted Colonel Turretini, one of the greatest living authorities on such matters. As a result of Mr. Taylor's queries the Colonel made an offer to come to the colony and make an exhaustive examination and report for a sum of £2,250 in all. A member of the Council has given notice that he will move at next meeting to have negotiations opened up between the Council and Colonel Turretini.

Sheffield.—Major Pringle has inspected a number of additional lines laid down recently by the tramways department. These extensions are in several parts of the city, and a list of them shows that—the system now being almost complete so far as the centre of Sheffield and the suburbs within a couple of miles are concerned—the work of giving facilities to the residents in more remote parts is being pushed on. The town clerk has been instructed to draw a new set of by-laws adapted to electric traction and to existing conditions, especially in connection with the overcrowding of the tramcars. It has been arranged that the Tramways Committee shall subscribe £1,000 from the accumulated funds as a donation to the Yorkshire Agricultural Show, which is to be held in Sheffield next year.

Motor Traction Co.—The directors of the Motor Traction Company, Limited are proposing the reorganisation of the concern with the object of providing working capital and to put the Company on a thoroughly sound financial basis. It is proposed to form a new company with a nominal capital of £100,000 in shares of 10s. each, of which 100,000 will be cumulative preference shares, carrying 6 per cent. dividend and entitled to one-half the surplus profit after paying 10 per cent. on the ordinary capital, and having priority as to capital, and 100,000 ordinary shares. It is only proposed to issue at present 78,612 preference and 78,612 ordinary shares, credited in each instance with 7s. 5d. per share paid up, leaving 21,388 shares of each class for future issue.

South London Electric Railway.—It is stated that the directors of this railway are cherishing the idea of making the Bank Station a great junction for all the tube railways in the Metropolis, so that a passenger, having once gone underground, need not come up again till he has reached his destination. The Bill authorising the extension of the line from Islington to Euston will be reintroduced next session, and that line will provide a station at St. Pancras, with subways connecting it with the Great Northern, the Midland, and the Metropolitan stations. Several of the other tube lines will act as feeders to the South London line, and subways will make connection with them at various places, which will tend to greatly facilitate locomotion about the Metropolis. The company are also promoting an independent line at Brixton, practically a revival of the scheme known as the City and Brixton Railway.

Railway Signalling.—The Great Central Railway Company, in order to accelerate their main-line traffic, are reported to have just completed a contract with the British Pneumatic Railway Signalling Company for the installation of automatic pneumatic signalling through the celebrated Woodhead Tunnel between Sheffield and Manchester. It is one of the longest railway tunnels in Great Britain. Owing to the impossibility of "manning" a signal box in so unfavourable an underground position, Woodhead Tunnel, which is over three miles in length, has had to be worked as a single block section of the main line, expresses being consequently greatly impeded at this point, where traffic at all times is abnormally heavy. With the new signalling plant the Great Central Railway, by dividing the tunnel into sections of 1,200 yards long, will accelerate their express traffic between Manchester, Sheffield, and London.

Dundee.—A scheme for the utilisation of the electrical tramways for the carriage of mineral and heavy goods traffic is proposed. In a report to the Tramways Committee on the financial result of the working of the city's tramways from May to November, 1902, the tramway manager states that the working expenditure during that period was £21,201. 3s. 4d., being £512. 6s. 8d. less than the estimate. The revenue amounted to £21,313. 8s. 4d., or £1,059. 8s. 4d. better than the estimate. The working expenses applicable to the Constitution-road line, it is pointed out, will fall wholly against the second half of the year, and the revenue required to be earned during the same period so as to reach the estimate for the whole year is £21,552, or £124 more than the amount earned during the first half-year. This increase, the manager expects, will be realised by the addition to the receipts from the Constitution-road line.

Lincoln.—One of the main difficulties in the way of the compulsory purchase of the Lincoln tramways by the Corporation is reported to have been removed. Part of the undertaking is in Bracebridge, and although the Lincoln Corporation some time ago passed a resolution calling upon the company to sell to them within a given time that portion of the undertaking which is in Lincoln, the Bracebridge Urban District Council hesitated to pass a similar resolution with respect to the tramways at Bracebridge. The reason for this was that Bracebridge had no desire to work half a mile of tramway themselves, and they did not wish to purchase it and then find they had no power to resell it to the Corporation. They consequently declined to do anything until the law on the matter had been thoroughly ascertained, but on Thursday last week a special meeting was held, and after hearing a statement from the clerk the necessary resolution was adopted.

Light Railway Schemes.—The applications made to the Light Railway Commissioners on Nov. 29 for orders to authorise light railways are 20 in number, six of which are for amending orders for the purpose of extending the time for the compulsory purchase of lands and for the construction of the respective railways, for deviations, and for other purposes. The remaining 14 total to a mileage of 79¼ miles, and are estimated to cost for construction only the sum of £620,320. Electricity is proposed as the motive power in 11 cases, amounting to a mileage of 65¾ miles, steam in two cases of the total mileage of 11¼ miles, and in one case of 2¼ miles the motive power proposed is steam or electricity. The standard gauge of 4ft. 8½in. is proposed in seven cases of the total mileage of 50¼ miles, and the gauge of 3ft. 6in. in the remaining seven of a total mileage of 28¾ miles. Five applications, amounting to 17½ miles, are made by local authorities, and three applications, amounting to 19 miles, by existing great railway companies.

Salford.—The first portion of the tramways system which the Salford Corporation are about to provide within the area of the Prestwich District Council, has been opened for traffic. The Corporation have entered into an agreement with the Council to construct and work the lines in Prestwich for a period of 21 years. They propose to undertake a similar task in the district of the Whitefield Council, which lies to the north of Prestwich. These lines will eventually afford through communication between Salford and the Whitefield boundary, and at this latter point a junction will be effected with the electric cars of the Bury Corporation. The portion of track opened for traffic extends from the Salford boundary to the Prestwich railway station. It has been laid down and electrically equipped within a period of eight weeks. The work of carrying the line forward to Whitefield is to be commenced immediately, and the whole length of seven miles of track, to the far extremity of the Whitefield district, will probably be completed in a few months' time.

Bournemouth.—The provisional agreements made between the Corporation and the Poole and District Electric Traction Company, Limited, for the purchase by the Corporation of the undertakings of the company were approved by the shareholders of the company at an extraordinary general meeting held in London on Friday. On the same day the Poole Corporation expressed their willingness to acquire the tramways between Poole and Bournemouth, if the same could be acquired on reasonable terms, and appointed a committee to negotiate with the Bournemouth Corporation. The following new lines of tramways are nearly completed, and the Board of Trade has been applied to for an inspection at an early date: (1) from Lansdowne to County Gates, *via* Old Christchurch-road, Commercial-road, and Poole-road; (2) from the Square to the cemetery, *via* Richmond-hill and Wimborne-road; (3) from Holdenhurst-road to the cemetery, *via* St. Paul's and Lansdowne roads; and (4) from the cemetery to Holdenhurst-road, *via* Charminster, Capstone, and Durnford roads.

Paris.—The Paris correspondent of the *Financial Times* has sent the following interesting information to his paper: "In consequence of the ruinous loss of traffic by the horse tramway lines running along the outer boulevards as a result of the recent opening of the No. 2 Electric Metropolitan Railway, the Paris General Omnibus Company offered to reduce its fares if the authorities would allow the use of the overhead or trolley system of electric traction on the company's tramcars. It at once became evident, however, that the authorities were opposed to any disfigurement of the boulevards by overhead trolleys. It is true they at present tolerate the trolley in the centre of Paris on the Eastern Parisian Company's line, but only as a temporary measure, and because the underground tunnelling work for Metropolitan line No. 3 would have completely disorganised the 'contact' system employed on the Eastern Parisian Company's lines. In view of this strong opposition the Omnibus Company has decided to abandon the idea of competing with the 'tube' by means of electric traction, and has now applied to be allowed to use compressed steam. The struggle, however, which the Omnibus Company is now attempting to carry on against the 'Metro,' as Parisians call the new 'tubes,' is a hopeless one. It can never run its tramcars so rapidly nor give such a frequent service as the 'tube' does with its trains. The 'Metro,' too, is now in full public favour."

Manchester Southern Tramways.—Several letters have appeared lately in the local papers with reference to the provision of electric tramways in the districts which surround Manchester. On the one hand, there are those who are supporting the scheme of the Manchester Southern Tramways Company, which is an offspring of the British Electric Traction Company; while, on the other hand, there are as many who would like to see the local tramways in the hands of

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the local authorities. One of these latter, in a communication to the *Manchester Daily Dispatch*, urges that "the local authorities through which the proposed tramway is to run should do all in their power to check the progress of these companies, who, finding their powers frustrated in the large towns, are endeavouring to monopolise the roads of our suburbs for the making of wealth. The question is not whether the British Electric Traction Company, the Manchester Southern Trams, or any other company shall work it; they are all alike as far as the principle goes. But the vital point is: Shall our local authorities leave our roads to private companies for the benefit of a few individuals, when, as has been proved in dozens of cases, the ratepayers (if municipalisation takes place) have better advantages too well known to repeat here; whilst the profits which would otherwise go into the pockets of the shareholders are being used to the advantage of the whole community?" This is answered by a letter from Mr. Alf. M. Fowler, M.I.C.E., in the same paper, who contends "that a reliable public company can better serve the district through which the tramway passes than several small local authorities combining together, as such combinations result in delay, expense, inconvenience, and difficulty in subsequent working." In conclusion, he asserts that "tramways in some districts would never have been introduced if they had waited for the wakening up of small local authorities to combine, and, further, in some cases, local authorities are quite prepared to allow a public company to lay down tramways when a doubt exists as to their pecuniary success."

South Lancashire.—A report just issued by the directors of the South Lancashire Tramways Company gives a good idea of the company's operations up to Oct. 31 last. During the period covered by the report the constructional work has proceeded with as much expedition as circumstances permitted. Some delays occurred in the conduct of negotiations with various local authorities in the acquisition of property required for road widening, and in the completion of engineering contracts. These difficulties have now been almost entirely overcome. Several sections of the tramway system have been opened for traffic, and other sections are in an advanced state and nearly ready for public use. The section from Knotty Ash to Prescot (establishing communication between Liverpool and St. Helens) was finished in January last, and passed by the Board of Trade in April. It was not until the end of June that the Corporation of Liverpool joined up the city lines to those of this company. Since the line has been working the traffic receipts have been highly satisfactory. The next section taken in hand (covering about 25 miles of track) extended from Bolton through Atherton and Leigh to Lowton, and from Tyldesley through Atherton to Hindley, and thence through Ashton-in-Makerfield to Haydock. The construction was begun in October, 1901, but the causes already indicated considerably delayed the progress of the work. The Bolton-Lowton and the Tyldesley-Atherton sections were passed by the Board of Trade Sept. 25, 1902, and the cars commenced to run on Oct. 20. The directors believe that the service has given entire satisfaction to the people of the district. Considering the inclement weather the receipts have been good. The further sections joining up the system with St. Helens at Haydock are in a forward state, and will be ready for use in a few weeks' time. There will then be in operation a direct tramway service between Liverpool and Bolton, *via* St. Helens and the company's trunk line. The generating station and car-shed at Atherton are finished as regards buildings necessary for the present requirements. The greater part of the electrical equipment has been installed and is at work. The sub-station at Hindley is making good progress. The company have given notice of an application to Parliament in the ensuing session for a Bill to amend and enlarge some of the company's powers.

London County Council.—The County Council on Tuesday accepted the tenders of Messrs. Dick, Kerr, and Co. and Messrs. J. G. White and Co. for road work and platelaying in connection with the reconstruction of further portions of the southern tramways. The full list of tenders received will be found elsewhere in this issue. The report which the Highways Committee presented to the Council on the subject showed that the chief engineer has reported fully to them on the first four tenders, and has asked their special consideration to those of Messrs. Dick, Kerr, and Co. with Lorain special work, and of Messrs. J. G. White and Co. with Hadfield special work. These tenders are from firms quite competent to carry out the work; and, while Messrs. Dick, Kerr, and Co.'s tender is the lowest in amount and they can start the works within four weeks from the date of the order to commence, that of Messrs. J. G. White and Co. is the most favourable as regards time, as they are in a position to commence within three days of the order being given, and the rate of progress guaranteed by them is better than Messrs. Dick, Kerr, and Co. can undertake shall be kept up. Messrs. White and Co. have further, in a letter sent in with their tender, offered to deal, in a rather more complete manner than was provided for in the specification, with the existing tramway traffic during the reconstruction of the lines. The engineer has reported to the committee that, after going into the questions of both time and money, he finds that there is little to choose between the respective tenders of Messrs. Dick, Kerr, and Co. and Messrs. J. G. White and Co., and he has expressed the opinion that the best interests of the Council would be served if the work were to be divided into two portions, and one given to each of those firms. A considerable saving of time will be effected by the adoption of this arrangement, for under it the whole of the works are to be completed by Sept. 1, 1903, while the original specification provided that the tramways from the Elephant and Castle, *via* Old Kent-road, etc., to East Greenwich, should be completed within 42 weeks, and those from the Elephant and Castle, *via* Walworth-road, etc., to New Cross-gate, within 52 weeks from the date of the engineer's order to begin, which would make the dates for completion Oct. 16 and Dec. 31 respectively. The original specification also provided for a bonus of £500 a week for the completion, in less than the time specified, of each of the two portions of the tramways, and for a penalty of like amount for non-completion within the time; and the committee propose that, having regard to the altered circumstances, this amount should be reduced to £100 in each case. As regards the price to be paid for the work under the respective contracts, Messrs. Dick, Kerr, and Co.'s original tender, providing for Lorain special work, was £208 218. 19s. 5d., and Messrs. J. G. White and Co.'s original tender, providing for Hadfield special work, was £216 630. 10s. 4d., the mean of the total of the two tenders having been £212,424. 14s. 10d. These firms have at the request of the committee submitted fresh tenders, as follows, for the respective portions of the work which they suggest should be entrusted to each, and the amounts of these tenders are: Messrs. Dick, Kerr, and Co.'s £102,066. 2s. 11d., and Messrs. J. G. White and Co.'s £109,679. 18s. 6d., making a total of £211,746. 1s. 5d. These have been accepted. It will be necessary, in connection with the pending reconstruction, for electrical traction, of further portions of the Council's tramways, to arrange for the supply of additional quantities of rails, etc., supplementary to those which are being supplied under the existing contract. The quantities now required are approximately—track rails, 2,245 tons; slot rails, 1,470 tons; conductor tees, etc., 580 tons; together with the necessary soleplates, fishplates, and bolts and nuts. The Highways Committee accordingly recommended that tenders for these articles be invited by public advertisement, and that they be authorised to open the tenders during the Christmas recess, and accept those which may be the most advantageous In connection with the reconstruction of the New Cross and Greenwich lines the committee recommended the expenditure on capital account of £3,000 for the employment of temporary assistants and a staff to supervise the outdoor portion of the work. Reporting on the contract for switchboards for sub stations which had been let to Messrs. Cowans, Limited, the committee recommended that this firm be allowed to sublet the manufacture and supply of parts of the work to others than the firms originally specified, subject to the consent of the Council's engineer. The total capital expenditure proposed under the Council's Tramways and Improvements Bill for next session is £1,254,000.

LIGHTING AND GENERAL.

Harrogate.—The public electric mains are to be extended.

Bangor.—The total lamps connected at the end of October were 7,705.

Bolton.—The electrical engineer has been empowered to engage a junior assistant at once.

Lyndhurst.—The Lyndhurst electric lighting order has been extended for three months.

Swindon.—Mr. R. W. Grubb, M.A., of Eastbourne, has been appointed assistant electrical engineer.

Eccles (Lancs.).—Electricity for lighting purposes is now being supplied through penny-in-the-slot meters.

Boston.—At the last Council meeting notice was given of a resolution with regard to lighting the town by electricity.

Dorchester.—The Town Council are consulting Mr. Enright with regard to a proposed installation of electric lighting.

Luton.—Tenders will be called for the supply and delivery of the necessary distributing mains, estimated at about £2,000.

Tonbridge.—Current was started at the electric light works on Saturday, and the greater number of the customers were supplied.

Colchester.—The Council have decided to apply for sanction to borrow £7,000 to purchase additional plant for the electric light station.

Slough.—The Uxbridge and District Electric Supply Company intend to apply for a provisional order for extending to Gerrards Cross and Fulmer.

Grantham.—The Town Council have adopted the free wiring rules proposed under their agreement with the Urban Electric Supply Company, Limited.

Leigh.—A committee of the Urban District Council met a committee of the Southend Corporation on Dec. 5 to discuss a joint electric lighting scheme.

Greenock.—The Corporation have appointed Mr. James A. Robertson, Dumbarton, chief electrical engineer for the burgh at a salary of £250 per annum.

Hastings.—An electric light main is to be extended at a cost of £114. The recent extensions in connection with the electricity works will be opened on Dec. 16.

Coalville.—It is stated that the Post Office authorities will in the near future establish telephonic communication here, at the rate of £4. 10s. per subscriber per annum.

Dundee.—Mr. W. H. Tittensor, electrical engineer, having been offered the appointment of electrical engineer of Preston, steps are to be taken to appoint a new engineer.

Award.—We are informed that Messrs. Johnson and Phillips have just been awarded a medal for their enclosed "Ark" lamps by the Royal Cornwall Polytechnic Society.

Sleaford.—The Urban District Council intend to apply for power to borrow £2,000 to procure additional engines and dynamos to meet the increased demand for electric light.

Bury.—The extension of electricity supply to Tottington and Ramsbottom is under discussion. The former Council have applied for terms and the latter are being asked to join.

Chichester.—The drafts of the agreements with the electric lighting company which proposes to embark on a scheme for the city will probably come before the next meeting of the Council.

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Rival Cables.—The Eastern Extension, Australasia, and China Telegraph Company have opened public offices in Sydney, Adelaide, and Perth for the collection and delivery of their telegrams.

Whitefield.—The Lancashire Electric Power Company intend to apply to Parliament for powers to acquire Whitefield's electric lighting order, and the matter will come before the next Council meeting.

Wokingham.—The Town Council have agreed that the present automatic light controllers now in use are not satisfactory, and the company has been informed that the whole number must be replaced.

Walsall.—The Council have decided, on the recommendation of the Electric Lighting Committee, to sanction an expenditure of £10,050 to extend the electric lighting mains in the Mellish-road and Caldmore districts.

Pocklington.—The York Electrical Company has submitted a scheme to the Board of Trade for lighting the town by electricity. The Urban District Council will shortly discuss the matter with the electrical company.

Worcester.—Details relative to the application for parliamentary powers being made for the Shropshire, Worcestershire, and East Denbighshire Electrical Power Company are before the General Purposes Committee.

Stockton.—The electricity rental to Sept. 30 amounted to £844. 11s. 1d., as compared with £598. 17s. 4d. for the corresponding period of last year. The new electrical plant will be laid down during the present month.

The All-British Cable.—The Pacific cable, which has been in use for some time past for the transmission of private messages, was opened for public traffic on Monday. The occasion was not marked by any special ceremony.

Eton.—The Urban District Council have decided to allow the Windsor Electrical Installation Company to work and run the machinery at the pumping station by electric power instead of steam as an experiment for six months.

West Indian Cable Rates.—The rate for cabling between Cuba and this country is 1s. 10d. per word, against 3s. per word to Jamaica, which is only 100 miles further. The rate to Demerara is 7s. per word, against 3s. per word to New Zealand.

Agency.—We are informed that Messrs. T. Harding Churton and Co., of Atlas Works, Leeds, have appointed Mr. Robert Jones, of Swansea, to represent them for the sale of their dynamos and electric motors in South Wales and Monmouthshire.

Bristol.—The Electrical Committee of the City Council have appointed a sub-committee to watch the proposals of the Somerset and District Electric Power and Light Syndicate, who propose to establish their generating station at Radstock.

Diary.—We have received from McCorquodale and Co., Limited, the 1903 "Railway Diary and Officials' Directory," and also a copy of "The Railway Almanack" for the ensuing year. This useful publication maintains in shape and contents its usual high standard.

St. Annes.—The electrical engineer has submitted two estimates for the additional plant required to enable him to efficiently supply the tramways company with electricity for working their tramways. A special meeting will be called at an early date to consider the whole question.

Barnstaple.—The Town Council have purchased the Town Mills and the mill leat connected with the property. It is believed that the property will provide ample water supply for electric light purposes, and will also be of great advantage to the Council for general purposes.

Bushbury.—The workmen employed at the Electric Construction Works, Bushbury, held a dinner on Saturday at Wolverhampton, followed by a vocal and instrumental concert. During the evening Mr. J. Ganley presented the conductor (Mr. Charles Evans) with a silver-mounted ebony baton.

Whitby.—The Urban District Council in consolidating their electric loans have received sanction to the borrowing of £20,073 for the purpose of paying off the outstanding balance of a loan of £20,500 raised under the sanction issued by the Board on May 29, 1900, to the borrowing of £26,000 for purposes of electric lighting.

Perth.—A proposal to extend the electric plant owing to the increased demand for light, and in view of the probability of requiring at an early date electric energy for the tramways, has been remitted by the Electric Lighting Committee to the Town Council in committee for consideration. The extensions are estimated at £4,975.

Kilmarnock.—At a mass meeting of the ratepayers on Wednesday a resolution was carried expressing approval of an electric lighting and traction scheme, but disapproving of any scheme being undertaken by the Corporation until they had invited and considered proposals from private companies. A *plébiscite* of the ratepayers is also to be taken.

Coventry.—The electric light undertaking continues to make steady progress. The report for November shows that 53.885 units were sold, as against 46.351 for the corresponding month of last year. The National Electric Wiring Company have written terminating their agreement with the Corporation for free wiring at the expiration of six months.

Bermondsey.—At the last meeting of the Borough Council a letter was read from the School Board for London stating that the Works Committee did not propose at present to light with electricity any of the schools in the area of supply by the Bermondsey Council. Alderman Dumphreys said he had a notice of motion on the agenda paper of the Works Committee of the School Board which, if carried, would result in the electric light being installed in all schools where alterations or enlargements were being carried out.

London County Council.—At Tuesday's meeting the offer of the National Telephone Company, already reported in these columns, was accepted. The following notices under Electric Lighting Acts and Orders were agreed to: from the Lewisham and District Electric Supply Company, of intention to lay low-tension mains along a portion of Loampit-vale; the Metropolitan Electric Supply Company, to lay low-tension mains along a portion of Oxford-street; and the Woolwich District Electric Light Company, to lay mains along Beresford-place.

Sunderland.—An enquiry will be held to-day by Colonel Hepper into the application of the Town Council for sanction to borrow £74,000 for the purposes of electric lighting. It has been decided to obtain two motors and a distribution board for power circuit for the technical college, at an estimated cost of £163. The court-yards, cross-streets, staircases, and the living-room in each tenement in the workmen's dwellings, Hat Case area, are to be lighted by electricity, the current to the tenements being supplied through penny-in-the-slot meters.

St. Marylebone.—The arbitration proceedings in connection with the purchase of the Metropolitan Electric Supply Company's local undertaking by the Marylebone Borough Council were resumed on the 10th inst. The referee's award will probably be announced in January next, after which the subject will be discussed by the Council. From floating reports it appears that Messrs. Debenham, Leaf, and Co. are confident that the final award will be more favourable to the Council than to the company, and that the amount which the ratepayers will have to pay for the municipalisation of the local electricity supply will be less than three-quarters of a million sterling. This would be a great drop from the company's estimate of over £2,000,000. On Thursday the Council consented to the laying of various mains by the said company.

South Africa.—The Durban Town Council require tenders for telephone material. The Durban Port Advisory Board are considering the installation of telpherage for the handling of cargo. The *British and South African Export Gazette* says: "Among the new municipal electric lighting schemes on foot is one for lighting Salisbury, Rhodesia, at an estimated cost of £50,000, Mr. Crawford Lindesay, the town engineer, having prepared the plans. The Mowbray Town Council, being dissatisfied with the light supplied by the local company, have decided to call for tenders for the lighting of the town on the termination of the existing arrangements. The terms of the offer by the De Beers Company to supply current to Kimberley not giving complete satisfaction, the Town Council have decided to carry out the previously contemplated extension of its own plant. A sum of £17,000 is to be expended on the new works. The authorities of Greytown, Natal, are likewise contemplating the inauguration of an electric lighting service." The Kimberley Borough Council require electrical plant for lighting extensions.

Hackney Electricity Works.—We have received from Mr. L. L. Robinson, borough electrical engineer of Hackney, an abstract and analysis of the accounts of the electricity department for the period of 11 months ended Sept. 30 last, as follows: capital expended at end of period, £207,722; revenue from electricity supply—private lighting £7,528, public lighting £3,931 (£11,459); revenue from meter rents, etc., £147; total revenue, £11,606; total working expenses, £4,969; gross profit, before providing for interest and repayment, £6,637. Interest on loans, etc., amounted to £6,710, the financial result being a deficit of £73. The following items are also given in the accounts: capacity of dynamos, 1,800 kw.; maximum load reached, 996 kw.; load factor, 11·6 per cent.; number of 8-c.p. lamps connected at end of period, 52,451; number of units generated, 1,137,330; number of units sold—private supply 512,954, public supply 413,125—total, 926,079; average price obtained—private supply 3·53d., public supply 22·8d., combined 2·97d. An analysis of costs is as follows: fuel and heat, £2,031 (cost per unit sold, 0·526d.); oil, waste, water, and stores, £205 (0·053d.); wages of workmen, £1,196 (0·310d); repairs and maintenance, £223 (0·058d.); total works costs, £3,655 (0·947d.); management expenses—salaries, rents, rates, and taxes, etc., £1,314 (0·343d.); total costs, £4,969 (1·290d.).

Ormskirk.—The Urban District Council have informed the Southport Corporation that owing to the refusal of the County Council to give permission to lay the cable the Council regretted it was unable to proceed further with the negotiations, and desired to thank the Electricity Committee of the Corporation for their offer and the assistance they had given to the Council in the matter. The Electric Lighting Committee were at the last meeting of the Council empowered to take such steps as they thought necessary for obtaining offers for the disposal of the Council's provisional order. It was also explained what had been done towards endeavouring to obtain a supply of electric light in Ormskirk. In January last the committee received a report and estimate from Messrs. Trentham and Peers, electrical engineers, of Manchester, as to the probable cost of lighting the town by electricity. Their estimate for a complete scheme amounted to about £15,000. Assuming that the Council obtained the sanction of the Local Government Board to borrow this amount, it would practically swallow up the whole of their borrowing powers. At the present time the Council has to provide a further supply of water for the town. They also contemplate laying-out a recreation ground. In April last the committee received a report from the Southport Corporation in which was stated the terms and price per unit they would be prepared to supply the electric light to Ormskirk. Subsequently the ratepayers were circularised, and very satisfactory replies were received. However, the necessary consent of the County Council towards laying a cable from Southport to Ormskirk could not be obtained, and the Electric Lighting Committee had been reluctantly compelled to advise the selling of their provisional order under certain conditions. They wished to safeguard themselves in these respects: that the price per unit to be charged should be fixed; that certain arrangements should be made as to the breaking up of the streets; and that the Council should have an opportunity at any future time of buying back the electric light plant at a price to be fixed.

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Middlesbrough.—The struggle for supremacy between electricity and gas for the purposes of street-lighting is still going on. At the last meeting of the Watch Committee the electrical engineer and the gas manager presented reports in advocacy of their various systems, and the committee deferred the final consideration of the matter until their next meeting.

Stafford.—The Electricity Committee are making an alteration in the charge for motor purposes. The existing charges for current will be revoked and the following scale substituted: consumption per quarter per horse-power—for the first 200 Board of Trade units, 2½d. per unit; for quantity exceeding 200 Board of Trade units, 1d. per unit, subject to 2½ per cent. discount for cash.

Electric and General Investment Co.—The directors have declared the following interim dividends: at the rate of 6 per cent. per annum on preference shares for the six months ending the 31st inst., being 3s. per share; 10 per cent. on the capital paid up on the ordinary shares, being 2s. per share for the six months ended the 30th ult. Both dividends will be paid, less income tax, on Jan. 1, 1903.

Stroud.—The resolution that application be made for a provisional order enabling the Council to supply electricity for all public and private purposes within and throughout their district, to approve form of draft provisional order which has been prepared and deposited at the Board of Trade, subject to such additions, alterations, and variations as the Board of Trade or Parliament may think fit to make therein, has been sealed.

Battersea.—Electric distributing mains and arc light leads are to be extended at a cost of about £900, and 3,000 yards of ·10 square inch cable procured of Callender's Cable and Construction Company at a cost of £201. Application is to be made to the London County Council for sanction to the borrowing and the advance of the sum of £523. 12s. 7d. to defray the cost of wiring and fitting up the Council's stores and workshops at Battersea Park road for the supply of electric light.

Llandilo.—It is stated that an electric lighting plant for 1,000 8-c.p. lights only has been obtained. Now the works are supplying up to 1,900, so that no more applications for current can be entertained. The demand is now up to 120 amperes for the light, and only 130 can be supplied. The question of obtaining new plant, for which the contractor of the installation has submitted a tender for £985, and another for £1,100, is left in abeyance until Mr. Howell has been consulted.

Wireless Telegraphy.—It is stated that the Marconi Company has communicated to Sir Edmund Barton an offer to establish wireless telegraphy between Australia and New Zealand, the tariff to be 4d. a word Sir Edmund is averse to private competition with the Commonwealth Telegraph Department, but he is in correspondence with Mr. Chamberlain on the subject. A similar installation is mooted for the West Indies, owing to the heavy cable rates—referred to in another paragraph.

Doncaster.—The borough electrical engineer in his last report gives the following details: Number of applications received since Oct. 6, 1902, up to the present date 21, being equivalent to 588 8-c.p. lamps; number of consumers on books, 236; number of 8-c.p. lamps applied for up to present date, 15,894; number of 8-c.p. lamps connected, 15,206; number of 8-c.p. lamps awaiting connection, 688; number of consumers awaiting connection, 10. The extension of several electric cables has been agreed to.

Chesterton.—The Urban District Council have consented to the grant by the Board of Trade to the Cambridge Electric Supply Company, Limited, of a provisional order to authorise the said company to produce, store, supply, sell, transmit, and distribute electricity for all public and private purposes as defined by the Electric Lighting Act, 1882 and 1888, and the Electric Lighting Clause Act, 1899, within the area of the parish and Urban District Council of Chesterton, in the county of Cambridge.

Hull.—At the last meeting of the Council the following resolution was proposed: "That, in view of the uncertainty as to the financial results of the establishment of a municipal telephone service in Hull at the rates proposed, no further steps be taken in the matter, unless those who have undertaken to become subscribers will also undertake to pay such higher rates (if any) as may be found necessary to prevent the undertaking becoming a burden on the rates." The motion, however, was not seconded.

Tunbridge Wells.—According to the last advice, no reply has yet been received from the Postmaster-General in reference to the proposed transfer to the National Telephone Company of the borough telephones. The Telephone Committee have decided that "all constructional work be suspended for the present"; and the committee further reported to the Council that they had instructed the telephone manager to incur no further expenditure whatever on capital account, except what was absolutely necessary, until further instructed by the committee.

Arbroath.—The Council have decided to inform the Board of Trade that, partly owing to the existing depression of trade in Arbroath, but more particularly on account of the town having been obliged to take up the question of a gravitation water supply for the burgh, and being now pressed by the Local Government Board to proceed with it, the Council deemed it inadvisable to carry out in the meantime the Arbroath electric lighting order, but they desired that the Board of Trade would allow the order to remain in force until the town's water supply had been dealt with and completed.

Walsall.—The Electric Lighting Commistee in their last report recommend the extension of mains in Mellish-road and Caldmore districts, at an estimated cost of £5,700 and £650 respectively, that a sub-transformer station, with the necessary equipment and feeders, be provided for the Highgate and Caldmore districts at an estimated cost of £3,700, and that application be made to the Local Government Board for a loan of £10,050 to defray the cost of carrying out the foregoing works. A further recommendation by the commiteee is that the electric lighting mains be laid in Belvedere-road at an estimated cost of £200.

Works Extensions.—We are informed that the Sun Fan Company, Limited, Longside-lane, Bradford, have extended their works and plant by the addition of another building so as to more than double their capacity, and have removed their head office to the works, to which in future all communications should be addressed. Messrs Nalder Bros. and Thompson, Limited, 34, Queen-street, London, E.C., have extended their works and plant at Dalston, notably in making provision of several automatic machines for making screws and turned parts, owing to considerable increase in business. At the same time the firm have provided a dining-room as an adjunct to a canteen which they have in those works.

The Underground Strand.—It is stated that a short section of 130 yards of the Strand between Charing Cross Station and Agar-street is honeycombed by no fewer than 22 "mains," to say nothing of some 2,500 side connections. These mains are apportioned as follows: Post Office cables, 8; Charing Cross and Strand Electric Supply, 4; Metropolitan Electric Supply, 2: London Electric Supply, 1; "live" water-mains (New River Company), 3; gas-mains (Gas-light and Coke Company), 2; London Hydraulic Power, 1; main sewer, 1. In addition there are in this short distance 100 manholes and 11 "dead" pipes and mains.

Bradford.—The Cleansing Committee of the Corporation propose to combine the production of electricity with the destruction of refuse at the Sunbridge-road works, and to use the electricity so generated for the lighting of portions of Sunbridge-road and supplying current for the Sunbridge-road trams. A scheme involving an expenditure of £8,000 has been referred to the chairman and deputy-chairman of the Electricity Committee and the chairman and deputy-chairman of the Cleansing Committee for further consideration. It is estimated that there is sufficient waste potential power at the works to generate 1,000,000 units of electricity per quarter.

Swansea.—The Corporation Telephone Committee have decided to proceed with the telephone service forthwith in the borough proper and the Mumbles. The last report of the engineer showed that the number of consumers was 289; number of equivalent 8-c.p. lamps on the books is 38,588; the number of consumers actually connected to the mains is 247; and the number of consumers who had applied for supply since the last report, 38; making a total of 9,283 8-c.p. lamps applied for. A new 300-kw. steam generator supplied electricity to the whole of the borough for the first time at the end of last week, and a second one of equal capacity is being tested.

Russia.—The St. Petersburg correspondent of the *Financial News* states that the Russian electrical factories of Messrs. Siemens and Halske, which work with a capital of 7,000,000 roubles, have closed their business year 1901-1902 with a net loss of 299,690 roubles, 60 per cent. of which must be put to the account of branches in Russia. Last year there was a dividend of 2½ per cent. The last report characterises the present state of the electrical industry in Russia as extremely unsatisfactory, and states that no improvement can be expected unless greater facilities in the Russian Custom and railway system are granted to this industry. With the exception of one or two specialities, all electrical products would otherwise have to be imported from abroad.

Grimsby.—The borough surveyor (Mr. H. G. Whyatt) and the electrical engineer (Mr. W. A. Vignoles) have presented a report to the Destructor Sub-Committee relative to risk that might ensue to the chimney for the electricity works and the destructor from heat from gases. They lay down measures to be taken for safety, and say there need be no necessity for outlay on a firebrick lining. Regarding the sale of steam to the Electricity Committee, a reasonable payment would be ¼d per unit, which for 300 working days per year would represent £125 per annum. They also recommend that as one-third of the total cost of the sum of £2,273 expended on the chimney was due to the provision made for the destructor, the Destructor Committee should pay one-third of that total.

Southwick.—The committee who have had under consideration the application of the Brighton Town Council for permission to tunnel under the Southwick Canal and to construct a 7ft. subway to the electric power station for the purpose of carrying their electric cables and providing means of crossing for their workmen and others have resolved: "That, having regard to the fact that the trustees were put to an unnecessary expense to preserve their rights when the Corporation promoted their Electricity Bill (which has not yet been paid by the Corporation), the trustees cannot consent to the tunnel being made till such time as the Corporation enter into an agreement with the trustees to pay all costs in connection with preserving the trustees' rights if necessary, and also to indemnify them against any injury to the harbour or vessels using it."

The May-Oatway Fire Protection and Glasgow Fire Brigade. According to the *Glasgow Evening News*, the decision of the Fire Brigades Committee of the City Council, upon the advice of Captain Paterson, to allow ratepayers whose premises are protected by Messrs. May and Oatway's automatic system of heat telegraphy to be placed in direct communication with the central fire station is evidently popular, and is leading to a steady improvement of the fire risks of some of the most important blocks in the city. The same paper gives a number of installations, amongst which we note that Messrs. Arthur and Co. are equipping the whole of their mammoth warehouses, and the shops from 48 to 108, Queen-street, and from 223 to 245 in Ingham-street. This will constitute a record, as being the largest warehouse installation of automatic alarms in the kingdom

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Llanelly.—At a recent meeting of the Property and Estate Committee of the Urban District Council it was stated, in reply to a question as to the present position of the electric lighting and traction schemes, that the wire company were making every endeavour to get others to take over their obligations, and that the tramway company were pressing the wire company to complete their contract. The scheme of the Carmarthenshire Electric Power Company was entirely separate from the local undertaking. The town had certain rights in regard to electric light and power under their provisional order and the light railway order. The promotors of the Bill for the county did not seek to interfere with the existing rights of the town. It was suggested that the Council should wait until the Bill was deposited, and then approach the county promoters and explain their powers and obtain such protective clauses as they deemed necessary.

Spain.—A dispatch has been received at the Foreign Office from the acting British consul at Corunna, calling attention to the absence of electric appliances of British origin in that town, where two companies producing electricity for the lighting of the city are established. The acting consul gives the names of some firms in Corunna to whom British manufacturers of dynamos, motors, arc lamps, projectors, etc., lighting, power, and traction plant would do well, it is said, to send their catalogues (in Spanish). He adds that a syndicate has been formed to establish a company to compete with the other two companies mentioned above in producing electricity for the lighting of the town. Communications should be addressed to the Director Senor Don Diego Fernandez Herce, Calle Real, La Coruna. According to the acting consul, it is important that, in giving prices for lighting plant and other machinery, these should be quoted c.i.f. Corunna.

Northfleet.—At the last Council meeting a letter was read from the Gravesend Corporation, stating that if the Council would state their requirements with regard to electric light, the Corporation would be prepared to enter into negotiations for the supply of current. The letter will be considered at the next meeting. The Kent Electric Power Company have been asked to submit any proposals which they had to make for the working of the Council's electric lighting order as soon as possible. Referring to the extent to which the light from some of the public lamps was obscured by the poles erected by the tramway company, the Surveyor stated that the experiment tried by him of affixing lamps to the tramway poles had turned out to be not satisfactory, owing to the vibration created by the cars when passing. The surveyor was directed to shift the lamp columns that were in close proximity to the tramway poles to more suitable sites at a greater distance away from such poles.

Darlington.—Mr. J. R. P. Lunn in his last report states that the number of units generated in September was 16,750, as against 12,008 last year, showing an increase of 4,742, or 39½ per cent. Application had been received from 27 intending customers, who would require 1,890 8-c.p. lamps. During the month 182 yards of distributing main had been laid in Kendrew-street and Polam Plantation. The electric lighting cable is to be extended in Clay-row and from Duke-street along Barnard-street. Sanction has been received to borrow £14,500 for the purpose of the electric lighting generating station extension; the committee will advertise for tenders to carry out the work. A second engine and dynamo will be purchased from Messrs. Parker and Sharp. At the anniversary services of the Paradise Sunday School, Darlington, a unique children's service was held, conducted entirely by the scholars, consisting of a series of addresses upon "Belief in God," and were illustrated by numerous electrical experiments The efforts of the scholars were much appreciated by the large congregation, and by desire portions of the service were repeated at the annual tea and meeting on Wednesday.

Cresswell.—The Parish Council have carried out a successful electric lighting scheme, which was inaugurated last Wednesday. The installation has been laid down by Messrs. John Davies and Son, electrical engineers, of Derby, under the superintendence of Mr. R. H. Haggie and Mr. W. H. Davis, jun. The power is supplied from the engine-house of the Cresswell Colliery Company, and consists of a high-speed vertical engine of 70 h.p., driving a four-pole generator. The mains are taken from the engine-room to a central pole in the village, from where the current is distributed. In all there are about 10 miles of cable. The lamps are 32-c.p. incandescents, and are fixed on creosoted poles about 100 yards apart. The lights are controlled from the engine-room by three main circuits, and provision is made for three more circuits when required. Under the railway bridge special provision is made to protect the railway company's wires. We believe this is the first time that the main roads of the Derbyshire County Council have been lighted by electricity, and as the power is supplied by a private company special permission had to be obtained from the Local Government Board by the Council. The installation has cost £650, and the cost will be met by a lighting rate of 3d.

Glasgow.—The first annual dance of the Corporation telephone employés took place under happy auspices at the Grand Hotel last week. The company numbered over 90 couples. About 11 o'clock the entrance of Lord Provost and Mrs. Primrose was the signal for applause, and his lordship later expressed the pleasure it gave him to be present. Introduced by ex-Bailie Alexander, who paid passing compliments to the lady operators, the Provost said that the telephone department was a body which showed evident signs of a very active and virile youth, and offered every prospect of a middle age and manhood of great power and strength. The enterprise had been entered upon with some diversity of opinion as regarded the constituent members of the Town Council. There was now, however, only one desire in the municipal circle, now that it had been decided that it was a legitimate and proper sphere for corporate effort, to put their shoulders to the wheel in order to see it triumphantly carried through. At the present moment there were 7,300 telephones working, while there were 1,250 on order at the present moment, making a total of 8,550. It was perfectly reasonable to suppose that within a year 10,000 subscribers would be obtained for the system, producing an income of £50.000 a year, or an amount which, on a reasonable calculation, could justify the predictions of the most sanguine advocates of this venture in municipal life.

Tiverton.—A scheme for lighting Tiverton by electricity, to be worked in conjunction with the Corporation gasworks, was recently laid before the last meeting of the Town Council by their engineer, Mr. J. Siddalls; but before deciding on adopting it, it was thought advisable to see upon what terms outside companies would instal the light. Messrs. Crompton and Co. have offered to find the capital required, pay £300 towards the cost of the provisional order, £30 a year rent for a site near the gasworks, and £50 a year for the monopoly, the Council having the right to take over the undertaking at any time after seven years at a valuation as a going concern. Christy Bros. and Middleton will find capital, pay £400 towards the provisional order, buy half the site for £150, and hand over to the Council all profits after paying a 7 per cent. cumulative dividend and forming a reserve fund. If the Council, after 14 years, should want to purchase, it could do so by repayment of all capital expended and a premium of 20 per cent. Messrs. Christy asked for a partnership of 21 years, the profits to be divided during that time (Messrs. Christy taking two-thirds), and when the term expired the works would be the property of the Council without further payment. Messrs. Edmundsons' Electricity Corporation offered a partnership, the Council to find capital estimated at £20,000, to be repaid to the Council by yearly instalments to a sinking fund and for interest, the partnership to be for 25 years.

PROVISIONAL PATENTS, 1902

Nov. 27.

26164. Improvements in apparatus for automatically moving the points of tramway and railway lines, applicable also to switches on trolley wires for electric tramways. Albert King, 60, Wilford-grove, Nottingham.

26168. Improvements in combined lamp-holders and switches for glow lamps. Charles Henry Davies, 36, Temple-street, Birmingham.

26112. Electric tram pillar. James Rothwell, Ivy Cottage, Kirklees, Tottington, near Bury.

26141. Improvements in means for adjusting the distance between the magnet system and the diaphragm in telephones. Otto Köhler and Paul Behrens, 65, Chancery-lane, London. (Complete specification.)

26162. Improvements in electric conducting cables and process of making the same. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Russell Spaulding, United States). (Complete specification.)

26163. Improvements in electrical cut-outs. Evered and Co., Limited, and Stanley Evered, 7, Staple-inn, London.

26165. Improvements in rotary electric transformers. Fredrik Wilhelm Wülff, 18, Buckingham-street, Strand, London.

26190. Improved electromagnetic arrangement for preventing the collision of railway trains. Attilio Beer, 27, Chancery-lane, London.

Nov. 28.

26219. Improvements in electrical switches. Bertram Thomas and Charles Bourne, Cornbrook Telegraph Works, Manchester. (Complete specification.)

26222. The "non-hysteresis" unipolar dynamo or motor for continuous current. Andrew Dutczak, 65, Grafton-street, Tottenham Court-road, London.

26272. Improvements in alternate-current motors. Charles Antony Ablett, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

Nov. 29.

26341. An improved safety guard for use with overhead electrical tram wires. Herbert Frederick Hill, 37, Chancery-lane, London.

26347. Improvements in electric arc lamps. Henry Bevan Swift, 31, Waldegrave-road, Upper Norwood, Surrey.

26374. Improvements in electrical connecting terminals. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26375. Improvements in electrical connectors. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26376. Improvements in electrical switches. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26377. Improvements in electric igniters for gas-engines. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26378. Improvements in electrical connections or couplings. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26379. Improvements in magnetic clutches. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26380. Improvements in automatic electric potential regulators. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

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26381. Improvements in electric controllers. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26382. Improvements in electric rheostats. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26383. Improvement in electric field coils and methods of making the same. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26385. Improvements in electric arc lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26386. Improvements in electrical synchronism indicating apparatus. The British Thomson-Houston Company, Limited, Reginald Charles Clinker, and Edmund Basil Wedmore, 83, Cannon-street, London.

26388. Improvements relating to dynamo-electric machines. Secondo Sacerdote, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26395. Improvements in and relating to wireless telegraphy. Alessandro Artom, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

DEC. 1.

26409. Improvements in lighting public thoroughfares, streets, and places with electricity, gas, and other illuminants, and apparatus therefor. James Townsley Pearson, 8, St. James's Hall, Burnley.

26416. Improvements connected with railway and tramway points operated by or from the vehicles and in points or switches for use upon overhead conductors of electric railways and tramways furnished with points. Stanislas Zylberlast, 18, St. Ann-street, Manchester.

26419. Improvement in electrostatic voltmeters. George Walker Walker, Trinity College, Cambridge.

26420. Improvements in switchboard frames. John Grice Statter, Norfolk House, Norfolk-street, Strand, London.

26428. An electric railway engine and appliances attached thereto. No overhead wires or underground or ground appliances required. Henry Charles Mayer, 6, Carrington-road, Stockport.

26448. Improvements relating to secondary or storage electric batteries. Ernest Cyril McKinnon, 45, Southampton-buildings, Chancery-lane, London.

26455. Improvements in electrically-operated railway or tramrail point shifters and the like. Charles Alfred Meatchem, 7, Carmichael-street, Govan, Glasgow.

26476. Improvements in or relating to overhead conductors for electric railway and like systems. Coloman de Kandó, 111, Hatton-garden, London. (Complete specification.)

26477. Improvements in or relating to rotatory-current motors connected in cascade system. Coloman de Kandó, 111, Hatton-garden, London. (Complete specification.)

DEC. 2.

26508. Improvements in or relating to guide ropes for trolley poles for electric cars. John Millar, 115, St. Vincent-street, Glasgow.

26512. Improvements in perforators, more particularly for use with automatic telegraph transmitters. John Gell, 21, Finsbury-pavament, London.

26526. Arc lamp-post ladder. Alexander Whitie, 6, Old-change, Cheapside, London.

26541. Improvements in automatic non-interfering successive repeaters for fire-alarm circuits Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (The Gamewell Fire-Alarm Telegraph Company, United States). (Complete specification.)

26552. Improvements in selective signalling by electro-magnetic waves. Reginald Aubrey Fessenden, 24, South-ampton - buildings, Chancery - lane, London. (Complete specification.)

26553. Improvements in current-operated receiver for electro-magnetic waves. Reginald Aubrey Fessenden, 24, South-ampton - buildings, Chancery - lane, London. (Complete specification.)

26557. Improvements in and relating to electromagnetic traction increasing devices. Albert Alonzo Honey, 77, Chancery-lane, London. (Complete specification).

26585. Improvements in signalling apparatus for telephone systems. William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Edward Egan, United States.) (Complete specification.)

26586. Improvements in or pertaining to ship's telegraphs. Hermann Friedrich Wilhelm Lucke, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 24.

1901.

17482. Apparatus for electrically lighting railway trains. Gill.

24534. Fenders for electrically-propelled cars. Durose and Tortoiseshell.

24632. Field magnets of dynamo-electric machinery. Brown.

24686. Street lamp fittings for incandescent electric lamps. Hawtayne.

24737. Portable electric batteries or combined batteries and lamps. Sutherland and Marcuson.

24803. Controlling electric motors. British Thomson-Houston Company, Limited. (Buck.)

24804. Switching apparatus for alternating electric currents. British Thomson-Houston Company, Limited. (Hewlett.)

24807. Electric controllers. British Thomson-Houston Company, Limited. (Case.)

24809. Electric brakes. British Thomson-Houston Company, Limited. (Potter.)

24811. Controllers for electric motors. British Thomson-Houston Company, Limited. (Tirrill.)

25008. Electrical relays. Siemens Bros. and Co., Limited, and Gordon.

25186. Accelerometers. British Thomson - Houston Company, Limited. (Carey.)

25389. Removable covers for electric railway conduits. British Thomson-Houston Company, Limited. (Hild and Stewart.)

25821. Trimming for upholstering and the like, applicable as a covering for electrical wires and gas tubes. Hall.

25833. Method of supporting and joining the power wire for electric tramways or railways. Hewer.

25901. Section insulators for the overhead construction for electric tramways or railways. Loggey and Hewer.

25946. Brush-holders for dynamo-electric machines. British Thomson-Houston Company, Limited. (Baker.)

26137. Electric railways on a sectional conductor block system and signals therefor. British Thomson-Houston Company, Limited. (Potter.)

26232. Dynamo machines. Dumas.

26307. Message counters for telephone exchanges. Oppenheimer. (Actiengesellschaft Mix und Genest.)

26694. Electric circuit breakers. British Thomson - Houston Company, Limited. (Read.)

26696. Electric rheostats. British Thomson-Houston Company, Limited. (Hall.)

26697. Electric rheostats. British Thomson-Houston Company, Limited. (Yates)

1902.

868. Fitting and reflector for carrying electric and other lamps and lights. Stead.

1126. Methods of generating electrical energy. Wassilieff.

7860. Coin-controlled machines for giving electric shocks. New Polyphon Supply Company, Limited, and Schmidt.

16264. Electric switches and cut-outs. Dorman, Smith, and Baggs.

16896. Electrically-controlled semaphore signals for railways. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktiengesellschaft.)

17685. Electric energy meters for alternating currents. Blathy.

18465. Electric igniting apparatus for automobiles and the like. Klement.

19488. Electrolytic electricity meter. Y Hernandez, y Miura, de la Pena, and y Ortega.

20289. Telephone systems. Macadie.

20555. Electromagnets. Waterman.

22356. Retarding devices for use in connection with electrical measuring and like instruments. Benecke.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-⅝
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated and Helsby Cables, Ord., 1-70,000	5 ..	7½-8
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
—— (1902 Issue)	100 ..	100-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	101-103
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	2¾-3
—— 5 per cent. Debentures	100 ..	101-106 p.c
Edison and Swan United, "A" Shares, 1-99,261	3 ..	⅛-¼
—— "A" Shares, 01-017,139	5 ..	1½-2½
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-1¾
—— 7 per cent. Cumulative Pref.	2 ..	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102

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Name.	Amount paid.	Last price.
	£	£
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10½
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16½-17½
—— 4½ per cent. Preference	5	5½-5¾
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20¼-21½
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105

Electric Lighting and Supply.—

Blackheath & Greenwich District Ordinary 1,201-101,200	1	½-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	110-113
Bournemouth and Poole, Ordinary	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	10-11
—— Debenture Stock. Red.	100	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	101-104
Brompton and Kensington, Ordinary	5	10-10½
—— 7 per cent. Preference	5	10 10½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	6½-7½
—— Nos. 20,001-30,000	5	6½-7½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " " £10 Ord.	6	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	105-108
Charing Cross and Strand	5	9-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5½-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5½-6
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	124-129
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London and Brush Provincial, Ordinary	10	3¼-9½
—— 6 per cent. Cum. Pref.	10	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6-6½
—— 6 per cent. Cum. Pref.	5	6-6½
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3½-4½
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	6-6½
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	3	1¾-2¼
—— 6 per cent. Pref.	5	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	96-99
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	108-114
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9½
—— Preference	4	6½-6¾
Notting Hill Electric Lighting	10	14½-15½
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	3-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8½-9½
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3¼-3¾
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3¼-3¾
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	5	6-6½

Name.	Amount paid.	Last price.
	£	£
Electric Railways.—		
Central London, Ordinary	100	106-109
—— 4 per cent. Pref.	100	105-108
—— " " deferred	100	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-119
City and South London, Consolidated Ordinary	100	75½-76½
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	127-130
—— " " " '01	100	123-127
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	93-96
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	4¼-4¾
—— Permanent 6 per cent. Debenture Stock, 1888	100	127-132
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-3¾
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,500	10	9½-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12¾-13½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12-12½
—— 5 per cent. Perpetual Debenture Stock	100	123-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2-3
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4¾-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	96-98
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4¾
—— 4 per cent. Debenture Stock	100	96-98
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	11½-12
—— " " " "	10	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	106-107
—— " " Prov. Crts.	100	105-107
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	2¼-3¼
—— 5 per cent. Mortgage Debentures, 1-1,715 (Rsgd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¾-10¾
—— 5 per cent. Cum. Pref.	10	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	18s.	14/16-15/16
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	90 p.c.	90 p.c.
Telephones.—		
National Telephone, Preferred	100	92-94
—— Deferred Stock	100	62-64
—— 6 per cent. Cum. First Pref.	10	12¼-13¼
—— 6 per cent. Cum. Second Pref.	10	11¼-12¼
—— 5 per cent. Non-Cum. Third Pref.	5	5 5½
—— 3½ per cent. Deb. Stock, Red.	100	95-98
—— 4 per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	¾-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 29	839	628	+ 211	+ 6,630	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	Dec 6	4,826	4,785	+ 41	+17,124	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	,, 5	699	629	+ 70	+ 3,942	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	,, 4	267	222	+ 45	+ 369	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	,, 6	170	158	+ 12	− 172	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	,, 7	1,467	1,366	+ 101	+ 4,459	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	—	—	—	—	—	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57ᵃ
Bristol Tramways Company	,, 5	4,129	3,815	+ 314	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	8,675	2,010,873	323,044*h*	1·03	6·46	—	4·65
Central London Railway	,, 6	7,140	6,957	+ 183	+11,754*h*	12	12	,, 31	335,086	41,188,389	1,243,730*a*	1·88	64·29*a*	27,923	34·89*a*
City and South London Railway	,, 7	3,551	2,931	+ 620	+21,709	12½	9½	,, 31	62,601*a*	7,008,842*a*	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	,, 4	390	372	+ 8	+ 5,944	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	,, 6	159	170	− 11	+ 36	4½	—	,, 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	,, 7	83	85	− 2	+ 87*h*	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	,, 5	3,470	3,331	+ 139	+2,954	46	46	,, 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	,, 7	669	686	− 17											
Dundee City Tramways	,, 3	814	667	+ 147	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	,, 6	12,109	10,972	+1,137	− 6,952	104	95	,, 31	582,146*e*	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	—	—	—	—	—	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	,, 6	907	867	+ 40	—	48	48	Sept. 30	29,061*h*	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	,, 6	1,657	1,594	+ 63	+ 2,844	19	9½	,, 30	72,331*h*	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	Nov. 29	9,164	8,627	+ 537	+36,272	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	Dec. 7	1,470	1,417	+ 53	− 615	15½	15½	June 30	69,152	8,426,976	787,010*a*	1·97	21·07*a*	4,450	15·94*a*
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 7	3,746	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82*f*
Southampton Corporation	,, 4	895	702	+ 193	—	11	—	,, 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	,, 7	975	978	− 3	—	19	17	,, 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·3

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *d* Total receipts. *e* Electric traction only. *f* Including one section of horse traction.

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Supplement to "The Electrical Engineer,"

DECEMBER 12, 1902.

THE ELECTRIC NITRIFICATION OF THE ATMOSPHERE.*

BY WM. HAND BROWNE, JUN.

Nitrogen, although it is one of the most necessary materials for all animal and vegetable life, and constitutes about four-fifths of the earth's atmosphere, is, under ordinary conditions, one of the most inert elements, and cannot in general be used by these living organisms in its free state. There are, however, certain plants which have associated with them colonies of bacteria endowed with the ability to fix nitrogen—that is, to cause it to combine with other elements such as oxygen and hydrogen, and in this way it becomes available for vegetable food. The main supply of nitrogenous material upon which the plants draw is that formed by the decomposition of all animal and vegetable substances. Here a process similar to fermentation goes on, and the combinations containing nitrogen are converted into other forms, principally ammonia, nitrates, and nitrites, and are then suitable for vegetable food. These processes, however, are exceedingly slow and only sufficient to supply the demands of vegetable life under natural conditions. For this reason all waste animal and vegetable matter should be returned to the land to supply the needs of the living plants.

Under the conditions of our civilisation, where population is concentrated in small areas, this is not always done. Most of the refuse of our large cities is destroyed or thrown into the sea. Thus, not only have the fertile lands been exhausted, but the conditions which cause such great loss also call for forced production from the ground and increase the rate of deterioration. In addition to these losses there are 100,000 tons of nitric acid alone used yearly in the arts, and this is all prepared by treating a nitrate with concentrated sulphuric acid, and distilling. In this necessity for supplying the losses going on so rapidly, the vast deposits of guano, Chile saltpetre, and other fertilisers have been of incalculable benefit to the human race. These supplies, however, are not inexhaustible, and we are already beginning to see the end. Sir William Crookes, in his address on the wheat problem before the British Association in 1898, stated that unless artificial means for supplying this need were found within 30 years the wheat crop would not be sufficient for the needs of the race and we would be facing starvation. This startling announcement renewed interest in the problem of utilising the inexhaustible supply of nitrogen contained in the air. Much work had already been done in attempted solutions, and though combinations could be effected between nitrogen and oxygen, the processes were so inefficient and the output so small that the reaction was only of scientific interest.

The earliest record we have of the fixation of nitrogen is that of Priestley's experiment in 1785 of passing an electric spark through air contained in a tube. He found that a small quantity of the oxygen and nitrogen combined. Cavendish was one of the early investigators, and he, as all other workers on the problem, has made use of the same phenomenon. The first nitrifying chamber consisted of an inverted V-shaped tube. The upper portion of this contained air, and the legs were partially filled with mercury, upon which rested a layer of a solution of caustic potash. Platinum electrodes were passed up through the legs of the tube until the ends were close together at the top. Upon passing a spark between these, oxides of nitrogen were formed. These reacted with the caustic potash solution, forming nitrates and nitrites. As a scientific process this method is successful and of value. It was used by Rayleigh in his separation of argon to eliminate the nitrogen from the air. Practically, however, the process was too slow and inefficient to be used for the manufacture of compounds of nitrogen. Many attempts were made in the last century to make the process commercial, and various means were employed to cause the spark to pass. Static or influence machines were tried. The combined effect of spark and brush discharge was tested by Prim. Induction coils were employed, and a patent on this application was taken out by Newton as early as 1859. In 1892 Crookes tried high-tension alternating currents. None of these methods, however, promised success.

This was the condition of the problem when Mr. Charles S. Bradley and Mr. D. R. Lovejoy began work in 1899. After long and patient experimentation, they have evolved an apparatus which can produce nitric acid on a commercial scale and at a moderate cost. In their work it was found that the early apparatus had some serious defects. One of these depended upon the change in the resistance of air when heated. When the potential between two points is increased until a spark passes, the column of air through which this passes is heated, and its resistance falls, and a corresponding increase in the current passing between the electrodes will take place. Under these conditions the greater part of the electrical energy is converted into heat, and comparatively little reaction takes place between the nitrogen and the oxygen of the air. Another defect in the earlier apparatus is due to the dissociation caused by the action of the arc itself upon the oxides of nitrogen as they were formed. To avoid this loss it is necessary that the air which has been exposed to the arc should be removed as quickly as possible.

After studying the effects of different kinds of arcs, both alternating and direct, it was found that a long, thin, direct-current arc was the most efficient. This arc is formed by allowing a spark to pass between two platinum points, and then drawing these apart quickly to prevent an increase in the current, which otherwise would follow the heating of the air. In this way a long, thin arc is formed. The current passing is small, and a larger quantity of air is exposed to the arc. The potential used is about 8,000, causing an arc to jump about $\frac{3}{16}$ in. through the air. In addition to the motion of the electrode, it is found necessary to place in series with the electrodes an inductance coil. This prevents the sudden rush of current which would follow the establishment of the arc, and also maintains the arc for a longer time than would otherwise be the case. The arc does not break until it has reached a length of from 6in. to 8in. To prevent the decomposition of the oxides formed by the further action of the arc, the air is kept in motion between the electrodes and is withdrawn from the nitrifying chamber as quickly as possible after it has been subjected to the action of the arc. The reactions which take place in this process are exceedingly interesting. The air taken into the nitrifying chamber contains oxygen and nitrogen. Under the action of the arc, a small part of these combine to form nitric oxide. This reaction takes place only at high temperature and is endothermic—that is to say, it is accompanied by an absorption of energy. It has been stated that the reason the reaction is not continuous—that is to say, that it does not go on after being started—is that the temperature caused by the combination of two gases is not equal to that required for the reaction. This, however, is incorrect, because there is an absorption of energy in this reaction, and it therefore has a cooling effect. The energy required is 21,575 calories. Nitric acid is a colourless gas which has the property of taking up oxygen,

* Reprinted from the columns of the *Electrical Review* of New York.

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forming nitrogen trioxide and nitrogen peroxide. Doubtless both of these are formed in most cases, and these reactions are accompanied by a liberation of heat nearly eqnivalent to that absorbed when the nitric oxide is formed. These two higher oxides of nitrogen have a red colour and a very penetrating odour. They react with water to form nitrous and nitric acids. The following are believed to be the reactions which take place in the process :

$$N + O + 21{,}575 \text{ calories} = NO \quad . \quad . \quad . \quad (1)$$

The nitric oxide, NO, may take up additional oxygen, according to either of the following reactions :

$$2NO + O = N_2O_3 \text{ (nitrogen trioxide)} \quad . \quad . \quad (2)$$
$$2NO + 2O = 2NO_2 \text{ (nitrogen peroxide)} \quad . \quad (3)$$

If the temperature be kept down, these gases react with water in the following way, the result being chiefly nitrous acid :

$$N_2O_3 + H_2O = 2HNO_2 \quad . \quad . \quad . \quad . \quad (4)$$
$$2NO_2 + H_2O = HNO_2 + HNO_3 \quad . \quad . \quad (5)$$

At higher temperatures the reactions taking place give nitric acid, as follows :

$$N_2O_3 + H_2O = 2HNO_2 \quad . \quad . \quad . \quad . \quad (6)$$
$$3HNO_2 = HNO_3 + 2NO + H_2O \quad . \quad . \quad (7)$$

The nitric oxide resulting from this reaction then goes through the reaction indicated in equation (3). In the actual operation it is desirable to prevent the formation of nitric acid in the nitrifying chamber, and for this reason dry air is used. The air is taken in at the centre of the chamber, which consists of a large iron cylinder about 4ft.

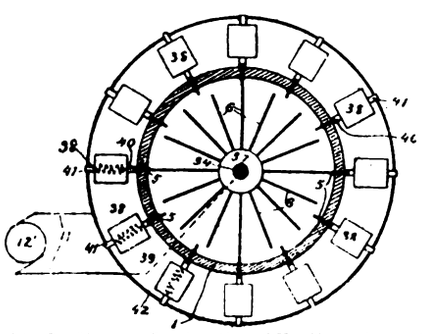

FIG 1.—Showing Construction of Nitrifying Apparatus.

in diameter and 5ft. high. It is taken out in six channels along the side and near the electrodes. There are six vertical rows of electrodes in the present type of apparatus, each row containing 23. These are wires tipped with platinum, having the tip bent upward and passed through porcelain sleeves in the side of the chamber. The wires passing from these electrodes are carried to the inductance coils placed in oil tanks. The other set of electrodes is mounted on a revolving shaft passing vertically through the centre of the chamber and driven by a direct-connected motor placed above. This shaft has six rows of 23 arms each, arranged spirally and all tipped with platinum. Current is carried in by a slip-ring on the shaft, jumps the small space between any two electrodes, and passes out through the coils back to the generator.

The construction of this apparatus is clearly shown in Fig. 1. The cast-iron cylinder is shown in 1, and the vertical shaft carrying the moving electrodes, 6, is shown at 34. The fixed electrodes, 5, are connected in series with the inductance coils, 38, and are connected in parallel by the ring, 42. At 12 is shown the generator connected to this ring and to a slip-ring on the revolving shaft. This figure, however, does not show the vertical air ducts, these latter being a later improvement. The object of arranging these electrodes in spiral rows, and not vertical, is simply to distribute the time of striking the arcs, and to make the load on the generator uniform. The shaft revolves 500 times a minute, making in this time 414,000 arcs. When the air leaves the nitrifying chamber it passes to a large galvanised iron tank, the object of this being to give sufficient time for the second reaction (that in which the nitric oxide takes up more oxygen) to take place. From here it passes to a vertical tower filled with coke, down which trickles water, or any other material. The oxides of nitrogen are absorbed and carried out at the bottom of the tower into a reservoir, from which the liquid is drawn, to be pumped again to the top of the tower. The results of the reactions give a mixture of nitrous and nitric acids, or if the oxides are absorbed by potassium hydrate—as at present is being done—we have nitrates and nitrites. The relative proportions of the two compounds can be varied by varying the temperature. If the chamber is kept cool, more nitrites are formed ; if the temperature is raised, we have nitrates predominating. The efficiency of the process is low. Air passes through the chamber at the rate of from three to four cubic feet per minute, and not over 3 per cent. of the nitrogen contained is oxidised. This low efficiency is immaterial so far as the gases are concerned, since the raw material is absolutely free ; but it is desirable to secure a greater output from the chamber. This can be done by enriching the air to be treated with oxygen. Work is now being carried on to find the most economical mixture.

At the same time that the enriching oxygen is supplied to the nitrifying chamber, this operation can be used to keep down the temperature of the mixture

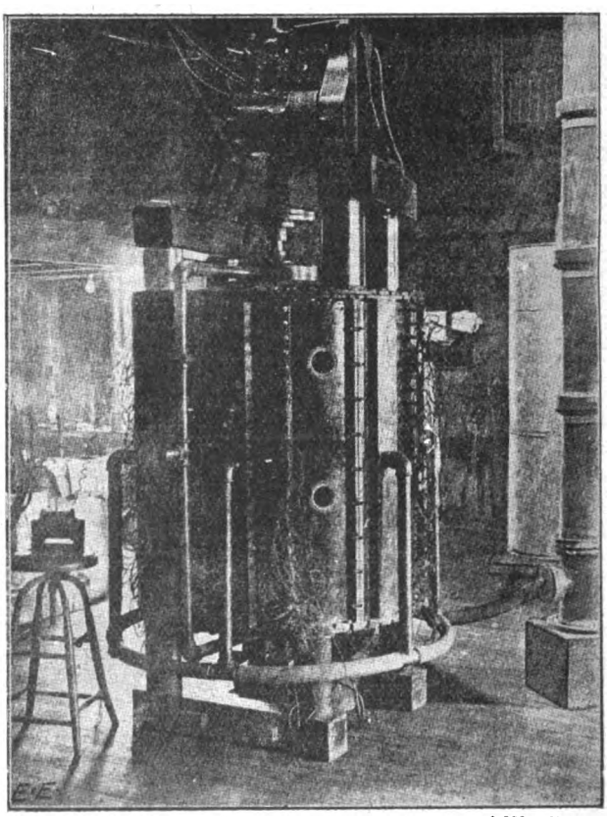

FIG. 2.—The Nitrifying Chamber, using Direct Current at 8,000 volts.

and thus give complete control of the relative proportions of nitrate and nitrite formed. Fig. 2 shows the nitrifying chamber. The connecting wires for the stationary electrodes will be seen hanging at the side. In front are seen two small windows for watching the behaviour of the apparatus while in operation. The air-pipes show how the air is led in at the top and bottom of the chamber near the centre. The vertical channels in the side of the chamber are also clearly shown. These channels are covered on the inside with a thin sheet, leaving but a small opening. This opening is just about at the point where the arc breaks, and as the motion of the revolving shaft and its electrodes keeps the volume of air within the cylinder revolving, the effect of these sheets is to shave off the outer surface of the revolving cylinder of air and thus carry out through the pipes shown the oxides of nitrogen as rapidly as they are formed. This modification of the apparatus is quite new, and has been found very efficient. From these vertical ducts the pipes conducting the gases away can be seen. To the left of the nitrifying chamber is one of the inductance coils connected to an electrode. Above the chamber can be seen the driving motor coupled directly to the shaft. This apparatus has been found to be far more efficient than the early types, one of which is shown in

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Fig. 3. In this machine the nitrifying chamber is horizontal, and contains two sets of fixed electrodes and a revolving shaft having also two sets of electrodes. This shaft was driven by a small synchronous motor, shown to the right, the speed being 1,500 revolutions per minute.

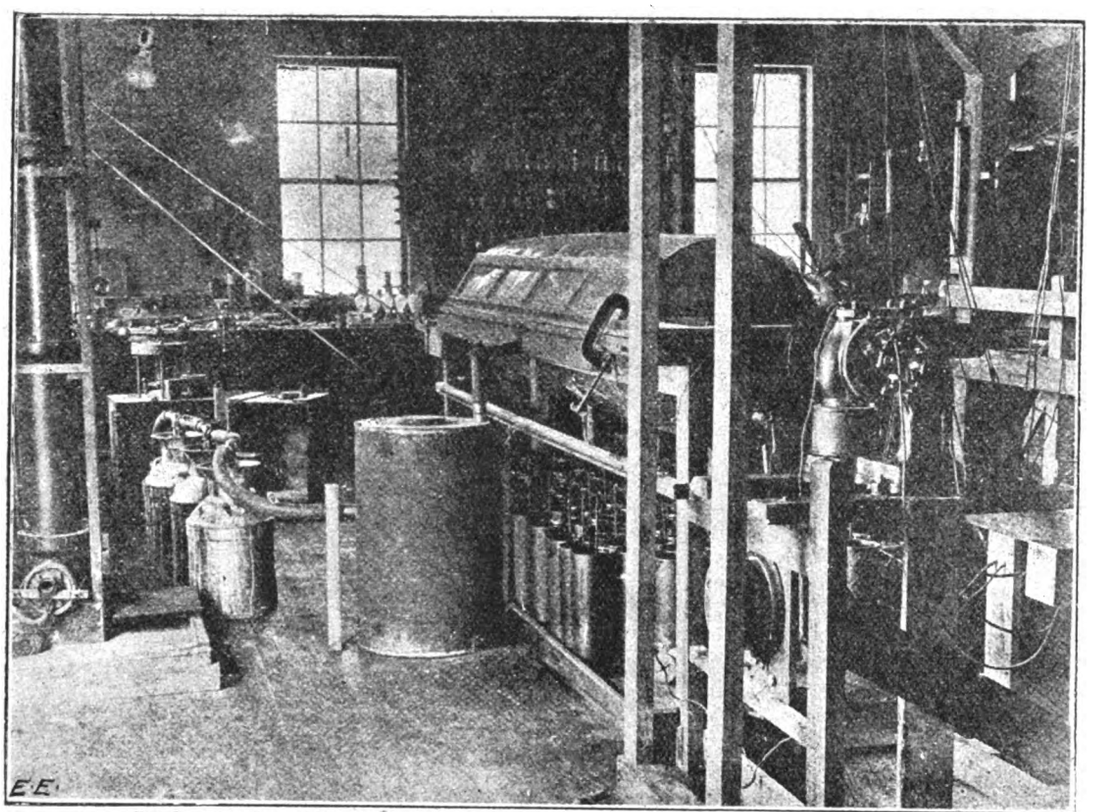
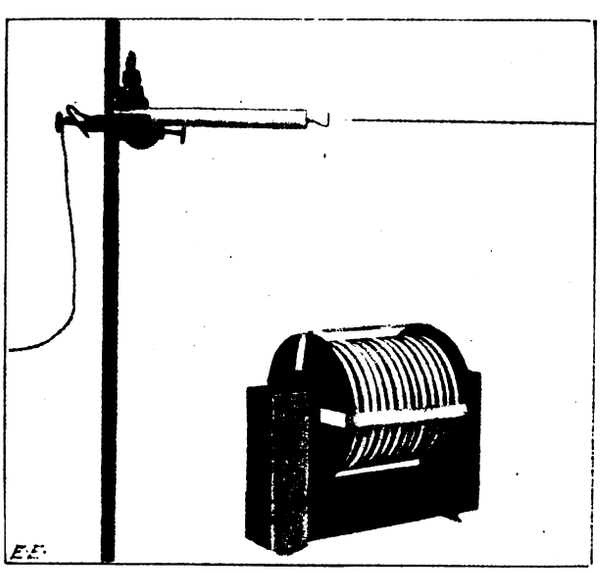


FIG. 3.—Early Type of Nitrifying Apparatus, using Alternating-Current Arcs and a Synchronous Motor.

High-tension alternating current was supplied to the electrodes, and as there was but one cycle per revolution it is evident but two sets of electrodes could be used. The alternating current before entering the nitrifying chamber was rectified by a commutator 14in. in diameter placed on the shaft. Inductance coils were used to prevent short-circuits at the instant of striking the arc. The output of this machine is comparatively small, and not to be compared to that of the apparatus previously described The machine illustrates, however, the patient work which has been done by the inventors of this process Fig. 4 shows a pair of electrodes. The stationary electrode, as previously described, is enclosed in a porcelain sleeve and inserted in the side of the chamber. The wire is tipped with platinum and the end turned upward, this simply to allow for small irregularities in the height of the revolving electrode. The latter is shown on the right, and consists of a steel rod tipped with platinum. As previously described, the arc jumps to the moving electrode when it has approached within about $\frac{3}{16}$in., and is then drawn out by the electrode moving away from the stationary one. What would be practically a short-circuit is prevented by the inductance coil. The nature of this arc is very characteristic. It consists of a small violet cylinder surrounded by a reddish flame. The chemical effect of this arc seems to be proportional to the surface exposed, while the energy consumed is proportional to the volume of the arc. This explains the higher efficiency of the small, thin arcs. By using a lower voltage or a higher speed, the arc can be drawn out until it becomes merely a spark. The useful effect of the spark is very small. The chemical reaction seems to produce ozone rather than oxides of nitrogen.

Fig. 5 shows one of the inductance coils. This coil has been developed after a great deal of study and trouble. In ths first coils an open magnetic circuit was used, and the layers of wire were wound horizontally from one end of the bobbin to the other. These coils, although well insulated, were found to be very inefficient. In operation the wire became quite hot, while the iron itself remained cool. The cause of this, as found by Mr. Lovejoy, was the displaced currents flowing in the coils, and caused by the capacity effect of every pair of layers. To overcome this objection, the coils are now wound in short vertical sections, and as many of these sections mounted side by side as may seem desirable. The magnetic circuit is formed of thin stampings, bolted together, with adjustable air-gaps, which permit adjustment of the time constant of the coil. These coils, when in use, are placed within an oil-bath.

The present arrangement of apparatus, which, it must be remembered, is merely experimental, is shown in Fig. 6. The nitrifying chamber is seen in the centre of the figure, with the driving motor above. The wires attached to the fixed electrodes can be seen passing to one terminal of the inductance coils. These coils are placed in a series of troughs containing oil. The other terminals are carried out and connected in parallel by a wire supported on the overhead framing. To the left of the figure is seen the galvanised iron tank in which the second reaction takes place. From here the gases are drawn out and passed up through the vertical tower shown between the nitrifying chamber and the tank. At the foot of this tower can be



FIGS. 4 AND 5.—Showing respectively the Electrodes and the Induction Coil.

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seen the receiving vessel which, at present, is usually filled with caustic potash. This is drawn up, as already explained, and introduced at the top of the tower, whence it gradually finds its way back, absorbing gases on the way down, and finally runs back into the vessel.

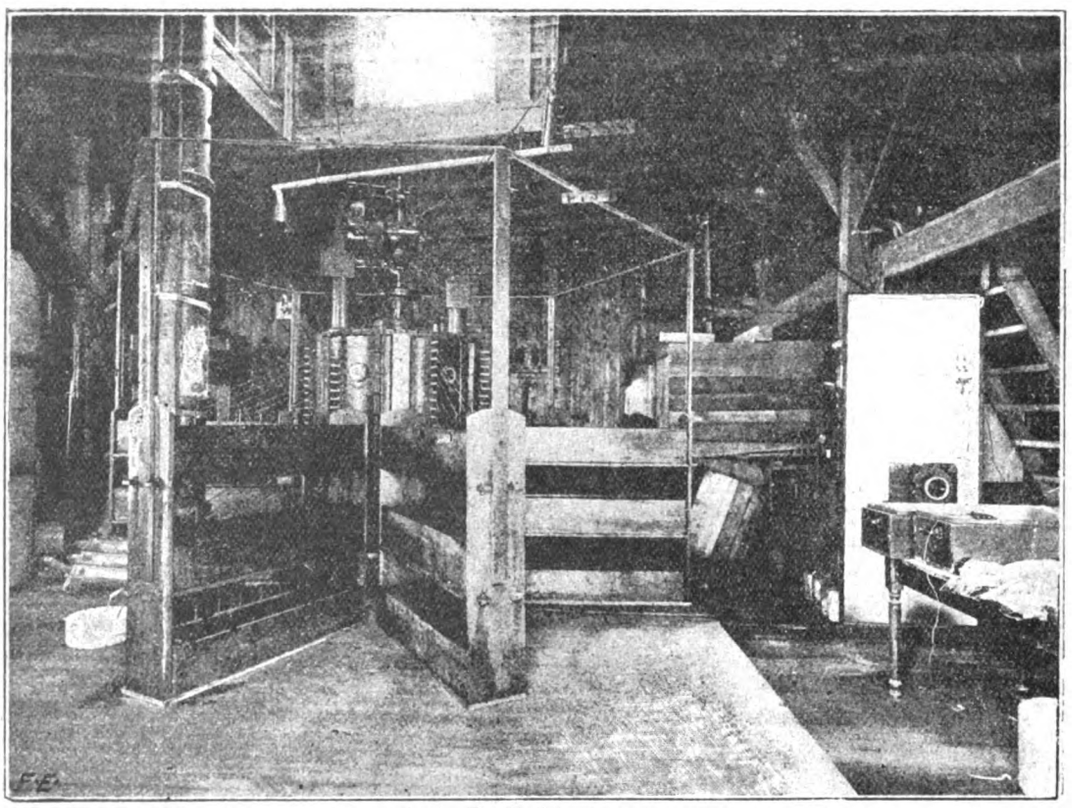

FIG. 6.—The Nitrifying Apparatus.

The generator (Fig. 7) used to produce these high direct-current voltages is quite interesting. There are but few high-voltage direct-current machines to be had to-day except those used for arc lighting. The machine selected for this work is one of the large two-pole "Wood" arc dynamos. The capacity at 10 amperes is 150 lamps, giving about 7,500 volts. This machine when used for arc lighting is furnished with two sets of brushes to ensure sparkless commutation and to permit of regulation. In its present application the four copper brushes have been removed and two carbon brushes placed in the holders. An exciter is provided giving a very complete control of the voltage of the generator. It was found that this machine when running unloaded and separately excited would give 15,000 volts apparently without any distress, and with no tendency to flash around the commutator. When the machine is in operation the voltage is adjusted by varying

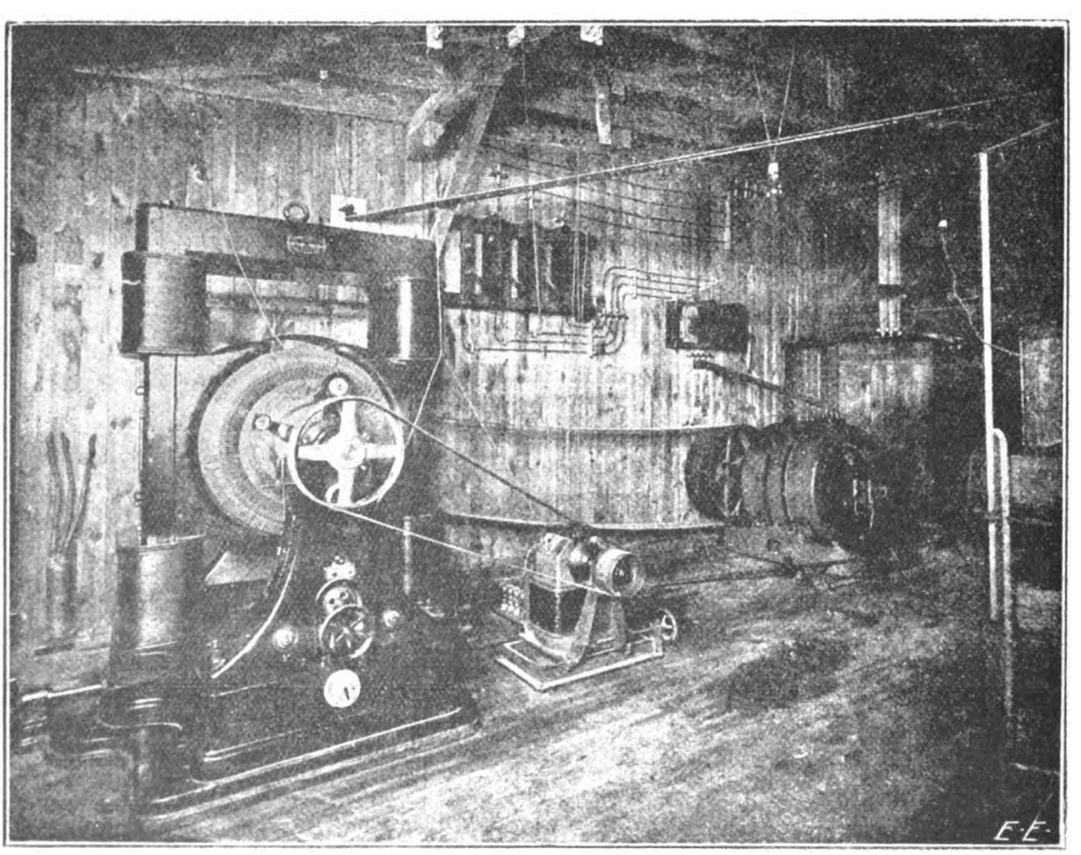

FIG. 7.—The 10,000-volt Direct-Current Generator.

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the field current, and the brushes are set for minimum sparking. The generator is driven by the 2,000-volt two-phase induction motor shown on the extreme right.

As already stated, the efficiency, or, rather, the percentage of oxygen in the air which combines with nitrogen, is small, but this feature of the operation is of little importance, except in so far as it limits the output of the chamber. The energy efficiency, however, is also very small, being only about 3 per cent. This, of course, will affect the cost of the products of operation, and the problem of raising the efficiency is one that is receiving a great deal of study. So far as the commercial application of the process is concerned, however, this point is at present a minor one, since nitric acid can be manufactured in this way at a much less cost than it can be produced by treating nitrates with sulphuric acid.

The results of the tests recently made by Prof. Chandler, of Columbia University, show that one kilowatt-year will produce one ton of 70 per cent. nitric acid, with a cost of energy of 20dol. per horse-power-year. The expense per pound of acid would be less than 1·6 cents. The current price of this acid at this time is five cents a pound. The figure given, of course, does not include the charges for interest, depreciation, and labour. This last item, however, will be extremely small, since the only apparatus requiring watching will be the generators and the pumps for circulating the absorbing liquid. It is the intention of the Atmospheric Products Company to erect, as rapidly as possible, a large building, and to furnish this with apparatus which will absorb 100,000 h.p. This in itself is a great undertaking, and the company has already constructed the building for a machine shop in which to make its own apparatus.

It may be interesting to enquire what effect a plant of this size would have upon our available supply of oxygen. One hundred thousand horse-power applied continuously to cause oxidation of nitrogen might, on first thought, be expected to have an appreciable effect upon the composition of the air. A slight calculation, however, will immediately dispel any fears in this regard. The air consists of about four parts of nitrogen and one of oxygen, so that, making allowance for their weights and assuming that the weight of the gases per square inch of the earth's surface is 14·7lb., we have as available oxygen 3·4lb. per square inch. The earth's atmosphere, therefore, contains approximately 13×10^{15} tons of oxygen. In one year 100,000 kw. will produce 100,000 tons of nitric acid, containing 76,000 tons of oxygen, an insignificant quantity compared with the total. There are many applications in which this process will be valuable, not only in the production of nitric acid and compounds of nitrogen, which will be practically pure, but in other operations, such as the manufacture of sulphuric acid, in which oxides of nitrogen are necessary. The manufacture of fertilisers, as already discussed, will offer a vast field for the system. At the present time nitrogenous fertilisers usually consist of refuse animal or vegetable matter or Chile saltpetre. Many soils require lime in addition to this. By exposing limestone to the action of these oxides of nitrogen, calcium nitrate and nitrite can be formed directly without the acids being actually formed, and this form of fertiliser, using as it does a cheap and necessary base, will be very valuable as well as economical. The oxides of nitrogen can be easily condensed and shipped from point to point, where they may be used to form nitric acid, and in this way effect a considerable saving in freight.

Many other applications of this process could be suggested. At the present time, however, the solution of the fertiliser problem is doubtless the most striking.

SOME NOTES ON AIR-PUMP DESIGN.

BY C. L. BROWNE.

(Concluded from page 734.)

In jet condensers, where the injection water is of bad quality, the air-pump barrel should be fitted with a brass liner. The pump-rod also should be brass cased, or formed of gunmetal or Muntz metal. In the British and American navies the whole of the air-pump is composed of a copper alloy.

The bucket of a vertical air-pump requires no packing, and works far better without, it being the usual practice to turn several shallow grooves in the periphery of the bucket to hold the water. The underneath edges of the bucket grids and ribs, or of any projections on the bottom of the bucket, should be carefully rounded off, so as to minimise the shock when the bucket strikes the water on its down stroke. A large number of serious air-pump breakdowns have been directly due to the use of brass packing rings in air-pump buckets, which soon wear thin and break. The best packing, if any, is rope packing, being usually formed of $\frac{1}{2}$in. or $\frac{3}{4}$in. manilla rope, special provision being made for securing the loose ends.

The number of loose parts in an air-pump should be reduced to a minimum. In case studs are used in the pump they should preferably be of gunmetal or Muntz metal, and be fitted with brass nuts, otherwise they are liable to corrode up, which will necessitate their being replaced every time the pump is stripped for periodical examination. The nuts within the pump should also be securely locked, and a split pin passed through the bolt above the nut is not sufficient for the purpose. Locomotive engineers have learned from painful experience what are the limitations to the usefulness of the split pin used as above. Nuts so secured have been known to come adrift both by shearing the split pin and also by bending the pin right back and passing over it. In a case where a specially selected steel split pin was used on a passenger locomotive, the vibratory action of the nut against the pin caused the latter to hammer its way clean out through the end of the bolt. The weak point in the action of the split pin is that in 99 cases out of 100 it allows the nut to slack back by an appreciable amount before it offers any real resistance to its movement. A better, though more expensive, method is to pass a taper split pin through both nut and bolt. It has been recommended that such studs and bolts as will not be disturbed in overhauling the air-pump should be well riveted over the nut, but many engineers have an instinctive dislike to this practice as being unmechanical. Undoubtedly, the process of hammering the bolt or stud over the end of the nut has a tendency to ease the initial tension thereon, and many short bolts have become quite slack before the process has been completed.

Another important point with regard to air-pumps which is frequently overlooked is their regular indication. For this purpose, air-pumps of any size should have bosses cast on them for receiving the indicator cocks, and an attachment fitted to the motion for the indicator cord. Diagrams from air-pumps are exceedingly interesting and instructive, as recording the combined action of the water, water vapour and air passing through the pump, and yet many engineers who dutifully indicate the engines under their charge at frequent and regular intervals are satisfied with such knowledge of the internal action of the air-pump as can be gained from the face of the vacuum gauge. Many difficulties in large waterworks pumping engines and also in air-compressors have been satisfactorily overcome by applying the knowledge of their action gained by an intelligent use of the indicator. Indeed, this instrument has played no small part in the perfecting of their design. The larger sizes of air-pumps should be regularly indicated, and the indicator diagrams taken therefrom should be carefully preserved and recorded, as is the usual practice with the diagrams from the main engines, and by carefully comparing the cards obtained at different times, both from above and below the bucket, the causes of any decreased efficiency may be readily located. It is also convenient to mark on these cards, in addition to the atmospheric line, the pressure line due to the temperature of the hot-well discharge. The efficiency of the pump can thus be seen at a glance. The pressure of the air in the condenser is directly influenced by the action of the air-pump, the vapour pressure being dependent upon the temperature, and unaffected by the pump.

A specialised vertical single-acting air-pump with a large future before it is that known as the Edwards air-pump. The principle involved in the action of this pump is the same as that which obtains in the method which is frequently

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adopted for exhausting the air from the globes of incandescent lamps, where successive drops of mercury fall down a tube past an aperture leading into the vessel in which the vacuum is to be created, each drop of mercury cutting off from the vessel and removing such air as exists in the tube between itself as it passes the aperture and the preceding drop. The bucket of the Edwards air-pump as it descends on the down stroke uncovers a number of ports round the lower part of the air-pump barrel, thus establishing a connection between the condenser and the air-pump barrel above the bucket. The bottom of the bucket is made conical in shape, and the base of the pump is similarly shaped to receive it. The water from the condenser flows by gravity into the pump, collecting at the bottom, and the descending bucket striking this water projects it at a high velocity through the ports in the pump barrel above the bucket. The ascending bucket passing these ports shuts off the communication between the contents of the pump and the condenser, discharging them through the head valves. Thus bucket and foot valves are done away with, allowing the pump clearances to be cut down to a minimum. The bucket valves and the foot valves in the ordinary pump necessarily occupy a large space, and it must be borne in mind that the clearance space between the underside of the head grid and the top of the bucket, when the latter is at its upper stroke limit, is filled with water and air at a pressure slightly in excess of that of the atmosphere. As the bucket descends the air contained in this water expands, and not only takes up the space which should be available for the air entering from the condenser, but also increases the resistance of the foot valves. In the Edwards pump the top and bottom clearances are decided only by such mechanical considerations as wear of brasses, etc. Almost any desired vacuum may be obtained with this pump, and the bucket may be driven at a high speed without impairing the efficiency of the pump. Sight and hand door are arranged for access to the head valves, and the makers claim that a leaky valve may be removed and a fresh valve put in its place while the pump is running and without impairing the vacuum. This, of course, means that the operation must be performed during a time less than that occupied by one double stroke of the pump. Unfortunately the makers do not supply a trained expert along with each pump in case it should be desired to perform this operation. With this pump the maintenance and repairs bill are reduced to a very low figure.

The horizontal air-pump is almost invariably double-acting, and is greatly inferior in efficiency to that of the vertical type, its average efficiency being, as stated above, from 30 to 35 per cent. The causes of this low efficiency are several, among them being large clearances, slippage through failure of valves to seat, reversal of direction of flow of the water through the pump, and the abrupt corners and pockets with which the pump frequently abounds; indeed, this class of pump presents many difficulties in design. When this type of pump is used in connection with a jet condenser, the air-pump barrel is almost invariably cast within the condenser, and in this form it is frequently to be met with in connection with horizontal Corliss mill engines, being driven by a prolongation of the low-pressure piston rod of the main engine. The pump piston is apt to wear down in the barrel and to allow a part of the contents of the pump to pass from one side of it to the other, instead of being discharged through the head valves. The wearing down of the pump piston generally causes trouble by air leakage at the pump-rod stuffing box, and it is a very common experience when indicating these pumps to find a much less perfect vacuum at the front end than at the back end owing to the above cause. It is difficult to detect this leakage by inspection, and for this reason it is best to use a "water-sealed" packing, a lantern brass being inserted in the stuffing box, and the space round the rod kept filled with water by means of a small pipe from the hot-well. A plunger is sometimes used instead of a piston in the interests of low first cost, and has the advantage that it may be packed without removal, but for several reasons is not to be recommended.

It is very important in a horizontal double-acting air-pump that the water be made to closely follow the pump piston, so as to prevent the air leaking past it, and to ensure the steady working of the pump, and for this purpose a head of water is required. Thus, it is best to place the discharge valves at the highest point in the pump, which plan also allows the free ascension of air. The foot valves also often give trouble, and in order to make them more sensitive they have been placed at an angle, and even in some cases inverted. In the best American practice it appears to be usual to place both the head valves and the foot valves above the working barrel of the pump, the head valves occupying a position directly over the foot valves. The movement of these valves in opening and closing is vertical, and is sometimes controlled by light springs. With this type of pump, when independently driven at a moderate speed and placed well below the condenser, a very satisfactory vacuum has been maintained.

Generally speaking, the remarks made with regard to the faults to be guarded against in the design of vertical single-acting air-pumps may be applied to those of the horizontal double-acting type; but judging from the number of inferior specimens at present working, but little time and attention has been bestowed upon the undoubted difficulties to be met with in their design, and where a high degree of efficiency is desired, the advice of an engineer especially experienced in this class of work should be obtained. Where the air-pump is direct driven, a practice which generally obtains with marine, mill, and large pumping engines, the capacity of the air-pump is frequently expressed in terms of the capacity of the low-pressure cylinder.

The following figures given by Mr. Seaton indicate present-day marine practice, expressing the ratio $\frac{\text{capacity of low-pressure cylinder}}{\text{capacity of air-pump}} = R$ under various conditions.

For jet condensation:

With single-acting vertical air-pump R = 10 to 15.
With double-acting horizontal „ R = 16 to 19.

For surface condensation:

With single-acting vertical air-pump R = 18 to 24.
With double-acting horizontal „ R = 24 to 28.

This method of computing the capacity of the air-pump is not altogether satisfactory, and cannot conveniently be applied where an independent condensing plant is to be installed, since the number of strokes made per minute by the pump may differ from the number of strokes made by the main engine in the same period of time. A general formula relating the capacity of the air-pump to the indicated horse-power developed by the main engines is equally unsatisfactory, since it takes no account of the amount of steam passing through the engine per indicated horse-power hour. A better and more convenient method is to deduce a general formula expressing the displacement in cubic inches per minute required of the air-pump in order to condense a given number of pounds of steam per hour at a given terminal pressure and with given condenser temperatures, and afterwards decide what shall be the bucket speed, etc. If t_1 = the temperature corresponding to the terminal pressure of the steam, t_2 = the initial temperature of the injection water for a jet condenser, T = the temperature of the hot-well discharge, and W = the number of pounds of injection water required to condense 1lb. of steam. By Regnault

$$W = \frac{1{,}114 + \cdot 3\, t_1 - T}{T - t_2} \quad . \quad . \quad . \quad (1)$$

This formula expresses the theoretical amount of water required to condense 1lb. of saturated steam under given conditions as to temperature in the laboratory, but extreme accuracy is not necessary in every-day practice. The quantity of water carried in suspension by the exhaust steam is not known, and generally a considerable percentage of the steam is condensed before it reaches the condenser. The injection cock, too, is never regulated to a high degree of nicety under actual working conditions; so that for any terminal pressure which may obtain in good practice the following formula may be safely used:

$$W = \frac{1{,}175 - T}{T - t_2} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

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In ordinary practice, and at temperatures which obtain in this country, W = from 25 to 26. Now, the condensed steam has to be removed by the air-pump as well as the injection water; and since 1lb. of water at ordinary condenser temperatures contains approximately 28 cubic inches, the water to be displaced by the air per 1lb. of steam condensed per hour =

$$\frac{(W + 1)\,28}{60} \text{ cubic inches per minute} \quad . \quad (3)$$

The air-pump has also to remove such air as may have found its way into the condenser, and the quantity of air existing in a jet condenser may be divided under two heads as follows: (1) the air carried in by the injection and feed water; (2) the air that has leaked in past the low-pressure cylinder glands and through leaky joints in that cylinder, in the exhaust piping, and in the condenser; also, where horizontal air-pumps are employed, through the pump-rod gland.

Dealing first with the air entrained by the feed and injection water, sea-water has been found to contain mechanically mixed with it about $\frac{1}{20}$th of its bulk of air. Undoubtedly the action of the waves materially assists in the aeration of the surface water of the sea; but all water, even when at rest, readily absorbs air, holding a portion of it in solution, and this air, as stated in the earlier portion of this article, is liberated in the condenser. Suppose that the pressure in the condenser is 2lb. absolute, the corresponding temperature being 126deg. F., taking the pressure of the atmosphere as being 15lb. per square inch, and the temperature 60deg F., any air introduced into the condenser will expand to $\frac{15}{2} \times \frac{126 + 460}{60 + 460} =$, say, eight times its previous volume. So that if W = a certain volume of water and air, of which $\frac{19}{20}$ths are water and $\frac{1}{20}$th air before entering the condenser, its volume after having entered the condenser, neglecting the inappreciable expansion of the water, will be $\frac{27}{20}$ W. Assuming the efficiency of a vertical single-acting air-pump to be ·5, which, as stated above, is about the average result obtained, the displacement in cubic inches per minute required for a vertical single-acting air-pump working in conjunction with a jet condenser per pound of steam condensed per hour =

$$D = \frac{(W + 1) \times 28 \times 27}{60 \times 20 \times \cdot 5} = 1{\cdot}26\,(W + 1). \quad (4)$$

And for double-acting horizontal pumps, taking their efficiency at ·35, this formula becomes

$$D = 1{\cdot}8\,(W + 1) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

These formulæ may be relied upon to give results in accordance with the best modern practice. No allowance, however, has been made for the volume displaced by the pump-rod on the down stroke, since it is only in very small sizes that the ratio of the displacement of the rod to that of the pump assumes any importance; and it is questionable even then whether its effect is not counterbalanced by the decreased efficiency of the small-sized pumps It will be seen that it has been assumed that the feed water contains air in the same proportion as the injection water. This will hardly be the case, since, except for such water as is added for "make-up," the feed water being constantly drawn from the hot-well will be more or less freed from air. The neglect of this consideration, however, makes an almost inappreciable difference in the computed size of the air-pump, as such difference as there is lies on the right side, since it increases the power of the pump to deal with such leakage of air as may exist in the steam plant.

To judge from the various American pump-makers' own ratings, air-pumps designed by the above formulæ will be rather larger than those constructed for jet condensation in the States. It is to be noted, however, that it is customary there to order the size next above that computed to be capable of dealing with the required amount of steam according to the builder's ratings. These ratings also are exceedingly erratic, in some cases it being assumed that a horizontal double acting air-pump possesses an efficiency considerably higher than that attained by an air-pump of the vertical single-acting type. The assumed pump efficiencies are in many cases extraordinarily high, and no allowance appears to be made for possible air leakage Those interested in the matter are referred to the list of ratings for air-pumps serving jet condensers by such firms as the Conover and Dean Bros. Companies

Referring again to such air as finds its way into the condenser through leakage in the plant, this is a very uncertain and variable quantity, and depends not only upon the design and type of the engine, but also upon the ability and attention of the engineers in charge. Among the worst offenders in this respect are the quick-revolution engines, in which the steam distribution is effected by means of piston valves. In the majority of these engines the boiler steam is admitted between the valve pistons, the exhaust consequently taking place on the outside. Thus the internal pressure at the low-pressure valve spindle glands is practically that of the condenser, and air leakage at this point is difficult to detect. It is no uncommon thing, in stations where one of these engines has been installed, to be told that when put on the condenser it lowers the vacuum by from 3in. to 5in., this result being generally traceable to the cause mentioned above. It was for this reason that many marine engineers of the old school used to like to see water drip past the low-pressure rod glands, considering that the presence of water sealed the gland against the entrance of air.

All pipe and other joints existing between the low-pressure cylinder and the condenser, and in both of them, should be thoroughly well made, and a reliable jointing used. Suspected joints also should be at once remade. The common method of holding a lighted candle near a condenser joint as a test for tightness is hardly conclusive. Although this air leakage may be greatly minimised by a careful engineer, it can never be entirely eliminated, and it should be taken into account as a factor to be considered in air-pump design, especially where a surface condenser is installed. Where the above type of condenser is used, if the water only were considered, the "air-pump" need be no larger than the boiler feed pump; but were the air-pump so designed, the pressure in the condenser would rise to that of the atmosphere in a few strokes of the engine.

It would appear at first sight that the boiler feed water being used over and over again would become so highly distilled as to be freed from the last trace of air; but it must be remembered that this water is exposed to the atmosphere both in the hot-well and in the feed tanks, the length of time so spent depending upon the capacity of each. The length of time taken by a particle of water in traversing the whole cycle through the boiler, engine, condenser, hot-well, etc., will vary with the type of plant. For instance, in a torpedo-boat destroyer under full steam this time may be as short as 15 minutes. Additional water has also to be constantly added, to make up for the losses due to leakage in the whole plant; and this water may possibly contain sufficient air to occupy, when expanded in the condenser, a volume equal to one-third that of the water; so that the air-pump has to handle, in addition to the condensed water, (1) air due to leakage in the whole plant; (2) air entrained by extra feed water; (3) air absorbed by water in hot-well and feed tanks.

Leaky condenser tubes, also, are not entirely unknown. Thus, since the above quantities are exceedingly variable, it will be impossible to deduce theoretically a satisfactory formula for expressing the capacity of the air-pump for surface condensation. When the air-pump is direct driven—that is, when it makes the same number of strokes per minute as the main engine—its capacity may be expressed in terms for the capacity of the low-pressure cylinder or cylinders. Values for the ratio

$$\frac{\text{capacity of low-pressure cylinder}}{\text{capacity of air-pump}}$$

for air-pumps for surface condensation were given in an earlier portion of this article. It will be better, however, as in the case of air-pumps for jet condensers, to equate the number of pounds of steam to be condensed per hour to the displacement in cubic inches per minute of the air-pump.

As a general rule, air-pumps for surface condensers are

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given about one-half of the capacity which would be given them were jet condensation to be employed. The majority of American pump-makers design these air-pumps with a displacement equal to about 12 times that of the condensed steam if single acting and vertical, and 20 times that of the condensed steam if double acting and horizontal. These figures are also in accordance with good British practice. Thus, if w = the number of pounds of steam to be condensed per hour, the displacement of the air-pump in cubic inches per minute =

$$D = \frac{w \times 28 \times 12}{60} = 5{\cdot}6\,w \quad . \quad . \quad . \quad (6)$$

for single-acting vertical pumps, and

$$D = \frac{w \times 28 \times 20}{60} = 9{\cdot}33\,w \quad . \quad . \quad . \quad (7)$$

for those of the horizontal double-acting type.

Having arrived at the displacement required by an air-pump for a given duty, the next point to be decided is the speed at which to work the bucket. In practice this speed varies very greatly. Where the air-pump is independently driven, the bucket or pump-piston speed varies from 35ft. to 120ft. per minute, the smaller sizes being driven at the lower speeds. In the mercantile marine, where the air-pump is usually direct driven, the bucket speed varies from 200ft. to 350ft. per minute, and in the British and foreign navies this speed varies from 250ft. to 450ft. per minute. Some of the "Atlantic greyhounds" are fitted with independently-driven air-pumps, and in these cases the average bucket speed would appear to be about 60ft. per minute. It is often stated in text-books, without any qualification, that the bucket speed must not exceed that at which the water, being put in motion by such head as is available, will follow the bucket. This assertion is liable to be misleading. Take, for example, an actual case. The main engines in a British warship running at 140 revolutions per minute drive an air-pump having a stroke of 13in., the mean bucket speed being 303ft. per minute. The maximum velocity attained by the bucket = 909ft. per minute, or $\frac{909}{60}$ = 15·16ft. per second. The area through the foot valves being one-third that of the bucket, the maximum velocity through the foot-valves will be (15·65 × 3) = 45·48; say 46ft. per second. Now, if the water is to follow the bucket, this velocity must be imparted to the water during the time occupied by one half stroke, or in $\frac{3}{2\,5}$ inch-second; or the acceleration of the water required = $\frac{46 \times 28}{3}$ = 429·3ft. per second per second, and the length of the passage from the condenser to the air-pump being 1ft., the pressure required to produce this acceleration would = $\frac{429{\cdot}3 \times {\cdot}432}{32{\cdot}2}$ = 5·45lb. per square inch. Added to this would be the pressure required to overcome the friction of the passage, lift the foot valves, and set in motion the water above them. It is quite evident that no such pressure is available, the fact being that the air-pump was filled on each up stroke with water to the extent only of one-tenth of its capacity, the pump being designed for that purpose. It is evident from the above reasoning, however, that in order to secure quick reciprocation of the bucket of a vertical air-pump, the column of water to be set in motion below the foot valves should be as short as possible.

The maximum velocity of the water through the bucket valves should not exceed 950ft. per minute, and since it will be difficult to obtain more than one-third of the area of the bucket for the passage of water, this consideration will limit the bucket speed. As the maximum speed of the water through the bucket valves does not depend upon the maximum speed of the bucket, but upon the maximum speed of the bucket *while water is passing through its valves*, an air-pump working in conjunction with a surface condenser, and only taking water through the bucket valves, at the lower end of the stroke when the bucket is rapidly coming to rest, may have a higher bucket speed than may an air-pump serving a jet condenser where the bucket will most probably meet the water when the latter is moving at its maximum velocity. The permissible velocity of air through the pump valves is much higher than would be advisable with water.

Some makers prefer, when jet condensation is employed, not to give the bucket a much higher mean speed than 200ft. per minute, as the descending bucket meeting the incoming column of water is liable to cause an objectionable shock where the speed of both is high. There is no doubt but that good design lies in the direction of short strokes and large diameters, since the larger bucket affords a more ample valve opening, and the friction absorbed in working the bucket is decreased. The depth also of the water lying on the bucket and foot valves will be less with a given displacement of water with the short-stroke pump, thus increasing the sensitiveness of the valves. The ratio $\frac{\text{diameter}}{\text{stroke}}$ is of as much as 2½in. in the British and consequently in foreign navies, and the American condensing plant manufacturers show a tendency in the same direction, although in the mercantile marine the average ratio would appear to be somewhat less. In independently-driven horizontal double-acting pumps the average ratio appears to be unity, these pumps being designed with the above ratio above or below unity according to the taste of the designer.

In these short notes upon air-pump design the writer has endeavoured to briefly indicate that thoughtful design in an air-pump for any particular duty has as much influence upon its efficient performance of the work it has been built to do as have such considerations as type, size, and bucket speed.

STIRLING ELECTRICITY ACCOUNTS.

The accounts of the burgh of Stirling electricity department for the year ended May 15, 1902, show a total expenditure on capital account to that date of £32,838. Abstracts of the revenue account, balance-sheet, etc., are given herewith.

Dr. Revenue Account.	£	s.	d.
Generation of electricity	873	7	7
Distribution of electricity	44	7	2
Attendance and repairs to public lamps	174	6	3
Rents, rates, and taxes	79	9	3
Management expenses, salaries, etc.	259	10	8
Special charges, insurance, etc.	28	3	10
	1,459	4	9
Amount carried to net revenue account	683	6	7
	£2,142	11	4

Cr.	£	s.	d.
Sale of current per meter	1,378	5	5
Public lighting	651	18	11
Rent of meters, apparatus, etc.	49	19	0
Sale of current under contract	1	18	0
Rents received	60	0	0
	£2,142	11	4

Dr. General Balance-Sheet.	£	s.	d.
Capital account—amount received	37,000	0	0
	£37,000	0	0

Dr.	£	s.	d.
Capital account—amount expended for works	32,837	19	6
Stores on hand	9	1	8
Rent receivable	18	0	0
Balance of debit of net revenue account	784	7	5
Cash in hand	3,350	11	5
	£37,000	0	0

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.			127,062
Quantity sold: Public lamps	48,501		
Quantity sold: By contract	228		
Quantity sold: Private consumers by meter	62,640		111,369
Quantity used on works			31,146
Total quantity accounted for			124,515
Quantity not accounted for			2,547
Number of public lamps			79
Total maximum supply demanded (kilowatts)			121

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NOTES.

British Association.—Our note last week on the proposed visit of the British Association in 1905 to the Victoria Falls was too definite in one respect. The invitation of the Chartered Company cannot be definitely accepted until it has been considered at an annual general meeting of the association.

Honour for Maxims.—It is announced that the Shah of Persia has conferred the rank of Commander of the Order of the Lion and the Sun upon Mr. Jules de Meray, the chairman of the Sir Hiram Maxim Electrical and Engineering Company. Our readers will remember that during the Shah's visit to this country last August he paid a special visit to the Maxim electrical lamp works, and expressed his great pleasure and interest at the operations carried on there in the process of electric lamp making.

Electric Light in Indian Cantonments.—The Government of India are taking practical measures towards the general adoption of electric lighting and punkah pulling in barracks and hospitals for British troops in that country. A committee has been appointed to advise the Government in the matter. The reference to this committee also includes the question of the installation of oil-engines and other motors in smaller stations, and as to the extent to which the apparatus can be economically utilised in the officers' quarters and for street-lighting in cantonments.

Edison's Storage Battery.—Mr. Edison, whose latest form of storage battery aroused considerable interest a few months back on account of the high claims made for it, is reported to be building five electric automobiles to run 5,000 miles each. They will all be equipped with his new battery, which it is the sanguine hope of Mr. Edison will enable a run of 100 miles to be made on one charge. A light run-about car is said to have recently covered 62 miles with a battery of 21 cells weighing 332lb., and at the end of the trial the car still ran at 83 per cent. of its normal speed.

International Peace Exhibition.—It is projected to hold an international peace exhibition at Johannesburg in 1904-5, and a meeting of the supporters of the movement was held a few days ago under the presidency of the Duke of Cambridge. His Royal Highness welcomed the news that the idea of this exhibition was being loyally supported by the other English colonies as well as British South Africa. The representatives of India, New South Wales, South Australia, British Columbia, and Canada also spoke in support of the scheme, and put forward the claims of their respective countries.

Fire-Alarm Telephones.—The latest reform of the Metropolitan Fire Brigade is the adoption of the telephone, which will greatly facilitate the locating and control of fires. With few exceptions, all the fire-alarms in the London area have been fitted with telephonic communication with the nearest fire station, which the first fireman arriving on the spot can set in operation by means of a switch carried in his pocket. This will enable him to give information as to the location, nature, and extent of an outbreak to the fire station, which will then be in a better position to meet the situation.

French Wireless Telegraphy.—The many rumours that have been going about to the effect that the French Government contemplate granting a monopoly of wireless telegraphy in France and her Colonies, are proved to be groundless. The Minister for Posts and Telegraphs has just issued a note in reply to many enquiries, pointing out that the monopoly of wireless telegraphy in those countries belongs entirely to the State, which has not the least intention of giving it up in favour of any individual or company. This, we think, will upset the calculations of Messrs. Branly and Popp, who, as noted in our last issue, have been trying to get a monopoly for their system from the French Government in return for certain advantages offered to the State.

Electric Tramways in Alsace and Lorraine.—A curious request has been made by the Minister of Alsace and Lorraine to the Société Industriel de Mulhouse, whom he has asked to select for him a competent electrical specialist capable of writing series of articles in order to refute scientifically the superstitions of various villagers in Alsace. It seems that the villages in which these superstitious people live have been recently provided with electric tramways, and the inhabitants believe that the aerial wires attract storms, and are the special cause of heavy falls of hail. Without a doubt the Minister will be able to get plenty of experts for the work, and we do not think any scientific explanations will be so effectual as the ordinary experience of the people after the lines have been longer in use.

Wireless Telegraphy.—In the Commonwealth of Australia wireless telegraphy is not yet, the Federal Ministry having refused to allow a private corporation to do telegraph business in the Commonwealth or between Australia and the surrounding islands. Should the proposed conference of Powers to draw up negotiations for the control of wireless telegraphy take place, it is not likely that the Commonwealth will be represented, but a delegate from the Postal Department will attend the ordinary telegraph conference to be held in London early in May next. With reference to Mr. Marconi's experiments at Cape Breton, it is claimed in the daily Press that he is now in daily communication by wireless telegraphy with Cornwall, but no authentic announcement has yet been received on the subject in this country.

Aberdeen Association of Civil Engineers.—Mr. C. A. Henderson, a member of the electrical staff of the Corporation of Aberdeen, recently read a paper before the above association on the working of electric motors in practice. In the course of the paper he explained the qualities of electric motors wound respectively on the series, shunt, and compound systems as regards speed variation, torque, and efficiency. He then went into the various ways of controlling speeds and of gearing motors to their work. This led up to the final consideration of what was the best type of motor for any particular class of work. An interesting discussion took place, in the course of which Mr. R. G. Nicol, the harbour engineer, mentioned the fact that Mr. Henderson was about to leave the Corporation service to take up an appointment with the British Westinghouse Company at Trafford Park. The meeting concluded with a hearty vote of thanks to the author.

Swansea Telephones.—The Swansea Telephone Committee have decided not to be influenced by the action of the Tunbridge Wells Corporation in parting with their telephone undertaking to the National Company. At a special meeting of the committee held on Friday last, which all the members of the Corporation were invited to attend, a long report by their consulting engineer, Mr. A. R. Bennett, was read and discussed. In it the accounts of the telephone undertakings in Guernsey, Glasgow, and Tunbridge Wells were analysed. The conclusion of the committee, after cross-examining Mr. Bennett at considerable length, was that the Swansea work should be proceeded with, and also the extensions to Mumbles. Mr. Bennett's explanation of the expenditure at Tunbridge Wells being

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more than his estimates was that, owing to wayleave difficulties, certain portions of the work had to be reconstructed even three or four times. His estimates for the work at Swansea are somewhat higher than those originally given for Tunbridge Wells.

The Trolley in Paris.—Following on the establishment of the trolley system of electric traction in the Avenue de la République and Rue du Quatre-Septembre, an enquiry is to be opened about Jan. 9 into the proposal of the tramway company of West Paris to substitute the aerial conductor and trolley for the section of their lines now equipped on the Diatto system. This section of the line, which would thus be changed over from the contact system to the overhead, is that from Billancourt Champ-de-Mars et Chatenay-Champ-de-Mars. Our contemporary *L'Industrie Electrique* comments on the way the trolley is invading by slow degrees the capital of France, in spite of the many objections raised against it for æsthetic reasons. The fact is that the conduit lines in Paris have cost so much to lay, and in certain cases to keep in repair, that the companies responsible for the tramway traffic are bound to adopt a cheaper method of electrical working. It would not be right to assume that the proposed change to the trolley system means that the Diatto system has been found faulty without knowing more of the facts of the case.

Electrical Coal-Cutting.—At a general meeting of the Midland Counties Institution of Engineers held recently at Nottingham, an interesting paper was read by Mr. W. E. Garforth on the application of coal-cutting machines to deep mining. In the discussion which followed, the question of the safety of electric motors in fiery pits was again to the fore. It was said by one speaker that a gassy mine was a source of danger, but that there was no greater risk in using a properly designed electric motor in such a mine than there was with the ordinary miner's safety lamp. In a gassy mine a fracture of the lamp would mean an explosion just in the same way as a fracture of the motor case would do. His opinion was that if there were a sufficiently great amount of gas to be ignited by a small spark from a motor, the pit was totally unfit to be worked at all. Other questions as to cost of upkeep, and especially cost of repairs were ventilated, but the discussion was not closed in view of the importance attached to it by the members. At the end of the meeting the members visited the Nottingham Corporation electricity works at Upper Talbot-street and St. Ann's Well-road, Nottingham.

British Empire League.—The Earl of Onslow presided over a meeting of the council of this league on Thursday last week in one of the committee rooms of the House of Commons, and among the matters brought forward for discussion was the Pacific cable enterprise. The league have continuously advocated, both in Canada and this country, an all-British line connecting the British Colonies with the Mother Country as an important bond of Imperial union. Sir Horace Tozer, speaking on the subject, referred to the circumstances which led to the Pacific cable being laid, and said that from the first Australia heartily supported the project which Canada had so warmly espoused. A resolution was unanimously agreed to tendering congratulations to the Imperial Government and to the members of the past and present Governments of the self-governing Colonies and States which have been partners in the project. The resolution also noted with much interest that through the enterprise of the Eastern and Eastern Extension Telegraph Companies a new cable system, which has the advantage of connecting Great Britain with South Africa as well as with Australia, having only one landing place not on British soil, has been completed during the current year.

Tramway Goods Traffic.—Following on the initiative of Huddersfield and a few other towns, the Dundee Tramways Committee are considering the possibility of augmenting their income by developing mineral and other heavy traffic on the electric tramway system of the city. Should the proposal be carried out, the Tramways Committee themselves would probably be the first to take advantage of it for supplying the electric power station with coal. At present the coal is transferred from the railway to the generating station in carts—a comparatively expensive operation. The scheme contemplates the laying of branch lines up to the sidings of the railway, so that goods would be delivered directly out of the railway trucks into the electric trucks without the intervention of any intermediary transport. Dundee would seem to be an ideal place for such an experiment. There are large numbers of mills and factories on the tramway routes, all of which could readily be connected with the tramway tracks, and coal brought either from the harbour or the railway depôts. In time also the manufactures could be removed in the same way. It is likely that the whole question will be discussed when the proposal to extend the tramways to the railway stations comes before the Corporation.

The Astor Turbine Patents.—It is now confirmed that Colonel J. J. Astor, the American millionaire, has dedicated all his patents on marine turbines to the public "in the hope that the development of the ideal turbine may be hastened thereby." The inventor claims that turbines built after his designs would be particularly suitable to central-station work for generating electricity, in which case the field and armature might be driven in opposite directions. This would improve the efficiency of the dynamo and increase its output for a given weight. Colonel Astor gives the following brief description of his turbine: "The turbine is shaped like a funnel, and comprises an outer shell or drum and an inner shaft running axially through it, these parts being relatively rotatable and each having oppositely set spiral blades. The steam is admitted into the outer shell at the small end and passes through the turbine, expanding into the large end of the shell and acting on the spiral blades to rotate the shell and shaft simultaneously and in opposite directions. By allowing both the inner turbine and the outer case to revolve, the speed necessary to ensure efficiency, which in ordinary turbines is often inconveniently high, is halved. As a result of this construction the weight is reduced practically 50 per cent." Presumably a trust will be formed to enquire into the subject of Colonel Astor's patents, and we trust that he has practical results to lay before experts.

Science Faculty at King's College.—Further information has reached us with regard to the endowment of King's College, particularly in relation to the engineering departments and the science faculty. In science and applied science there are altogether nine distinctive chairs, and to maintain these it is estimated that an annual income of £6,600 will be required. The capital necessary to bring in this yearly sum at 3 per cent. is £227,500. In addition to this, the engineering laboratory is in need of about £25,000 for additional buildings, a portion of which it is proposed to set apart for research. The additional equipment required includes a Willans, Belliss, Peache, or other high-speed engine; a Corliss engine; a Westinghouse or other direct-coupled gas-engine; a Mond or Dowson gas plant; a Parsons or other rotary engine; a Babcock or other large tube boiler, etc. Then there is the electrical engineering laboratory, which requires about £50,000 to cover the cost

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of extensions, additional equipment, and such charges as are absolutely required for the successful working of the department. The additional equipment includes steam boilers, steam and gas generators direct coupled, storage battery, direct and alternate current motors, transformers, switchboards, resistance frames, measuring instruments, switches, etc. The council will be willing, if so desired, to assign to any chair endowed in its entirety by a single donor the name of such donor.

Royal Statistical Society.—At a meeting of this society held on Tuesday, Dec. 16, at the rooms of the Society of Arts, Mr. W. M. Acworth read a paper on "English Railway Statistics." He began by expressing a belief that the inadequacy of the present English statistics was now generally recognised, and that reform was imminent, and he suggested that the Board of Trade should now appoint a committee to deal with the subject. After giving a list of the various documents relating to railways issued by the Board of Trade, he went on to discuss the general question of publicity, and urged strongly that this was even more in the interest of the railway companies themselves than of the public. Then, taking the existing half-yearly reports of the companies as his text, the writer proceeded to deal *seriatim* with the different tables of capital, assets, revenue, expenditure, traffic carried, etc. Under each head he gave corresponding tables from French or German or American reports. In every case the result went to show how scanty in comparison is the information furnished by the English companies. But it was pointed out that as the form and matter of the English accounts was prescribed by statute, the fault lay at the door of Parliament and not of the companies. One of the suggestions of the writer was that railway accounts should, like those of ordinary trading companies, be only made up annually, an interim dividend being paid for the first six months. He also suggested that maps and statistical diagrams would make the reports more generally intelligible.

Home Industries.—The competition between English and American manufacturers dealing in electrical supplies for tramway purposes is as keen as ever, but, curiously enough, the advantage of price is now frequently with the home suppliers. We had a few months ago to write a leader on this question, in order to combat a statement that our large English steelmakers are incompetent to turn out the special work required in tramway tracks. Statements of this kind are still to be met with, and, again, a number of contractors having agreements with American houses are apt to quote only for American-made plant. A case has recently arisen in Wigan over this very point, and the committee have found that the use of English-made special work will reduce the contract price a very considerable amount. Unfortunately, a subsidiary point for disagreement has to be settled because the committee, while accepting an English tender, do not wish to accept the lowest. The reason they give is local influence, and we are surprised to find that throughout the whole of the discussion no reference was made as to their engineer's opinion on the subject. We are quite sure that the Corporation committee will do well to get such work in England, but they must also remember that the cheapest tender does not necessarily mean the best work. Another interesting case of English engineers more than holding their own against American competition has recently been brought to our notice in connection with some milling plant supplied to China. In this case the English firm of Messrs. E. R. and F. Turner, of Ipswich, secured the original order both on price and delivery, and succeeded in fulfilling their contract obligations in these respects. The result has been the placing of further orders with this firm.

The Gas versus the Steam Engine.—Mr. M. Adams, writing in our American contemporary *Engineer*, makes out a strong case in favour of the gas-engine as compared with the steam-engine. After discussing the respective merits of the two prime movers, he gives the results of a test of the comparative cost of operating a gas-engine and a steam-engine. The coal used had a thermal value of about 14,500 British thermal units per pound. In the case of the steam-engine the total heat supplied was 15,261 British thermal units, including the heat return to the boiler. The following figures of the energy expended are interesting: loss at boiler, 4,349 British thermal units; used by auxiliaries, 290; loss in pipe, 168; loss in exhaust, 9,300; friction of engine, 137 and energy expended in useful work, 1,008 British thermal units. Thus he concludes 1,008 British thermal units is the amount transformed into mechanical work that can be realised under the very best conditions with a steam-engine. In the gas-engine there are also great losses, for of the 100 per cent. of energy which is supplied to the gas-engine it has been proved that 31 per cent. is carried away in the cooling water, and this is necessary to keep the temperature of the cylinder and piston down to the point where it is possible to operate them. Also about 43 per cent. is carried away in sensible heat in the exhaust of the engine. This leaves about 26 or 28 per cent. for doing useful work in the gas-engine, or 3,016 British thermal units, against 1,008 British thermal units for the useful work in a steam-engine. Most of the troubles of the gas-engine have now been overcome, and the author concludes that the gas-engine to-day stands as a heat engine which has many advantages over the steam-engine, and in the near future the gas-producer plant and the gas-engine will be looked at as a combination of economy.

Recent Electrical Development.—A lecture on electrical development in America was delivered by Mr. A. Morris Thompson at the recent meeting of the Dundee Society of Experimental Engineers, and elicited considerable interest from the fact that great advances have been made by America in all branches of electrical engineering in the past few years. The lecturer first described by means of diagrams and photographs the methods of tapping such sources of power as the Niagara Falls and the Lachine Rapids, and expressed the belief that there was a great industrial future before Canada in this direction owing to the enormous energy which was stored up by Nature in the shape of rivers and falls. As we know, advantage is already being taken in the Dominion of these vast natural resources of power in connection with manufacturing undertakings, and Mr. Thompson was safe in predicting a far greater development in the near future. This source of power, he thought, would be developed to a much greater extent when coal became less plentiful. Turning now to development in electric traction, he stated that tramway tracks in America were now almost universally laid on cross wooden sleepers, as in the case of railways, and the steel surface was made good on the top. The adoption of this method of construction was on the side of cheapness, which rendered it feasible to lay lines radiating from a town into the outlying districts to distances of from 20 to 40 miles, and in some cases 60 miles. Mr. Thompson advocated the use of the method in this country, particularly in scattered districts, which, it may be concluded, would allow of an extended network of tramways in country districts being carried out at considerably lower cost than with the present practice. He also described some of the applications of electricity for

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power purposes of various kinds in the States, remarking that only in one case out of 100 workshops he had visited did he find electricity not used. He especially called attention to the extended use of electric cranes, and, in conclusion, expressed regret that in Dundee, where there was so much room for new industries, little or no attempt had been made to get hold of any of the great industries that had been called into being by the development of electricity.

Returned from the War.—A very interesting function took place at Erith on Saturday evening last at the works of Messrs. Callender's Cable and Construction Company. It was a welcome home by the directors and their fellow-workmen of a number of reservists and volunteers who have returned from the seat of the late war, and have again taken up civil employment at Messrs. Callender's works. The welcome took the form of an excellent dinner at the works, at which 47 of the company's employés who went on active service in 1899 were entertained by the directors. It is a matter for congratulation that all have returned with the exception of one reservist and one volunteer, who died in South Africa from sickness; and it is to the credit of the company that, under the reservists' fund started by them, the widow of the reservist has received a pension for her support. The firm also very generously subscribed half-pay for all married reservists who were called out, and voluntary subscriptions were collected weekly from the employés and used to supplement this amount. In this way nearly £2,000 was allotted to the benefit of the reservists and volunteers, of which the firm contributed £1,445. The total disbursements to the reservists' families have amounted to £1,738, or a weekly average of £11. 6s. Mr. T. O. Callender presided at Saturday's dinner and gave the toast of "The Returned Warriors." One of these was Corporal Kibblewhite, of the 2nd Life Guards, who earned the medal for distinguished conduct in the field. On behalf of the firm he extended to them all a hearty welcome home. The party was subsequently driven to the National Schools at Erith, where the reservists were joined by their fellow-workmen and entertained at a capital concert. Mr. Callender again presided, and was supported by several of his co-directors and officials of the company.

Institution of Junior Engineers.—At the meeting of this institution on Dec. 5, the chairman (Mr. Kenneth Gray) presiding, the paper read was on "The Planimeter explained simply without Mathematics," by Mr. W. J. Tennant. After some introductory remarks as to the necessity of such an instrument as the planimeter for the use of engineers, who could by its means have calculations performed for them automatically, the author proceeded to describe the construction of the Amsler planimeter, and considered its principle of operation analysed graphically for a simple figure. The "sweeping in" of parallelograms as performed by the instrument was dwelt upon, and deductions drawn therefrom. The roller and its functions was treated and the method of obtaining results in different units shown, as was also the manner of ascertaining the mean height of a diagram by direct reading. The author then summarised the principal features of the action of the instrument, as, first, the sweeping of up-stroke and down stroke areas, two (or more) in number, by a bar whose length does not change during the operation, but which lies upon the whole more obliquely to its line of travel during the one stroke than during the other, assuming the measured figure to possess area and not merely length without breadth; and second, the automatic subtraction by the roller of these two classes of area one from another so as to present an indication of their difference. This indication is the area of the figure, no matter how irregular, around the boundary of which the tracer has been run. The question of looped indicator diagram areas was also considered, and Coffin's averaging instrument was described and its action illustrated. In conclusion, the author investigated the conditions obtaining when, in using the Amsler instrument, the pivot is encircled by the outline of the area to be measured. On the 10th inst. a party of members of the institution visited the works of Messrs. Elliott Bros., at Lewisham, where electrical instruments, switchboards, standard instruments for continuous and alternate current testing, recording instruments, etc., are made. All the various machines employed in the different processes of manufacture were shown in operation, some of them being quite unique in their character. The whole arrangement and management of the works impressed the visitors by their excellence.

Christmas Lectures at the Royal Institution.—Prof. H. S. Hele-Shaw's course of six lectures adapted to a juvenile auditory at the Royal Institution this Christmas promises to prove of considerable interest. He has chosen for his theme the wide subject of locomotion, which not only embraces traction on the earth and through the water, but aerial navigation as well. The first lecture will be given on the Saturday afternoon immediately following Christmas, and will deal with the invention of the wheel. In this lecture Prof. Hele-Shaw may be expected to discourse on the fundamental principles of locomotion. In the second lecture, on Tuesday, the 30th inst., he will bring his juvenile audience more into touch with everyday matters. The road motor is the subject for that afternoon, and the lecturer will describe the three classes of motors used on the road at the present time—*i.e.*, petrol, steam, and electrical. In connection with the electric motor, he may be expected to refer to the difficulties with storage batteries for automobile purposes, and how these difficulties are gradually being overcome; also to the special conditions under which electric motors at present are suitable. The third lecture, on Thursday, Jan. 1, will consider the position of the motor in its application to railways, the steam-engine being especially described and discussed. The adaptation of electricity to railways is the subject of the fourth lecture on Saturday, Jan. 3. Twenty-five years ago no electric railway existed, and Prof. Hele-Shaw will trace the development of the electric motor from that date. Having concluded that the locomotive carrying its own accumulator is less suitable for rails than for roads, he will turn his attention to the state of electric traction in this country, and refer in turn to the first successful electric railway in this country at Portrush; the electric overhead railway at Liverpool; the electric railways of London; the difficulties and advantages of the transmission of electricity; the great development of the electric tramway, and the reasons; high-speed travelling on electric railways; Behr's lightning railway; the lightning railway between Liverpool and Manchester; and special precautions for the prevention of accidents. The remaining two lectures, to be delivered on Jan. 6 and 8 respectively, will deal, the one with the self-propelled ship, and the other with the flying machine.

Glover's Almanac.—Messrs. W. T. Glover and Co have this year issued a tear-off sheet calendar on which extracts of electrical interest are given. The greater part of the printed matter on the slips is extracted from the *Proceedings* of the Institution of Electrical Engineers. These extracts are interleaved with illustrations of cable work in various parts of the United Kingdom. The quotations from the Institution *Proceedings* are exceedingly well chosen. For instance, on April 1 the extract

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reads: "In a central station I was connected with it was the habit of the men to give an electric shock from a magneto machine to visitors, and although it was found that different people seemed to feel differently, yet one boy could stand more than anyone else. He was, however, unfortunately, of weak intellect. Another case of which I have heard was at a bazaar, where money was placed in a bowl of water charged from a Ruhmkorff coil. One woman took the money out every time, and had to be paid to go away, as she nearly made them bankrupt. She also was of weak intellect. No doubt this insensibility was due to the brain being affected.—Mr. F. B. Aspinall (vol. xxxi., p. 750)." On April 3 Mr. C. H. Wordingham's views on procrastination are given thus: "The purchasers will procrastinate for months or years, allowing every trivial matter to delay them, but once they determine to go forward their lethargy is exchanged for panic and unreasoning haste. Here, again, over-production enables the foreigner to secure any of the contracts which in this case are often awarded to him, regardless of the price, because he can promise early delivery. The purchaser never considers that other contracts which must be executed first cannot by their very nature be carried out in so brief a period, and he finds subsequently, to his cost, that the plant, for which he has paid more than he would have had to pay to an English firm who required a reasonable time for delivery, is on his hands deteriorating and costing him heavy sums for demurrage." In cases where the subject is headed it is given in English, French, and German. Curiously, at the end of each of the foreign words the gender of the same is signified. For instance, on March 12 the extract is as follows: "Network, Réseau (m), Leitungsnetz (n). All our experiences of electrolytic troubles are in cases where the leakage current is one of considerable difference of potential at the points of leakage; but on the middle wire of a three-wire system there can be no differences of potential between the most remote parts of a network, unless the two sides are out of balance, and even in that case these differences must be very small. If the Board of Trade will allow earthing of the middle wire, say, at all feeding points instead of at the generating station, I do not think there will be any trouble at all.—Mr. W. A. Chamen (vol. xxv, p. 169)." The almanac is exceedingly interesting. The only fault that we have to find with it is that the leaves tear off rather too readily. In fact, we have already spoilt our calendar by looking too far ahead.

The Municipal Telephone Sale.—The anxiously-awaited decision of the Postmaster-General with reference to the sale of the municipal telephone system at Tunbridge Wells to the National Telephone Company was announced in the House of Commons on Thursday last week at question time. In view of the far-reaching importance of this decision, and the precedent which it establishes in such matters, we append Mr. Chamberlain's words in full. He said: "After carefully considering the important questions of principle affecting the telephone system of the United Kingdom involved in the application of the Corporation of Tunbridge Wells, I decided that I could not give my assent to the proposed sale except on certain conditions, which are necessary for the maintenance of the policy approved by Parliament in the Telegraph Act, 1899. The license held by the Corporation imposed on the conduct of their telephone undertaking certain important obligations which do not apply generally to the licensed business of the National Telephone Company. The most important of these obligations is the following: (1) that the charges for the exchange service shall be maintained within certain specified limits; (2) that no favour or preference shall be shown in the charges made to any subscriber, and that no subscriber shall, as a condition of service, be required to grant wayleaves, except for the connection of his own premises with an exchange; (3) that the construction of all plant shall be subject to the sanction and approval of the Postmaster-General; (4) that the subscribers in other areas to exchanges of the Postmaster-General and of his other licenses besides the National Telephone Company shall have the right to free intercommunication over the trunk-wire system without the imposition of terminal fees with the subscribers to the Corporation system, and that subscribers to the Post Office system in the same area shall have the right of intercommunication on terms to be settled by arbitration if necessary. The National Telephone Company lately accepted as a condition of their license in respect of the Tunbridge Wells area conditions 1 and 2, and thereby secured, under the operation of Section 3 of the Telegraph Act, 1899, as a result of the establishment of the municipal telephone system, an extension of the period of their license for the Tunbridge Wells area from Dec. 31, 1911, to April 30, 1925, the date of the termination of the Corporation's license. Under these circumstances I wrote to the company on Nov. 22 that I could not give my assent to the proposed sale unless they further accepted as applying in future to the whole of their system in the area the other obligations now attaching to the Corporation's system, in order that all telephone business in the area might in future be conducted in accordance with the principles approved by Parliament, and I made a further very important condition. In permitting the extension of the company's license in local areas where municipal competition might be established, Parliament intended to place the competing systems on an equality, but it did not contemplate the enjoyment of this advantage without competition. I therefore thought it necessary to secure for the Postmaster-General the right to terminate the company's extended local license on Dec. 31, 1911, the original date of termination specified in their general license. The Corporation's license, in order to provide for the continuance of the telephone service by the Post Office on its termination, gave the Postmaster-General the right to purchase such of their plant as might, on the expiration of the Corporation's license, be useful for Post Office purposes on what are commonly known as 'tramway terms'—that is, at its fair market value as plant in use. I have extended this condition to the whole plant of the National Telephone Company existing in the Tunbridge Wells area in 1911. These conditions, coupled with the terms as to rates of subscription, etc., contained in the agreement between the Corporation and the company, secure all the advantages contemplated by Parliament in sanctioning municipal competition as affecting both existing and future subscribers and the development of the general telephone system; and I am glad to be able to state that I have to day received from the National Telephone Company an assurance that, having regard to all the circumstances of the case, and looking at the matter not from the point of view of Tunbridge Wells alone, but from the broader standpoint as it affects the position of the Post Office and the company in the country generally, they are prepared to accept these conditions." It will be seen from the above that the National Telephone Company have had to forego considerable benefits in order to secure the consent of the Postmaster-General, and as far as the Tunbridge Wells area is concerned the difficulty of purchase in 1911 has been definitely solved. The same is the case in the London area, but elsewhere in the country the National Telephone Company will still hold a very strong position at the expiration of their license in view of the fact that the then Government will have no power to take over their undertaking except by agreement.

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MAIDENHEAD ELECTRICITY SUPPLY WORKS.

The number of towns in possession of works for the supply of electricity has been augmented very rapidly of late. The larger towns led the way in the matter of such provision; now it is the turn of the medium sized and small townships to follow in their wake. In striking contrast to the lack of uniformity which marked the schemes of yesterday, we now find, so far as small undertakings are concerned, differences only in detail, the low-pressure continuous-current three-wire system with accumulators representing the standard practice of to-day. The battle of systems, then, has not descended to the smaller towns, something approximating to uniformity of practice in their case prevailing instead, which is a state of things born of experience and no doubt favourable to the interests involved, but at the same time highly monotonous to the central-station engineer. It was with this reflection that we returned recently from a visit to the latest addition to the list of completed works—the property of the Maidenhead Corporation. No radical departure from the generally adopted standard has to be recorded in regard to these works, but it may be said that their design and equipment are alike excellent, lending to them quite a model character, and much attention has evidently been devoted to the perfecting of the details. Thus the borough of Maidenhead comes into possession of an up-to-date concern, as to the future success of which there can be little doubt, although it is handicapped to a certain extent by unusually dear coal and the high average cost of service connections, the better-class private residences standing far back from the roadways.

Maidenhead has a population of about 13,000. It is a town of the strictly residential order, boasting no particular industry, unless brewing be counted one, and the amount of this which is done in the district certainly speaks eloquently for the local demand. The area of the town is 2,123 acres, and its rateable value £72,905. The local supply of gas is in the hands of a company, the price charged being from 3s. 6d. to 3s. 9d. per 1,000 cubic feet. The present scheme of electricity supply may be said to date from 1898, when the consulting engineers, Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster, S.W., first reported to the Town Council. It is a modification of the original scheme which has been actually carried out at a cost of approximately £25,000. The system adopted as above indicated is that known as the three-wire continuous-current, with a pressure of 460 volts across the outers and 230 volts at the consumers' lamps, either pressure being available, of course, for motors. The charges in force are 6d. per unit for lighting and 3d. for power, with a rebate of 1 per cent. per 1,000 units consumed per quarter. In the interest of the long-hour consumer the advisability of adopting the maximum demand system for power supply is to be considered, we understand. The charge made on account of street-lighting averages out at about 2d. per unit supplied. In designing the scheme, provision has been made for the probable supply to a system of tramways in the district, it being the intention of the Town Council, we understand, to apply at no distant date for a provisional order under the Light Railways Act.

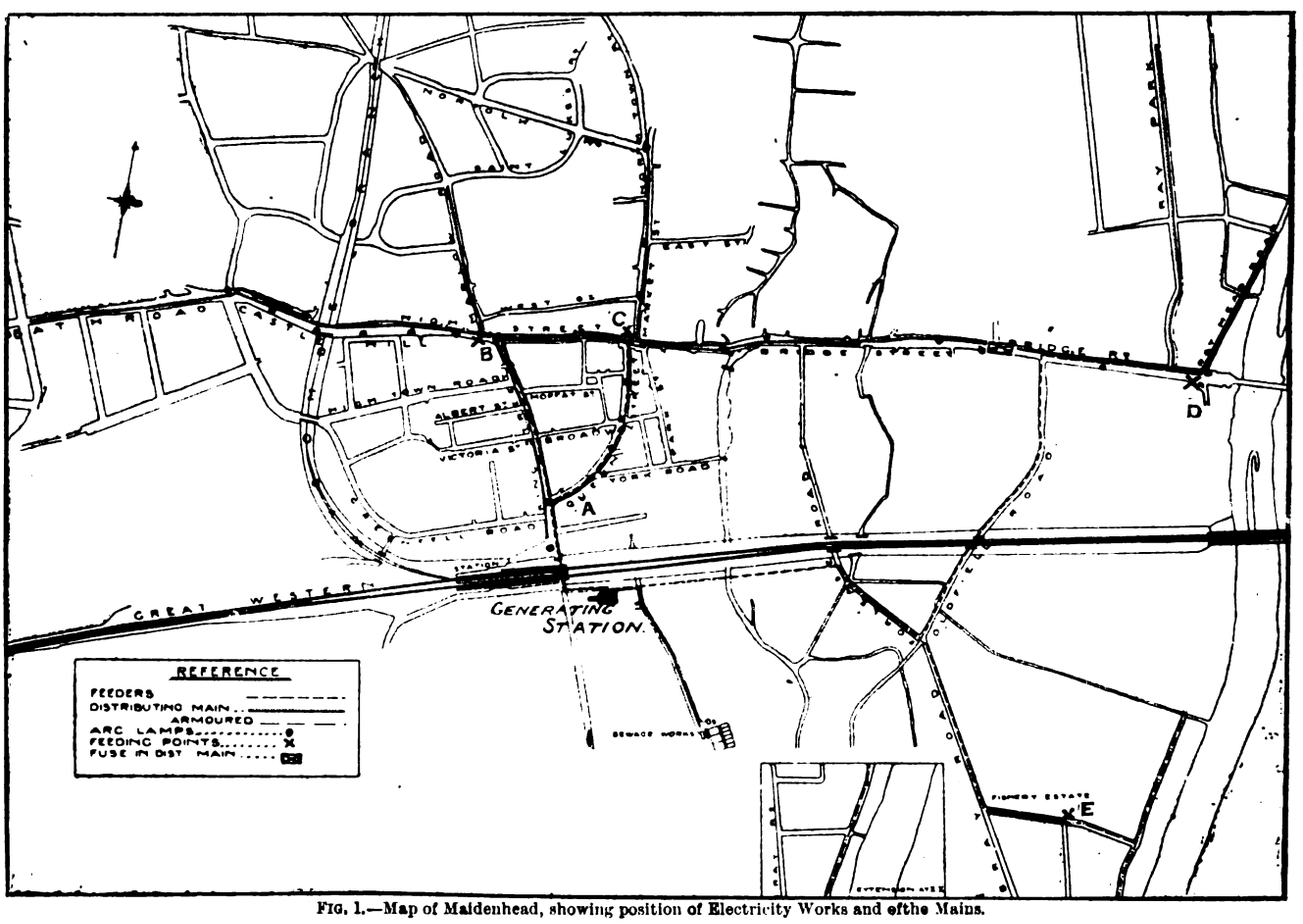

FIG. 1.—Map of Maidenhead, showing position of Electricity Works and ofthe Mains.

As regards the promoting of the present scheme of electricity supply in the borough, full credit must be given to Councillor James Edward Pearce, who worked with unflagging energy during its initial stages. Councillor Pearce officiates in the dual capacity of mayor and chairman of the Electric Lighting Committee, but is perhaps even better known in connection with his service in South Africa as an officer with the Electrical Engineers Volunteer Corps.

Proceeding to details of the undertaking, it must be mentioned that the generating station is situated on the Braywick-road, close to the Great Western Railway (as shown on the accompanying map, Fig. 1). The site provides ample room for future extensions, and although its distance from the river is to be regretted for certain reasons, this, we understand, was unavoidable, since no riverside site was available for the purpose at a reasonable price. The station has been built to the designs of Mr. P. Johns, the borough engineer, and is of red brick dressed with Bath stone. It consists of a boiler-house, engine-room, and accumulator-room, besides very ample and conveniently arranged office accommodation, stores, etc. The general disposition of the buildings and principal dimen-

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sions will be seen on referring to Figs. 2 and 3. The engine-room is faced with glazed brick up to the height of the traveller rails, and has a light iron roof provided with skylights and a louvred lantern for ventilation. The chimney shaft, 125ft. in height, is constructed on a patent system with segmental bricks, whereby a great saving in weight is effected—we believe about 50 per cent. on the ordinary method. It was erected in five weeks, and gives

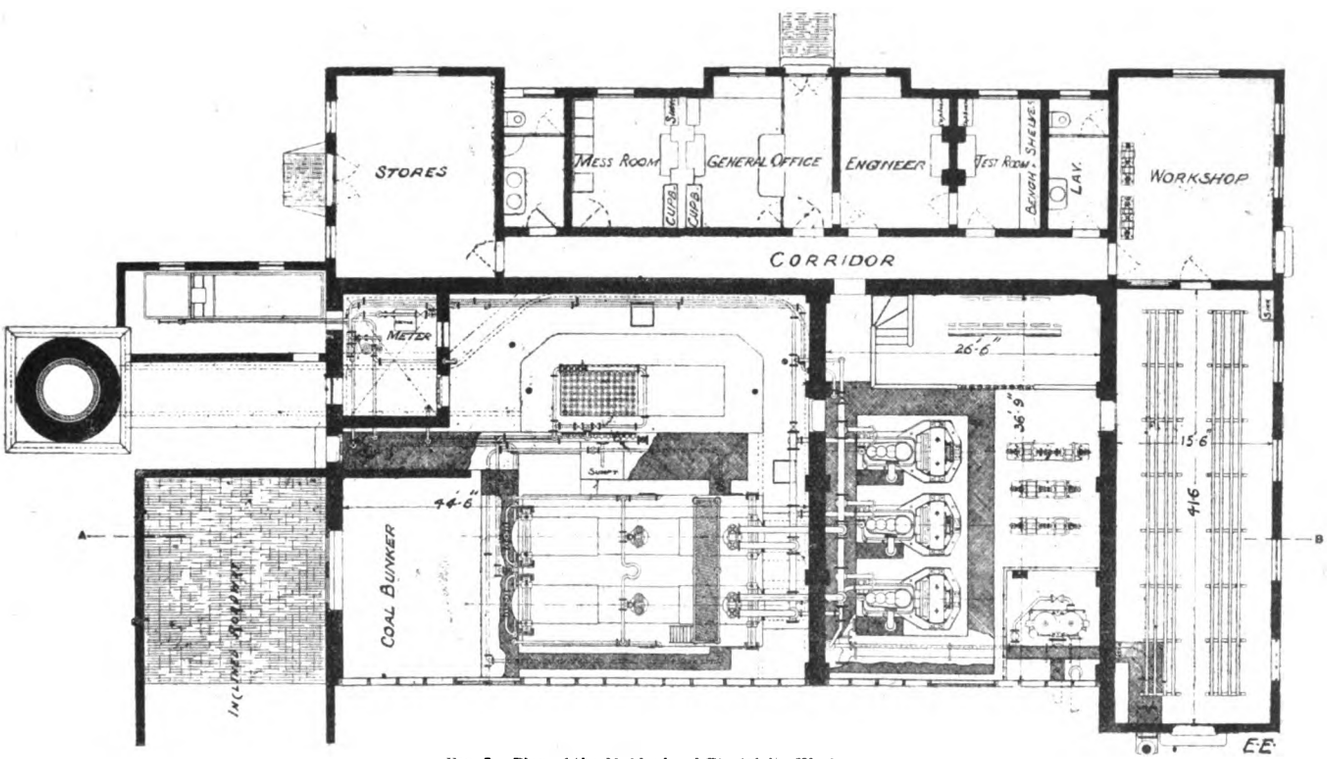

FIG. 2.—Plan of the Maidenhead Electricity Works.

an exceptionally good draught. Coal is conveyed to the station from a siding about a quarter of a mile distant, being carted up the inclined roadway (shown in Fig. 2) and tipped direct on to the stoking floor. The price of the coal—Welsh anthracite—delivered at the works is 23s. 10d. per ton.

As regards water for boiler feed and condensing purposes, this is obtained from a well sunk on the station site. The pumps provided for the purpose deliver the water from

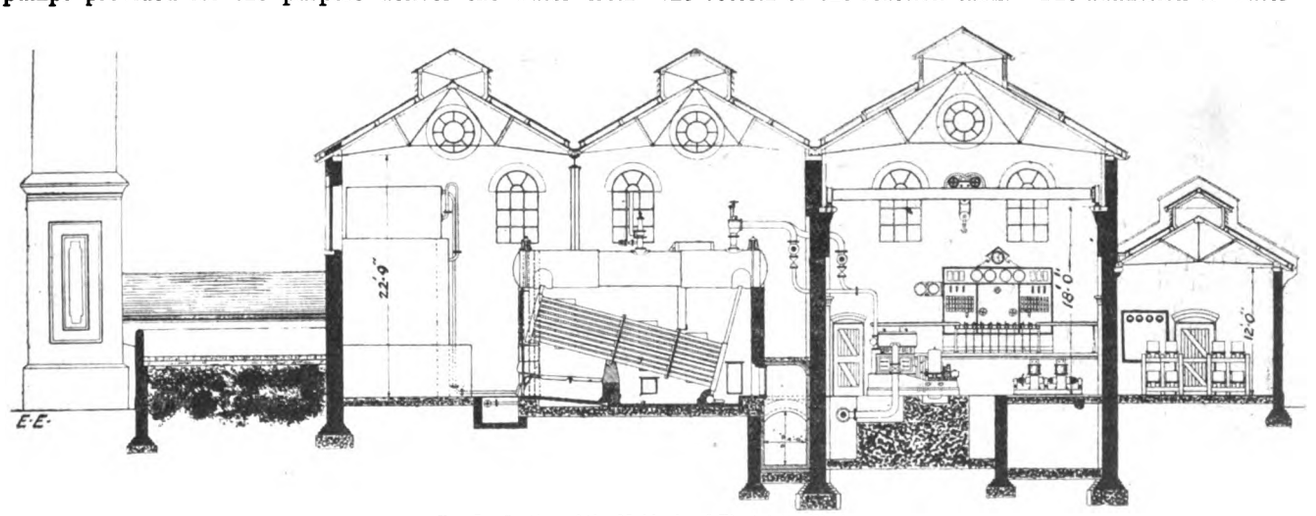

FIG. 3.—Section of the Maidenhead Electricity Works.

this well into a large service tank placed in a corner of the boiler-house at a considerable elevation above the floor level, as shown in Fig. 2 From this tank the water is drawn for boiler feed, but, being hard, the supply to the boilers is first treated by a water softener. The capacity of the well has not yet been fully tested, but its flow is enough for condensing at present. In order to conserve the supply of water from this source, it is probable that a cooling pond for the condenser water will be constructed, there being ample room

available. Meanwhile, provision has been made for an auxiliary supply of water from the town service mains in case of need.

In the boiler-house there are at present installed two Babcock and Wilcox patent water-tube boilers, set in one battery, each having 1,619 square feet of heating surface, and constructed for a daily working pressure of 160lb. per square inch. The same firm also manufactured the water

softener (Oscar Guttmann patent), which is capable of dealing with 1,500 gallons of water per hour. This softener and combined heater consists of a chemical tank, into which the quantity of soda required for the day is put. The tank is filled with water, and steam admitted to a flat perforated coil at the bottom in order to dissolve the soda. Underneath the chemical tank is the reaction tank, into which the impure water runs through a pipe, which reaches to the bottom of the reaction tank. The admission of water is controlled by a valve, which is actuated by means of a rod connected to a float in the storage tank for soft water. A similar valve, which is connected to the same float, controls the admission of the soda solution, but between this and the chemical tank an ordinary cock is interposed in order to control any variation in the strength of the chemical solution or in the composition of the water. The mixture of water and soda solution in the reaction tank is heated to near boiling point, and at the same time thoroughly agitated by means of a steam injector. The

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treated water flows from the reaction tank over a weir into a filter tank. This is rectangular, with divisions reaching alternately within a few inches from the bottom and top, forming compartments which compel the water to take a zigzag course. These compartments are filled with wood wool as filtering material, and this is so disposed by means of perforated plates that it can be compressed to the required density for the purpose of complete filtration, and at the same time a free passage is left for the water, with space underneath for the accumulation of sludge. The water passes from the filter in a perfectly clear state into the feed-water storage tank below. The outlet of this storage tank is connected to the feed pump, which latter exhausts into the tank. The whole arrangement is very compact and easily accessible, being placed under cover, as shown in Figs. 2 and 3.

There are two steam mains (see Fig. 3), one in the engine-room and one in the boiler-house, each connected to each boiler and engine separately. The exhaust is taken below the floor round the engine-room, across the condenser pit to the atmosphere, through an automatic exhaust valve.

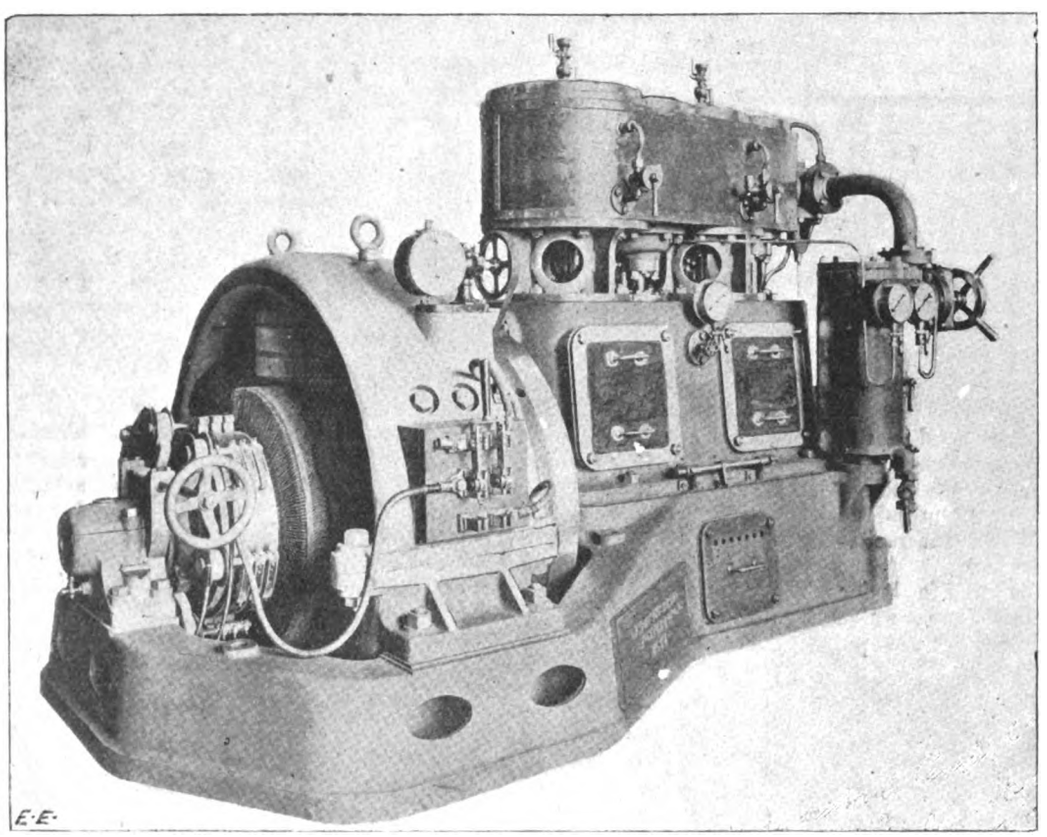

FIG. 4.—60-kw. Steam Dynamo, made by the Industrial Engineering Company, of Newton.

Before passing to the vertical pipe the steam is passed through an exhaust box in order to extract all grease and water. This does away with the unsightly exhaust head often fitted for the same purpose, and being in an accessible position it can readily be kept clean and in order. The condenser is of the jet type, by Messrs. J. H. Carruthers and Co., of Glasgow. The feed water can be delivered either direct into the boilers from the feed-water storage tank, or through the economiser provided in the main flue. The feed pump is by Messrs. G. and J. Weir, of Glasgow, and, in addition to this, each boiler is fitted with an injector.

As will have been gathered from the foregoing, the steam and feed pipes are in duplicate throughout, so as to minimise risk of breakdown. It may be mentioned that the whole of the pipework, condenser, pumps, etc., have been supplied and erected complete by Messrs. Aiton and Co., of Willesden Junction. The economiser is by Messrs. Arthur Lowcock, Limited, Coleham Foundry, Shrewsbury, and consists of 96 heating pipes, in sections of eight wide arranged in one group, provision being made for enlarging in the future. The bottom branch pipes are provided with access lids opposite each box, so that every section may be cleaned out separately. The top boxes are fitted with the new type of internal lid over each pipe, which can be easily removed and a pipe withdrawn without disturbing any other part of the apparatus. The scrapers are of Lowcock's patent spiral type, the scraper gear being operated by automatic reversing motion driven by a 1½-h.p. electric motor.

In the engine-room (see Fig. 3) there are installed three steam dynamos, each consisting of a vertical high-speed engine of 95 i.h.p. output at 500 revolutions per minute, coupled direct to a multipolar continuous-current dynamo of 60 kw. capacity at 460-500 volts terminal pressure. It will thus be seen that the total engine output amounts to 285 i.h.p. and the dynamo capacity to 180 kw. The contract for the three generating sets was placed with the Clayton Engineering and Electrical Construction Company, Limited, but owing to the liquidation of that company, the receiver (Mr. Broderick) made arrangements with the Industrial Engineering Company, Newton, Hyde, Manchester, who had purchased the entire works and plant of the Clayton Company at Newton, to complete the contract for him, and we are indebted to Mr. F. S. Ransome, A.M.I C.E., for the particulars below. The engines are of the two-crank compound self-lubricating type, having cylinders 8in. and 15½in. by 6in., running at a speed of 500 revolutions per minute. Fig. 4 is prepared from a photograph of one of the combined sets.

The dynamos were designed by Mr. H. V. Bowen, A.M.I.E.E. The machines are of the six-pole type. They are shunt and compound wound for lighting and traction purposes respectively. When operating as shunt generators each gives 60 kw. at any voltage between 460 and 500, and as compound generators 500 volts at no load, rising to 550 at full load. Each machine is provided with a throw-over switch mounted upon the yoke, so that in one position of the switch the generator operates as shunt, and in the opposite position as compound. The yoke and pole cores are of soft cast iron and steel respectively, and the frame is divided across the horizontal diameter. The armature stampings are mounted upon a substantial cast-iron spider and thoroughly ventilated. The armature coils are former-wound, and well insulated with tape and varnish before being laid in the slots on the periphery of the core. The slots are lined with insulating troughs made up of micanite

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and presspahn. The armature coils are assembled on the core upon the "straight out" or "cylindrical" system. The coupling is embodied with the spider and is cast with same, this arrangement relieving the shaft of practically all the driving strains. The commutator is of hard-drawn copper, and the average voltage between adjacent segments does not reach 15 volts. The cap of the end bearing is arranged that it can be removed without interfering with the brush gear. The current density of the carbon brushes does not reach 25 amperes per square inch at normal full load. Figs. 5, 6, and 7 are a few curves taken from one of these machines. Fig. 5 is the efficiency curve (including the friction of the brushes and end bearing) of the machine running as a shunt generator and with 480 volts at its terminals. The machines when tested operated with one set position of the brushes from no load up to 25 per cent.

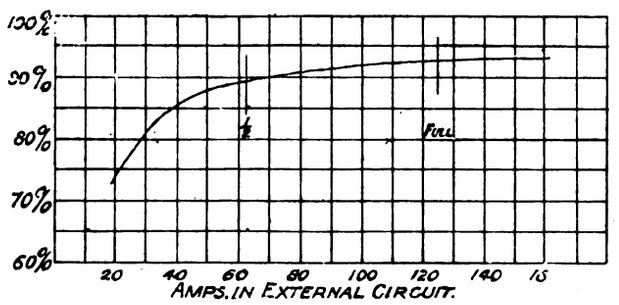

FIG. 5.—Efficiency Curve of Dynamos as Shunt Machines at 480 volts.

overload and without any sparking taking place, and also the full load was thrown on and off several times with unaltered brush position without any flashing over taking place. The temperature rise above the surrounding air of the parts of the machines, after running six hours at 480 volts 125 amperes, was only 45deg. F. on the hottest part of the armature core—under the pole face—the windings on the ends rising only 15deg. F., and the commutator and magnet windings each being under 30deg. F. The above figures indicate the thoroughness of the ventilation of the machines throughout. The excitation watts required at full load on the shunt generators were 920. The weight of each machine complete is a few pounds over three tons. We understand that the Industrial Engineering Company, of Newton, Hyde, are discontinuing the manufacture of high-speed engines, but are manufacturing dynamos and motors for all purposes and in all sizes up to 500 kw. since they have become possessed of the works lately in the occupation of the Clayton Engineering and Electrical Construction Company, Limited.

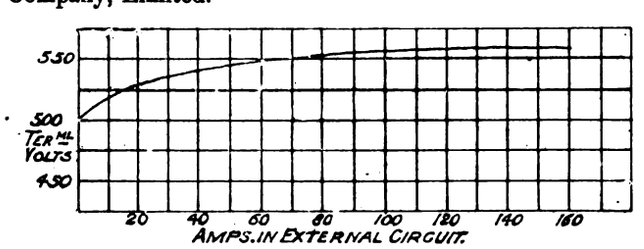

FIG. 6.—Compounding Curve of the Dynamo as Traction Generator.

The five-ton crane in the engine-room was supplied by the Chatteris Engineering Works Company. It has a span of 24ft. 9in., and is worked by hand ropes from the floor level. The crane is fitted with a self-sustaining brake which gives easy control over full load, the full load being lifted on a steel wire rope and grooved barrel. The lifting hook is fitted with ball bearing to ensure ease of turning with full load. All bearings are provided with Stauffer lubricators.

The accumulators, placed in the room to the right of the engine-room (Fig. 3), are of the Hart type, supplied by the Hart Accumulator Company, of Stratford. They are connected as two batteries, each of 128 cells. The guaranteed capacity of the cells is 35 amperes for 10 hours, or 70 amperes for five hours, with maximum discharge rate of 100 amperes for emergency. The capacities are to be provided without the volts on a cell falling below 1·86. The cells are contained in glass boxes. The plates are supported inside the boxes by an entirely new method, consisting of a teak-wood frame, which surrounds the section and prevents any possibility of spreading or buckling. For special charging two milking dynamos are provided, these being placed in the room adjoining the test-room, leads from one of the milking dynamos being taken into the test-room for meter-testing purposes. An exceptionally good equipment of testing instruments is provided, including a Crompton potentiometer.

The switchboard connections are shown in Fig. 8, from which the arrangement of the balancers and boosters can be seen. These machines are of the type made by Bertram Thomas, of Hulme, near Manchester. The switchboard was manufactured and erected by Messrs. Johnson and Phillips, of Old Charlton. The arrangement is remarkable for the way in which risk of arcing and fire has been reduced. Thus all the regulating resistances are placed under the gallery, where they are readily accessible for inspection from the engine-room floor. The regulating switches are mounted on the switch gallery rail. Another feature is that the board is arranged to deal with a traction load as well as lighting. Thus in each dynamo circuit there is on the positive side a British Thomson-Houston automatic maximum-current circuit breaker and an ampere-hour meter; on the negative side a quick-break combined main dynamo equalising and shunt-breaking switch, which ensures that the operations of making the shunt circuit, putting the compound winding on to the equalising 'bus bar, and, finally, putting the incoming dynamo on to the 'bus bars, are completed in their proper order by the movement of one handle. There

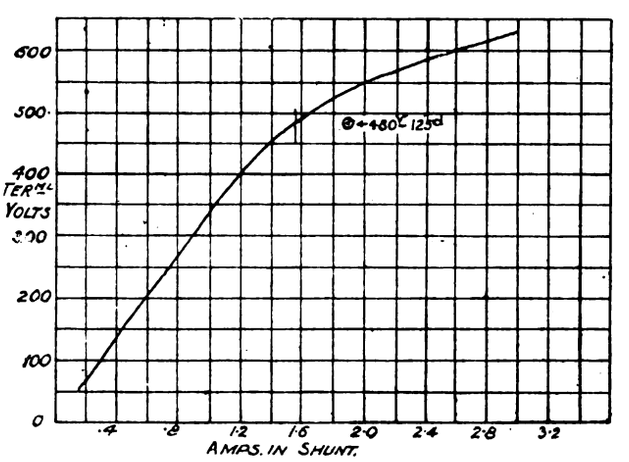

FIG. 7.—Magnetisation Curve with no Current through the Armature.

is also a single-pole switch, a fuse, and an ammeter. The battery circuit switches are arranged on either side of the zero wire, so that the difference of voltage on them is kept low. The switches themselves are placed behind the board, and connected by bare copper rods to the end cells of the two batteries. They are operated by gearing with aluminium handwheels in the front of the board.

The booster change-over switch is mechanically interlocked with the booster generator field-breaking switch, thus preventing the booster armature being short-circuited when the field is on. The side panels of the board are of the well-known plug type, with four horizontal plug bars on both positive and negative sides, and each of the generators, feeders, etc, have a vertical 'bus bar on each pole. The whole board is made up of enamelled slate and cast or wrought iron, etc., no wood or inflammable material being used throughout. All the instruments are of Johnson and Phillips's well-known make, being of the Weston type, the voltmeters having illuminated dials and the ammeters being of the edgewise type, some being at the bottom of the board and others at the top. There is a cast-iron pediment at the top with the usual eight-day clock, and a swing break on the negative side with two illuminated dial voltmeters placed across the feeders and giving the volts of any of the three or more feeders. All the cable work in the engine-house has also been carried through by Messrs. Johnson and Phillips, the cable being of their own well-known make, N. A. class, the cable being run on porcelain insulators.

The system of mains, as indicated above, is a three-wire

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one, and the contract for the supply and laying of the cables was placed with Callender's Cable and Construction Company, Limited. The cables are of a somewhat novel type, being triple concentric, with paper insulation, which is sheathed over all with a solid tube of vulcanised bitumen in place of the ordinary lead sheaths. The great advantage of this vulcanised-bitumen sheath is that it is a non-conductor, and therefore offers no inducements to stray currents, and is therefore not liable to disintegration by electrolytic action These cables are drawn into Sykes's patent jointed conduits. The network in the town consists of about four miles of distributors, of which two miles is of ·10, ·05, ·10 square inch sectional area, and the other two miles of ·08, ·04, ·08 square inch sectional area. The network (Fig 1) is fed at a point close to the river by a triple-concentric ·10, ·05, ·10 feeder, which feeder is about one mile in length, and at two other points in the middle of the town by simple concentric ·10 square inch cables, these two latter feeder points being about half a mile each from the generating station. The network is divided up into two distinct sections, connected through an underground safety fuse box. There are four arc lamp circuits: three of 10 lamps are run in series across the outers—*i.e*, 460 volts—and one of five lamps run in series between the middle and an outer. The arc lamp cable has a sectional area of ·022 single conductor insulated with vulcanised bitumen. A three-core pilot wire of the ordinary Board of Trade standard size is laid to each feeder point alongside each feeder. The system is very efficiently provided with disconnecting boxes, so that any street can be disconnected from the rest of the network at almost a moment's notice The Fishery Estate is treated as a separate network, which consists throughout of ·08, ·04, ·08 triple-concentric paper-insulated and vulcanised-bitumen sheathed cables laid in Sykes's conduit exactly as the rest of the town. In a few cases, where extensions are impossible, armoured cables have been laid.

The arc lamps in the public streets are 37 in number, there being three series circuits of 10 lamps each, one circuit of five lamps, and two odd lamps. These are all of the British Schuckert open arc type. The two incandescent lamps on the same poles are to be switched on at 11 p.m. each night. The positions of these lamps are indicated in Fig. 1. Nernst lamps are also to be tried for lighting additional streets, and if the experiment is successful, the whole street-lighting of the borough will be taken over.

The arc lamp standards were supplied by Messrs. McDowall, Steven, and Co., of Glasgow, and are of pleasing appearance. For about 7ft. above ground the pillars consist of a moulded base enriched with flutings and foliage in bold relief. The shaft is plain, and tapers towards the top, where it terminates in an arc lamp bracket of the "swan-neck" type, ornamented by scrollwork in cast iron of a simple but effective design, and arranged to project lamp 3ft. from pillar at a height of 20ft. above the ground. About half-way up the shaft there is an ornamental cast-iron cap, from which spring two small brackets to take incandescent lamps, and designed to harmonise with the arc bracket.

The demand for light and power has quite come up to expectations. The equivalent of about 4,000 lamps of 8 c.p. has already been applied for by some 80 consumers; also one of the local breweries is installing electric motors with an aggregate demand of 17 h p, which will provide a load for the day. In fact, it is expected the station plant will be fully loaded by the end of the winter, and extensions of plant are already contemplated. A special launch-charging station is being equipped on the riverside, and will contain a motor-generator, so that the voltage can be varied to suit the different requirements of electric launches. It is suggested that a supply will be given to one or two of the launch builders in bulk, which will enable them to use the current for their own purposes and to retail it to others. The supply meters installed up to the present are of the Chamberlain and Hookham type for large consumers, while Bastian meters are employed where the number of lights is small.

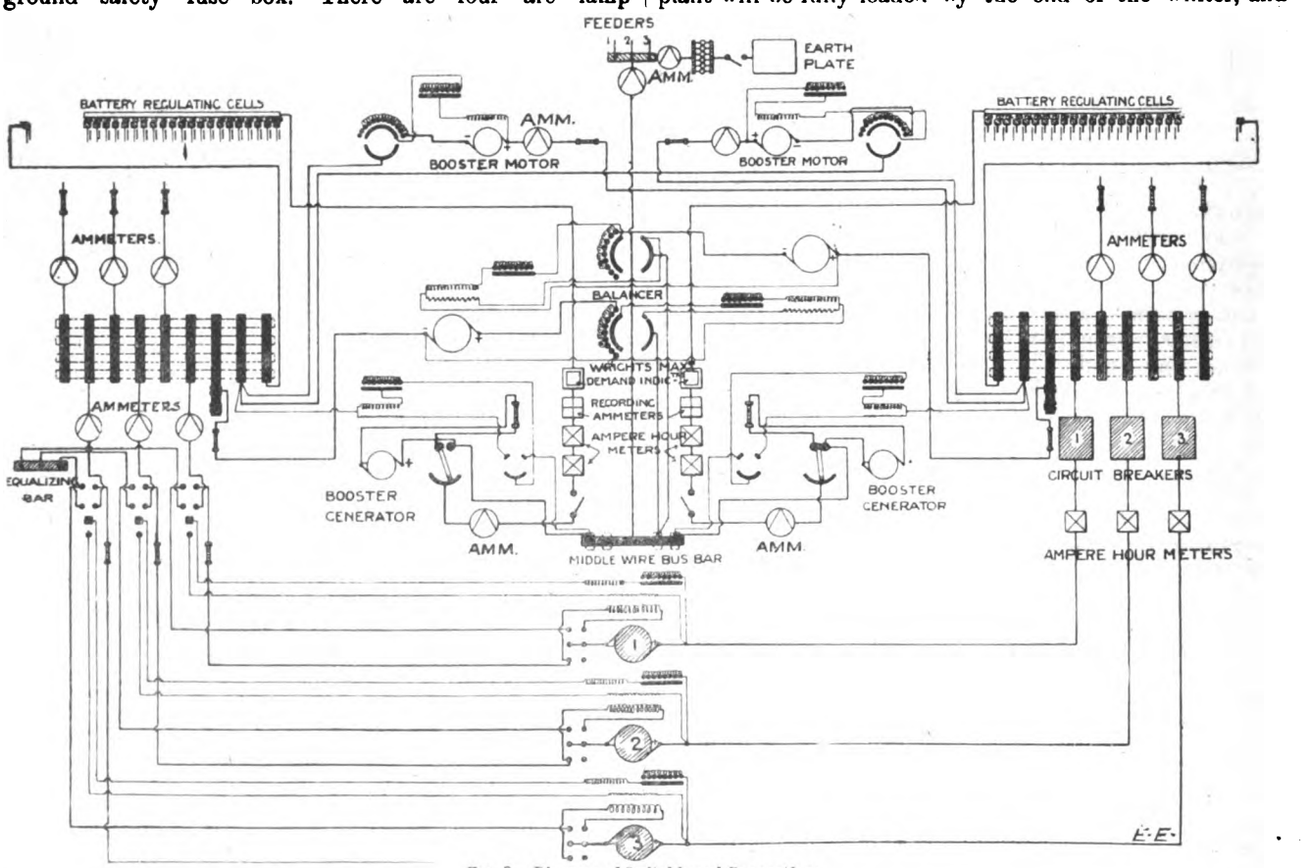

Fig. 8.—Diagram of Switchboard Connections.

The opening ceremony on Wednesday last was divided into two operations, the first of which took place in the central station. After a speech by Mr. J. E. Pearce, the mayor, in which the technical details of the undertaking were explained to the large company present, Mr. Ernest Gardner, M P., formally started one of the engines. After the works had been inspected, the company adjourned to the town hall, where the lights were switched on by the High Steward, Mr. W. H. Grenfell, M.P. After this function and the accompanying speeches were concluded those present were entertained to tea by the Mayor.

Mr. C. O. Milton, the resident engineer to the Corpora-

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tion, has had charge of the work during completion, under the superintendence of Messrs. Burstall and Monkhouse, the consulting engineers. Mr. Milton's extensive experience at Hull as assistant engineer eminently fitted him for the position of chief at Maidenhead, and it is worthy of note that the committee selected him for this position out of 130 applicants.

We have to thank the consulting engineers for the loan of the drawings from which our illustrations have been prepared, and also Mr. Milton and the various contractors for the various details of the scheme which appear above. It only remains to wish the Maidenhead electricity works a prosperous career under the able chairmanship of Councillor J. E. Pearce, who is sparing no effort to attain this end.

SOME ENGINEERING HINTS ON A TRAMWAY SYSTEM.

BY W. DALTON.

In the following article an endeavour has been made to discuss some of the chief points in the design and running of a tramways power-house, etc.

Site of Power-House.—The ideal site for the power-house when minimum transmission losses are desired should, if possible, be situated in the centre of the area of supply, providing that the price of the land is not prohibitive. But whether this site be adopted depends also on the availability of water for condensing purposes, and also if it be conveniently near a railway siding or river where the coal can be cheaply delivered to the bunkers. Another thing should also be taken into consideration to avoid legal troubles, and that is to isolate the works as far as possible from any property the owners of which might object to the vibration and noise of the running plant. There is no doubt that the ideal site is that close to the banks of a river or canal, as this means cheap coal and plenty of free water for condensing purposes. As a constant circulation of water could be obtained, no cooling towers or ponds would be required, thereby saving a great amount in capital outlay. With regard to the dimensions of the building, it should be designed for probable extensions consistent with a view to future demands. One of the greatest mistakes which engineers of many stations have to put up with to-day is conglomerated and unsymmetrical machinery, due to the station having been originally put down without any consideration having been paid to the probable future demands to be made on it.

Steam Plant: Boilers.—The type of boilers to be used is chiefly a matter of opinion, as both fire and water tube boilers have their good points. Water-tube boilers have the advantage that in cases of emergency loads they can be forced without fear of damage. If by some unforeseen accident they should lose their water and an explosion occur, the damage done is small as compared to a fire-tube boiler under the same conditions. The floor space occupied is small. Water-tube boilers require very careful handling, as if they are carelessly stoked fluctuation in steam pressure occurs, and if the feed water is not closely watched the same thing happens, or else, which is far more serious, priming takes place. Of course, what are claimed as disadvantages for this type can be got over if the boilers are well looked after. In the writer's opinion, Lancashire boilers are generally most favourable for central-station practice, combined with water-tube boilers for emergency loads. The ratio of water-tube type should be about 25 per cent. to the total boiler capacity installed. Boiler fluids should not be used unless the feed water absolutely necessitates it. When a boiler is new, a good plan to give it a kind of protective skin on its interior is to feed it with sea-water for the first week or fortnight; as this cannot often be procured, ordinary salt water might be used. On no account must oil be allowed to find its way into the boilers, or it will deposit on the furnace crowns and form a non-conducting covering, and the plates will heat; and, as is well known by every engineer, the ultimate result is, if this point be neglected, the crown of the boiler will probably bulge or collapse. To guard against this, the oil filters fitted in the engines should be well looked after. Turkish toweling makes a good filter. Instead of filters, oil separators are sometimes used, and give satisfactory results.

Engines.—The type of engine or sizes of units cannot very well be discussed, as they vary so much under different conditions. Where big units are required, the marine type of engine is very satisfactory. The advantages of Corliss valve gear over the ordinary "D" type or piston valve are generally known and recognised, but besides the quick cut-off produced, is that with variable expansion governing stresses on the moving and reciprocating parts due to rapidly changing inertia is overcome to a great extent, the engine runs quieter and more smoothly. The governing is also better, and there is less clearance.

Auxiliary Machinery.—When designing a station, all auxiliary machinery should be duplicated. Nine-tenths of failure of supply from stations can be traced to breakdowns of condensing plant, pumps, or engines driving mechanical stokers, etc., and having no spare gear to take their place. This is an important point, but one which is often overlooked. Electrical feed pumps are often adopted, but they have one drawback. If the volts drop, due to a load coming on just at the time when the boilers should be forced, the pumps slow down and the boilers get less water. Of course, speeding-up apparatus can be fitted, but, generally speaking, direct-acting pumps give more satisfaction.

Oil.—The quantity of oil used should have careful consideration. Engineers often pay little attention to this point, but it is a vital one. As long as they do not get hot bearings they seem quite satisfied. If they would only consider for a moment the power used in raising to a safe limit the temperature of an average bearing, and keeping it at that temperature, and the amount of coal thus wasted, they would treat the matter more seriously. For high-speed engines the oil used can be thinner than that for low-speed, but it should be of good quality. A cheap oil is never economical; on the other hand, it is detrimental to the efficient running of the plant, and helps to put up station costs. It is far better to have a dearer oil and use less of it, and get a better lubricating effect. The surfaces in a bearing should never touch. They should be kept separate by a film of oil. Good oil only will do this. Cheap oil will not. Let this experiment be tried. Buy a dear oil and use it carefully. Then try a cheap oil. Endeavour to use only enough of this oil to keep the bearing in the same condition as when the good oil was used. Compare prices at the end of the test, and it will be found that in the long run the cheap oil works out more costly than the more expensive kind, for the reason that a greater quantity has to be used proportional to its inferior quality. Automatic lubrication should be used wherever possible, as this gives an even and constant supply of oil. Hand oiling tends to flood a bearing one moment and the next the bearing has not enough oil to sufficiently lubricate it.

Switchboard.—The switchboard should be as simple as is consistent with it being practical. Complicated connections often lead to an accident being aggravated, due to an attendant losing his head at the time he most requires it, and pulling out or throwing in a wrong switch. Provision should be made on the board for the station lighting being run from the battery, and at night the lighting should always be connected this way, so that in the event of a machine circuit breaker coming out (which if it were a large unit would probably bring out all the others, if there were any running), the station lighting would still be maintained. This connection to the lighting should be taken from the "wrong" side of the circuit breaker, and thence through a smaller one to the lighting panel; so that if the battery should be floating on the line and a short occur, although the generator and battery circuit breakers might open, it would not affect the lights. If the town lighting is run from the traction board, the same arrangement should be made. Perhaps a better method would be to arrange that car-sheds, station, and town lighting be done from a high-speed direct-coupled set. It is the usual custom to fit maximum circuit breakers to the generators only, but where a battery is installed it is

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a good plan to fit minimum circuit breakers also. Suppose a machine is being taken out of parallel, it is advisable to let the current get as near zero as possible, so that the load is not suddenly thrown on the other generator (or generators) left running; and in the endeavour to do this the attendant engineer might let the load get past zero before he could pull the circuit breakers, which would not only tend to motorise the generator, but the battery current might reverse the polarity of the machine. Plenty of space should be provided behind the board. Serious accidents and loss of life occur through men having to work in a restricted passage behind the board.

Batteries and Boosters.—The only successful method of dealing with a rapidly fluctuating traction load is by means of a floating battery on the line direct, or through the armature of an automatic booster. For a station capacity of, say, 3,000 kw. to 4,000 kw. the battery power installed, if it is really going to be of any use, should be about 20 per cent. of the total engine power. For small stations—say 1,000 kw. to 2,000 kw. capacity—the battery power should be from 40 to 50 per cent of the total engine power. This would enable the steam plant to be shut down at times of light load. Many engineers a few years ago, appeared very sceptical as to the real advantages of a storage battery for traction work. They appeared to argue from one point of view only, and that was that the efficiency was, under the very best circumstances, only about 75 per cent., and that the cells soon deteriorated. The fact that the efficiency of the power put into the power taken out is only, say, 70 to 75 per cent, is no argument at all. It will be seen that the ultimate efficiency indirectly is much higher than this when the following is taken into account. With a battery the load on the engines is kept constant, thereby saving a great deal of wear and tear, reducing the stresses to a minimum, and generally prolonging the life of the engine. The volts are kept almost constant. When a heavy load comes on, the battery at once picks up that load, leaving the engine running as smoothly as though it were running on a test tank. When the load suddenly drops off, the battery drops it, the engine does not; and if it falls still lower, the engine still runs on with the same load, the amperes which went off the line having automatically been transferred to the battery charge. This happy state of affairs is even more apparent when the battery is connected through the armature of an automatic booster. The usual method adopted is that the main current of the station (or a portion of it) goes round the series coil of a booster, its exciting power being neutralised by a shunt winding. When the station load is normal, the two windings exactly neutralise each other, the battery doing nothing. If a load comes on, the increase in the series field intensifies it, which overpowers the shunt field, and the battery immediately discharges. If, on the other hand, the load drops, the reverse action takes place and the battery is charged. Another type of booster is for boosting up the volts for charging the battery, or boosting up a line or rail feeder, but is not automatic The series coils of the two generators are in series, and part of the current can be shunted, if desired, through a resistance. The line current excites the machines, as a part of a negative current in damp weather might tend to leave the rails, and the volts would not be raised in proportion to the increase of load. A subsidiary 'bus bar is provided with throw-over switches on the station switchboard, and when there is any undue drop on the feeder the machine is run up and the switches thrown on to the subsidiary bar. A good plan is to make out a set of tables of the drop in the feeders at various loads, and keep it by the switchboard and boost up accordingly. Another method is to watch the recording voltmeters on the Board of Trade panel, and see that the limit is not exceeded. If shunt-wound generators are used for traction work, an automatic series-wound booster should be used. With this arrangement, when the external load increases the battery begins to discharge, due to the volts on the generator falling As this discharge current excites the booster it gives a few additional volts, which increases the battery discharge still further, all the overload current coming from the battery.

Cables.—As the cables and mains on a tramway system form an important branch of the undertaking, too much attention cannot be given them. It is a mistake to put down cables of small section, as it is generally discovered later that they are quite inadequate to cope with the work put on them, and loss of power is the result. ·5 square inch section should be the minimum; even if the system originally is on a small scale, this will ultimately be found none too large. At the points where the line is fed, the feeders should be arranged to go through disconnecting boxes before going to the section pillars, so that they can be disconnected for testing purposes. By this means a very much more satisfactory test can be made, as if they are tested connected to the switch panels in the pillars a large leakage surface is provided, which makes the cable come out apparently low. This arrangement also applies to rail feeders. The types of cables in general use are indiarubber, jute, non-hygroscopic, guttapercha, and paper. Indiarubber as a form of insulation has been superseded by resinous oil impregnated paper for the following reasons: (1) very much cheaper compared with indiarubber; (2) its insulating properties are as good so long as moisture is kept from it; (3) its durability is greater in most cases than indiarubber. The same reasons apply to non-hygroscopic material. Guttapercha is never used, as it becomes very plastic at low temperatures, thereby causing decentralisation of the conductor. Jute is still used in many cases, and proves a very good form of insulating material. It is absolutely imperative that all cables insultated with paper and jute should be lead cased. The best form of armouring for a heavy cable is hoop iron. The only weak point about this type of armouring is that its tensile strength is small, but for heavy conductors this need not be taken into account. For small cables a wire sheathing is better, as its tensile strength is very great and no strain is put on the conductor. With regard to types of cables used for alternating or polyphase work, the chief thing in the design of a cable which is going to have a low power factor is capacity. Now, capacity not being a very tangible subject to study, it causes students and even engineers to lose their tempers, and after trying to grasp it for a few months they give it up altogether as hopeless. It certainly is too long a subject to discuss here, but capacity may be summed up as this: taking a piece of iron having a certain permeability for absorbing magnetic lines of force, then the capacity of an insulating medium for absorbing electrostatic lines of force can be held as an analogy to permeability. Capacity is proportional to the area exposed, and theoretically inversely proportional to the dielectric resistance. The losses due to a high capacity are in some cases greater than the $C^2 R$ losses. Electrification is a later form of capacity effect, and when testing cables the number of megohms which that cable gives is no criterion whatever of its quality or volt-resisting properties; its only advantage being the utility of being able to make a simple loop test to localise a high-resistance fault without making allowances for the resultant of the normal leakage.

Electrolysis.—Earth-plates on a tramway system invariably give trouble if used near the supply station as a means of bringing back to the generators part of the negative current. Insulated return feeders of an ample section should be used, as they tend to prevent electrolysis, and very little trouble from this source will be found if they be adopted, providing the bonding of the rails has had good attention. The bonds should be inserted in holes which have been freshly drilled without lubricating. The sheathing of the cables (both line and return) should be metallically connected together at all electro-negative points and the earth, the earth consisting of bonding to the rails or to the conductor of the return feeders. This will bring electrolytic action down to a minimum, although at times of heavy loads the current may tend to leave the rails at points distant from the station (especially in wet weather) and return by the sheathing of the cable: it will not affect the cable, as it has a metallic path to guide it back to the feeder. There is no objection to current getting into a system of piping or the sheathing of cables; it is where it gets out that the mischief is done. If there are feeders belonging to other electric supply systems adjacent or running parallel to the rail of the tramway, it would be to the interests of the owners to see that the sheathing of their cables are bonded to earth also

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If the tramway company will not allow them to be bonded to their rails they should be connected to earth-plates, as this will locate the electrolytic action to the earth-plate, and relieve the cables from any likelihood of damage.

Application of Polyphase Currents to Tramway Work.—In a previous part of this paper attention was drawn to the section of feeders not being less than ·5 square inch section, as the losses in smaller cables, if they are of any considerable length, are so great with a pressure of only 500 volts. Now, in some cases where the routes go from the centre of supply—say three to six miles—polyphase working can be combined with a continuous system with great saving and advantage. At the termini sub-stations could be built (if there are car-sheds, which is quite probable, the sub-stations could be included in them, and so save the cost of a special building) to contain the transforming apparatus. The most suitable system to adopt for this would be to generate three-phase currents at a pressure of, say, 5,000 to 6,000 volts, and then transform by means of a rotary transformer back to 500 volts continuous, the two sections of the line being separated in the usual way by section pillars and switches. For generating the three-phase currents a combination machine might be adopted at the power station, consisting of an engine with a continuous-current generator on one side for feeding the centre part of the town and a three-phase machine on the other side, or the three-phase sets might be quite separate.

NOTES ON POLYPHASE MOTORS.

(Continued from page 841.)

Turning again to Fig. 13, we see that when we employ a fourth wire the E.M.F. and current between each line wire and the neutral lead is that due to one of the three windings, A, B, or C, and therefore will have as its maximum value V or I. Between any two line wires we have seen that the tension will have as its maximum value V volts, but it is apparent that in this case also the current is that due to only one winding, and that therefore the maximum value of the current will never exceed I. In the case of the mesh formation the tension is that due to one winding only, but the current is the sum of the two currents in the two windings. These two currents are not in phase, therefore it is not sufficient to add the algebraical values, but, proceeding as before, we must add the sines, and shall obtain as the resulting value $\sqrt{3}$ I as the maximum value. Hence we see that with the star formation the current has as its maximum the value I due to one winding only, but that the tension between two wires is equal to $\sqrt{3}$ V; while with a mesh formation the tension between two wires is only that due to one winding, V, but that the current is equal to $\sqrt{3}$ I. The star formation, therefore, is more economical as regards the weight of the transmission leads required. This method of connecting up the windings has a further advantage, as, although not necessary for motor installations, the fourth lead can be run in combined lighting and motor installations; the tension between any line wire and this being only $\frac{1}{\sqrt{3}}$ of the tension between any two-line wires, often permits of a standard make of lamps being used for the incandescent lighting. For instance, if the voltage of a star-connected installation is 400, the E.M.F. between the fourth wire and the line is $400 \div \frac{1}{\sqrt{3}} = 230$, for which tension stock lamps can be obtained. This fourth wire in this case would only be carried to the lighting circuits, the motor circuits being run entirely independent of it.

We have treated the generator as though a three-phase dynamo were an adaptation of an ordinary direct-current machine. This is not the case at all. Any alternator can be altered to give a three-phase current, and it is immaterial whether the machine be of the revolving-field type, the revolving-armature type, or the induction type: they will all work equally well if properly designed and built. It will also be apparent that the conversion of a monophase alternator to a polyphase machine will increase its output, as the second and third coils on the armature to a great extent occupy space that cannot be advantageously utilised for the generation of a monophase current.

Polyphase motors are of two types—viz., synchronous motors and induction motors. The former are easy to understand, as they are simply polyphase generators run as motors. In the generation of an alternating current we are compelled to utilise a direct current for the excitation of the field, and consequently every alternator is separately excited from an auxiliary small dynamo called the exciter, which may be directly connected to the shaft of the alternator or belted to it or driven from a separate engine. If, now, an alternating-current generator is put down to run as a synchronous motor, it will still require to have its fields excited by means of a direct current; this direct current could, of course, be supplied from the alternator exciter, and a pair of small direct-current mains run from the switchboard to each motor. This method would be costly and complicated, so that, in place of adopting it, a small direct-current exciter is connected to each synchronous motor, and only a three-phase current is supplied. The way the motors are started is as follows. A compensator or other device to lower the tension is inserted in the circuit and takes the place of the starting resistance in the case of a direct-current motor, the current passing through the armature coils gives rise to a magnetic field, which induces poles in the iron of the mechanical portion of the field of the motor. These magnetic poles react on the armature, which commences to turn round. More current is required, and stronger induced poles are so created. Gradually the speed of the armature approaches to synchronism. In the meantime the armature of the direct-current dynamo connected to the motor has begun to revolve, and to generate an E.M.F. As the speed of the main motor approaches synchronism the voltage generated in the exciter will approximate to its normal, and the fields of the motor can then be directly connected to the exciter. The conditions of working are now those that obtain in practice, and the motor will be in true synchronism and the load may be thrown on. The great objection to the use of this class of motor is the cumbrous method of starting which it entails, added to the fact that the motors will not start under load. Each machine consisting of a motor proper with its exciter, there are more parts to be kept in order, and often no advantage over the more ordinary direct-current system.

The use of the synchronous motor exists still, because in certain cases it has advantages over the more customary installed induction motor. It has a constant speed for all loads, while, owing to the direct exciting current, its power factor may be made equal to unity. The efficiency of the synchronous motor is usually rather higher than that of the induction motor, while for very slow speeds it is cheaper to build, notwithstanding the fact that it consists of two machines, in place of the single type of machine given by the induction motor. A further advantage is that the current may be made to lead in phase, and so made to compensate to some extent the lagging current due to the induction motors in another part of the circuit.

As we have seen above, the action of the synchronous motor in starting is the same as that of the induction motor, but the conditions are not as favourable, consequently a synchronous motor is not suitable where frequent starting or large starting torques are required.

It must also be remembered that the speed of the synchronous motor depends upon the number of poles, so that when we speak of a motor running in synchronism, we do not necessarily mean that it runs at the same speed as the generator, but that it runs at the same speed as the generator would were it fitted with the same number of poles. The speed of the synchronous motor depends upon the periodicity and the number of poles, and not upon the voltage of the current supplied to it; hence the speed of the motor can only be altered by altering the speed of the generator, which has the effect of altering the periodicity.

Notwithstanding that synchronous motors possess certain advantages, they are not used to much extent in this country, and therefore we can pass from further consideration of them, and devote more attention to the more generally adopted induction motor.

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We have seen that in the case of the alternating-current generator we are dealing with the same principles that we have studied with direct-current machines. The E.M.F. is generated in the armature by the cutting of the lines of force of the inductors, and, as with direct-current machines, either the magnets or the armature may be the revolving part; or we may adopt a third method, and obtain a revolving magnetic field by means of a stationary field and revolving pieces of soft iron in the air-gap between the poles and the armature. In the case of the induction motor, the revolving field is obtained in a different manner altogether. Here we have still the two parts which may for the moment be called the field and the armature, either or both of which may revolve, but if both are at rest we shall still have a revolving magnetic field. This field revolving independently of the motion of any of the mechanical, magnetic, or electrical parts of the apparatus constitutes the great difference between polyphase and direct-current machinery, and it will be necessary to carefully consider the structure of the machines with reference to the behaviour of polyphase alternating currents in order to obtain a thorough grasp of the principles underlying the working of this class of motor. Another difficulty which at once presents itself to the student is to discover which part is the armature and which is the field magnet. There are two distinct windings; one receives current from the mains, and this current induces an E.M.F. in the other set of windings, which causes a current to flow through it. Now, the current through the first winding is proportional to the load on the machine, and this winding is, therefore, similar to the armature winding of the direct-current machine, and it would then appear as though this ought to be called the armature. Against this argument must be set the fact that, as a rule, this part did not revolve in the earlier-built motors, and as the usual practice is to call the revolving portion the armature and the stationary portion the field, it became customary to call this part the field. Again, in dealing with horseshoe magnets, for instance, the armature is the part which joins the two ends and completes the magnetic circuit when the magnet is not in use, any magnetisation which may exist in it being due to induction. This is the case with the central portion of the polyphase motor; it is magnetised by induction only, and also completes the magnetic circuit of the other part, and may, therefore, be called the armature. In order to avoid the confusion which arose owing to the uncertainty as to which part was meant by different people by the two terms, it was considered advisable to abandon their use entirely, and to name the internal part in which the current was induced the "rotor" and the other part the "stator." This got over the difficulty for a time only, for when this class of machinery was first built the rotor always revolved and the stator was always stationary. But the difficulty was only removed for a time, for nowadays some makers build machines in which the rotor revolves in one direction and the stator in another, and we have the anomaly of having a rotating stator. But the difficulty does not end here, for other makers build motors with a stationary rotor and a revolving stator, and so matters are worse confounded to the student than they were when the terms armature and field were employed.

French writers have overcome the difficulty much more effectually. As we have seen, one winding receives a current from the external source, and this current induces an E.M.F. in the other winding. Now by terming the part carrying the winding which receives the external current the "inducer," the function of the part is clearly expressed and there is no ambiguity, while the other part bearing the winding in which the current is due solely to induction can be equally well called the "inducted." Such a nomenclature avoids all misconception, and at the same time the terms are distinct in the one case from "inductor," the correct term for the active portions of the wires on the armature of a direct-current or alternating-current generator, and in the other case from "induced," the adjective used to define the E.M.F. which is generated in the winding of the rotor. As, however, the terms rotor and stator are those which, though very badly selected, are generally adopted in this country, they will be the terms employed in these notes.

A difficulty which generally confronts the student at the commencement of his investigation of the induction motor is to understand why, as the windings of the stator are directly connected across the supply mains, there is not a large rush of current through them sufficient to burn out the wires, or why the current taken should be proportionate to the load on the machine. The difficulty is increased by terming this portion of the machine the field magnets, the name it originally bore, as the windings are then liable to be confused with the series turns of a direct-current motor, which would be certainly burnt out were they so directly connected across the mains. If, however, it is remembered that an induction motor fulfils the function of a direct-current motor and an alternating-current static transformer, the difficulty will disappear. We have seen that when a coil carries a current which is subject to rapid fluctuations in value or to frequent reversals in direction, a counter E.M.F. is generated in the coil which prevents the current attaining undue proportions; we have also seen that the intensity of this back E.M.F. will be greatly increased if the coil is wound round an iron core, which is the condition which obtains in the case of the stator winding of a polyphase motor. If an alternating current is sent through the primary winding of a transformer when the circuit through the secondary is closed, the back induction is so great that it prevents more than the smallest current to flow; if, then, the secondary circuit is closed through a high resistance the back induction of this latter neutralises the back induction of the primary to a certain extent, and more current is so permitted to flow through the primary

FIG. 14.

As the resistance in the secondary is decreased, more and more current will flow through it, and equally through the primary. As we shall see later, the stator winding of the induction motor is equivalent in its action to the primary of the transformer, and the rotor winding to the secondary. Hence it is easy to deduce that if little or no current is induced in the rotor winding at light or no load, there will be only a small current flowing through the stator windings, not more than would travel through the shunt windings of a direct-current motor. As the load increases, if the current induced in the rotor windings increases, then the current flowing through the stator windings will equally increase. In other words, we may say that the action of induction dams back the flow of current through the stator windings at light loads, but that as the load is increased the induction of the rotor current removes in proportion to its value the retarding effect of the induction due to the stator current.

In order to demonstrate the revolving nature of the magnetic field, it is necessary to consider the distribution of the induction in the air-gap at various instants when the values of the currents flowing through the different phases have different values. For the sake of simplicity, we will first of all consider the distribution of the magnetic flux when the rotor is at rest. Every polyphase motor is built with so many poles, the speed of revolution depending upon the frequency and the number of poles, and being independent of the voltage. But though the motor is built with a given number of poles, these are not so self-evident as is the case with the direct-current machine. On the contrary, the stator is built up of a circular yoke, the internal bore of which is grooved into a number of equally-

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spaced slots, as shown in Fig. 14, which is an illustration of one of the stators as built by the Westinghouse Company; the number of poles is determined by the way in which the wires are placed in the slots, or, otherwise expressed, the number of poles depend upon the number of slots occupied by each coil and by the total number of slots in the stator.

Let us assume that in a three-phase stator there are 36 slots and six complete coils, so that the turns of each coil is wound in six slots. Then the winding plan of this stator will be that shown in Fig. 15, where A, B, and C represent the three phases. Let us also assume that the maximum current which flows through any coil is represented by $I_{max.}$ We must also at this point in our investigation remember that the magnetising effect of any single turn of wire is equal to $4\pi I \div 10$, where I is the value of the current, in amperes, which flows through the coil. If there are n turns in the coil this equation becomes $4\frac{\pi}{10} n I$; special stress is laid on this point, for, although it is one of our first and most elementary expressions in all magnetic work, whether for direct or alternating currents, it is of the utmost importance in dealing with the distribution of the magnetic flux in the air-gap of a polyphase induction motor.

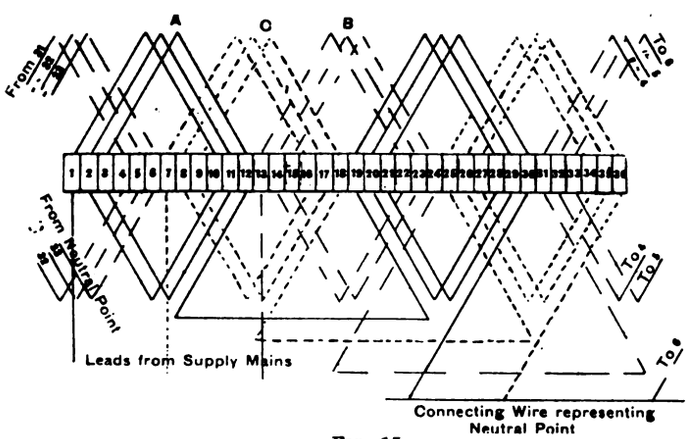

FIG. 15.

It is difficult to clearly represent the various circuits in the stator of an induction motor without the use of different colours, a distinctive one being used for each circuit. In Fig. 15, in order to make the circuits as clear as possible, the first phase is shown in full lines, the wires of the second phase in broken lines, and the wires of the third in dotted lines. If we are supposed to be standing at the front of the motor—*i.e.*, at the end at which the windings are connected to the mains—it is evident from Fig. 15 that the current will be flowing in the windings from us in the wires lying in slots Nos. 1, 2, 3, 4, 5, 6, 16, 17, 18, 19, 20, 21, 22, 23, 24, 34, 35, and 36; and to us in the slots Nos. 7, 8, 9, 10, 11, 12, 13, 14, 15, 25, 26, 27, 28, 29, 30, 31, 32, and 33. The figure, as has been said, is simply a plan of the windings, and in the actual stator would not lie opened out, but would form a circle, so that slot No. 36 would join slot No. 1. Considering the figure again in this light, we note that there are four belts, as it were, of conductors—viz., first a belt of nine slots, numbered from 7 to 15 inclusive, in which the current is flowing towards us; then a belt of nine slots, numbered from 16 to 24 inclusive, in which the current is at the same instant flowing from us; the next belt of nine slots contain wires in which the current is flowing towards us again; while the last belt contains the slots 33, 34, 35, 36, 1 to 6, in which the wires are carrying a current flowing from us. This is the condition of affairs at the instant when the current in the first phase has its maximum value, but as the current alternates the direction of flow in the various wires will alter, and at some moments one of the phases will be carrying no current at all.

Assuming, then, that at some given instant the current in the first phase possesses its maximum value, I, we know that the currents in each of the other phases will be equal to $-\frac{1}{2}$ I, and we can consider that there are four sets of coils forming magnetic poles in the stator. These four poles are due to the four belts of conductors before referred to; but in order to obtain these poles the wires must not be considered in the belts described, since it is necessary that each pole-forming coil shall consist of wires half of which convey current in one direction and half in the other.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

543. In an "Aron" meter is the speed of the swing of the pendulum increased or decreased by attraction in the coil below it? Give an example showing the result of both the repulsion and attraction.—C. G. S.

544. A 7½-h.p. three-phase induction motor drives by means of a belt a large punching machine. This machine has heavy flywheels and moving parts, and is very bad to start, though, when once up to speed, it takes very little to drive it. Readings were taken from this motor in the usual way—viz., with a wattmeter, ammeter, and voltmeter. In starting the motor it was found that, although the ammeter showed a very high reading, the wattmeter reading was comparatively low. As the motor gradually got up speed, however, the ammeter needle fell and the wattmeter needle *rose*, until a point was reached when both fell together till the motor reached full speed. Explain fully why the ammeter and wattmeter needles should move in opposite directions.—W. A. R.

ANSWERS.

Question No. 537.—Will the brake horse-power of an engine driving a Thomson-Houston arc lighter vary in proportion to the output, seeing that the current, field, and speed are constant for all outputs? N.B.—The amount of movement of the throttle-valve spindle is not perceptible for an output of 1,500 volts and 2,500 volts at seven amperes. Steam pressure constant.

Answer to No. 537 (*awarded 7s. 6d.*).—There is clearly something wrong with the particulars given in the question. As is well known, the output of a dynamo can be altered in two ways—by altering, firstly, the current; secondly, the E.M.F. Seeing that the machine is a Thomson-Houston arc lighter for arc lamps in series, it will be justified to assume the current to be constant: the E.M.F. must, therefore, vary with the output; but is is given in the question that the field and speed are constant for all outputs. The E.M.F., if this be true, must be constant, likewise the output. From these considerations it is obvious that an error has been committed, and that the error would appear to be, instead of stating the current through the field and field shunt was constant, merely the field itself has been mentioned; evidently the shunt has been overlooked. The brake horse-power required by the dynamo will depend on its output and efficiency. The efficiency of a series-wound dynamo mostly depends on its C^2R losses in the field and armature. In the particular case under consideration the armature losses from this cause are constant, and the losses in the field from the same cause varies with the output, or, in other words, the voltage, seeing the current is constant. This may be better understood when it is noted that the resistance of field shunt is increased to raise the voltage, thus causing a larger current to flow through the field windings, which are of constant resistance; the eddy currents and hysteresis losses will also vary with the output, or, more correctly, with the voltage, the speed being constant.

The Curve A here given shows the efficiency of a 1,000-volt series-wound dynamo for various outputs; the Curve B,

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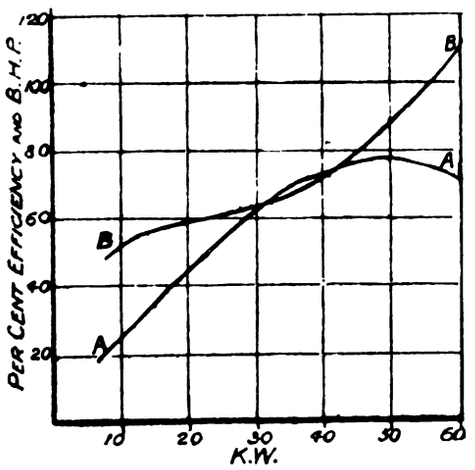
the brake horse-power required to drive the machine for various outputs. This last curve will show how the brake horse-power varies with the output in this particular machine, and from it, it will be seen that the two do not alter constantly at any particular point, but a general idea is shown of their relative values.



To find how the brake horse-power varies with the output of the machine alluded to in the question, it would be necessary to draw an efficiency curve similar to that shown. With regard to the movement of the throttle valve spindle being imperceptible for the output between 1,500 and 2,000 volts, this may be owing to the load between these limits falling in that part of the horse-power curve which has very little slope. In the machine the curves here given are taken from, it will be seen that from an output of 20 kw. to 30 kw. there is only an increase of 5 h.p., though the actual output increases by 13 b.h.p.; and it is quite possible that in certain machines where the efficiency curves rises very suddenly, the output may increase largely with only a fractional increase in brake horse-power.—A. J. J. G. W.

Answer to No. 537 (*awarded* 7*s.* 6*d.*).—The brake horse-power required falls off slightly with the voltage, though not nearly proportionately. This is due to the fact that the method of voltage regulation employed in these machines causes the efficiency to fall off rapidly at the lower voltages. Fig. 1 shows the armature and commu-

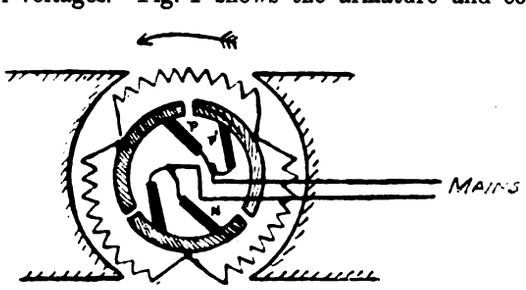


FIG. 1.

tator of an ordinary three-coil Thomson-Houston arc lighter diagrammatically. The two brakes, P P^1, of similar sign normally touch the commutator at points about 60deg. apart, whilst each of the three commutator plates covers about 115deg. When a number of lamps is cut out and the voltage has to be reduced in order to maintain constant current, the regulating solenoid causes the distance between the brushes of similar sign to be increased (the back brush being moved back about three times as much as the forward brush is moved forward), and the distance between brushes of opposite sign, like P N, to be reduced. This affects the action of the machine in three ways: (1) The coils which are in series between brushes of opposite sign have a smaller combined E.M.F., since the voltage of one opposes that of the other for part of the time. This produces the required reduction in terminal E.M.F. (2) As soon as the angle between brushes of opposite sign becomes less than 115deg, the machine becomes short-circuited momentarily six times in each revolution. This point has no direct bearing on the action of the machine. (3) Pairs of coils with different induced E.M.F.'s are constantly being put into parallel, and consequently large idle currents are set up in the circuit formed by two such coils and the two brushes of similar sign.

It is the large additional losses in armature and brushes due to the last effect which lowers the efficiency of the machine sufficiently to keep the brake horse-power almost constant over a wide range of voltage.—Q.

Answer to No. 537 (*awarded* 5*s.*).—The output of a dynamos is expressed in watts, the number of watts being equal to the volts multiplied by the amperes. By practice it has been found that 746 watts are equivalent to one actual or brake horse-power. Now, we know that horse-power is the capability to do work, and that work is the product of force and distance, its dimensions being $M\ L^2\ T^{-2}$. The dimensions of an electric current are $M^{\frac{1}{2}}\ L^{\frac{3}{2}}\ T^{-1}$, which are entirely different to the dimensions of work, and therefore the horse-power required to drive a dynamo must depend upon something more than the output of the machine in amperes only. Consider the matter in another manner. If the horse-power did not depend upon the E.M.F. as well as upon the current, it would take with the same percentage of efficiency the same horse-power to drive a plating dynamo giving an output of 4 volts 1,000 amperes as for a lighting dynamo generating 400 volts 1,000 amperes, although one is a 4-kw. machine and the other a 400-kw. generator.

The contention of "A. W.," however, would seem to be that the power is always the same taken by the machine, and, therefore, the efficiency falls in proportion to the lighter load. The case given, that the speed and the field are always the same, does not necessarily show that the E.M.F. generated is constant, and that at light loads part of this E.M.F. is wasted internally. The construction of a Thomson-Houston constant-current machine is vastly different to the usual direct-current dynamos met with in practice. In the first place, it is an open-coil machine, and consequently the theory of the collection of the current is quite different to that of closed-coil armatures. There are only three commutator segments and two brushes, but there is this difference from the ordinary brush: in the Thomson-Houston the brushes are in duplicate, and each pair are so arranged that the angular distance between the two constituents of each pair can be altered. The constant current is maintained by altering the E.M.F. as the resistance is varied in the outer circuit. This is automatically done by altering the angular distance between the two brushes. It is evident that if there are three sections to the commutator there are only three coils, and consequently that during the time each coil is in the neutral position it is cut out of circuit. At other times each coil will be in parallel with one of the other two coils, but this will only occur when the coil is comparatively idle. If at any time the current exceeds the normal, a magnetic device comes into action, whereby the second brush of each pair is made to lag further behind. The result of this is that the individual coils are each cut out of circuit for a longer period, and, therefore, the E.M.F. is reduced. The actual field strength may remain the same, but the number of lines of force cut by the coil during each revolution while supplying current to the outer circuit is reduced. It will be noted that the position of the brushes is not arranged for sparkless collection of the current, but to secure a constant current, consequently, as might be anticipated, these machines spark enormously, and special devices are adopted to blow out the sparks. "A. W." will find a long account of the thoory and design of this class of dynamo in Prof. S. P. Thompson's "Dynamo-Electric Machinery."

At one time these machines were almost universally used in all cases where arc lighting was required, and as the number of arc lamps required at various times varied, it would not have been wise to put down a machine which was efficient at one load only. Again, "A. W." must remember that the power developed by an engine can only be found from an indicator diagram, and not from simply watching the throttle valve to see if it alters its position. The mistake made appears to be in thinking that

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the full E.M.F. was naturally induced because the field strength and the speed remained the same, and that then this excess E.M.F. was deliberately wasted in the machine. This is not the case, the true fact being that by altering the position of the rear brush of each pair the time that each coil is supplying current to the outer circuit is reduced; hence for all practical purposes it may be said that at light loads each coil cuts fewer useful lines of force per revolution.—M.

Answer to No. 537 (*awarded* 5*s.*). — The horse-power delivered to the pulley of dynamo will not increase in the same degree as the output, because the electrical efficiency of the dynamo is higher at the greater load. This power will, however, vary directly as the output plus losses in windings, hysteresis, and friction. The reason so little difference is observed in the quantities of steam passing to the cylinder is due to the condition of engine and belt. It is apparent that at the smaller load an undue proportion of the energy developed by the steam in the cylinder is wasted owing to the inefficiency of the combination, and that taking the efficiency as the ratio between the watts at dynamo terminals and the steam delivered to cylinder, then the difference of the efficiencies at small and large load respectively is exceptionally great. By taking approximate figures, simple calculations for the two cases will make this clear.

The diagrammatic sketches represent the conditions. Let us suppose each section of armature winding to be 7 ohms, and that the field magnets are 10 ohms in resistance.

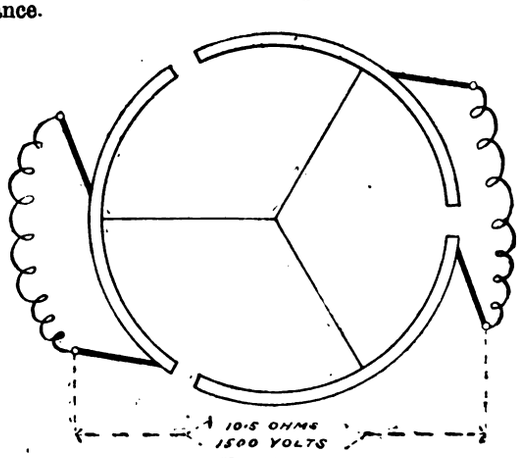

FIG. 1.

Resistance of armature $= 7 + \frac{7}{2}$
$= 10\frac{1}{2}$ ohms.
Resistance of magnets $= 10$ ohms.
Watts lost in dynamo $= 7^2 \times (10\frac{1}{2} + 10)$
$= 1{,}004{\cdot}5$.
Watts utilised in circuit $= 7 \times 1{,}500$
$= 10{,}500$.
Total watts generated $= 1{,}004{\cdot}5 + 10{,}500$
$= 11{,}504{\cdot}5$.

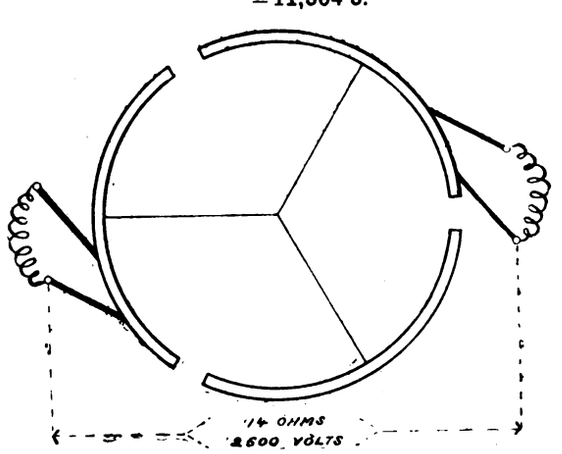

FIG. 2.

Resistance of armature $= 14$ ohms.
Resistance of magnets $= 10$ ohms.

Watts lost in dynamo $= 7^2 \times (10 + 14)$
$= 1{,}176$.
Watts utilised in circuit $= 7 \times 2{,}500$
$= 17{,}500$.
Total watts generated $= 1{,}176 + 17{,}500$
$= 18{,}676$.

Let us now allow (and it will be fair average conditions) efficiencies of 45 per cent. when running at 1,500 volts and 70 per cent. at 2,500 volts. Then

$$\frac{\text{Steam consumption at 1,500 volts}}{\text{Steam consumption at 2,500 volts}} \propto \frac{\frac{10{,}500 \times 100}{45}}{\frac{17{,}500 \times 100}{70}} \propto \frac{70}{75} \propto \frac{1}{1{\cdot}07}$$

—M. M.

[N.B.—The writer of this answer neglects the fact that the $C^2 R$ loss are included in the efficiency calculations.—ED. *E. E.*]

GOVAN ELECTRICITY ACCOUNTS.

From the accounts of the Govan Corporation electricity department for the year ended May 15, 1902, it appears that the total expenditure on capital account to that date amounted to £38,983. Abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., are appended.

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	1,740	10	4
Distribution of electricity	347	11	3
Attending and repairing public lamps	443	9	5
Rents, rates, and taxes	77	14	7
Management expenses	418	6	8
Law and parliamentary charges	1	5	5
Insurances and other expenses	113	16	11
	3,132	14	7
Amount carried to net revenue account	2,140	18	8
Balance for bad debts written off	59	6	9
	£5,333	0	0
Cr.			
Sale of current per meter	2,916	3	3
Ditto for public lighting	1,892	15	6
Sale and repairs of lamps and apparatus	81	9	3
Sundry fees	24	12	9
Law expenses during 1900-1 charged in error	417	9	3
	£5,333	0	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			480,786
Quantity sold — Public lamps	187,694		
Quantity sold — By contract	8,540		
Quantity sold — Private consumers by meter	213,163		
Quantity sold			409,397
Quantity used on works			20,960
Total quantity accounted for			430,357
Quantity not accounted for			50,429
Total maximum supply demanded (kilowatts)			320

Number of public lamps (10-ampere arcs), 100.

FORTHCOMING EVENTS.

FRIDAY, DEC. 19.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "Recent Practice in the Design, Construction, and Operation of Raw Cane Sugar Factories in the Hawaiian Islands," by Mr. J. N. S. Williams. If time permit, committee's report on "Standardisation of Flanges."

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "Electricity Supply from Double-Current Generators," by Mr. P. R. Wray.

Electro-Harmonic Society.—At 8 p.m., Holborn Restaurant. Smoking concert.

SATURDAY, DEC. 20.

Glasgow Scientific Society.—Eleventh anniversary dinner.

TUESDAY, DEC. 23.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "The Rupnarayan Bridge, Bengal-Nagpur Railway," by Mr. Stephen Martin-Leake. The succeeding paper will be "Electric Automobiles," by Mr. H. F. Joel.

SATURDAY, DEC. 27.

Royal Institution.—At 3 p.m., Christmas lecture. Prof. H. S. Hele-Shaw on "Locomotion."

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CONTENTS.

Notes	865	Trade Notices and Novelties.	886
Maidenhead Electricity Supply Works	870	New Committees	887
		Appointments Vacant	887
Some Engineering Hints on a Tramway System	875	Legal Intelligence	887
		Companies' Meetings and Reports	888
Notes on Polyphase Motors	877		
Questions and Answers	879	Contracts for Electrical Supplies	890
Govan Accounts	881		
Forthcoming Events	881	Traction Notes	892
Taunton	882	Lighting Notes	895
Correspondence	883	Provisional Patents, 1902	899
Reviews	884	Companies' Stock and Share List	899
The Institution Dinner	885		
Institution of Electrical Engineers	885	Complete Specifications	899
		Traffic Returns	900

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TAUNTON.

It is with extreme reluctance that we touch once more—and for the last time so far as we are concerned—on this imbroglio, but surely the Englishman's proverbial love of fair play must be considered, and both sides permitted to state their case. Mr. Thornhill, the electrical engineer to the Corporation, was attacked in a manner to be condemned by the strongest words in the English language. He is young, has a future at stake, and his honour is as dear to him as is personally that of any professional man. To enter a criminal action against a corporation official for applying a system which, if as bad as the opponents' standpoint of view would define it, could have no personal interest for him, was, we contend, a most unwarrantable method of dealing with the matter. "The Father of the Assistant," referred to in our issue of Nov. 28, put his case to our readers in our issue of Dec. 12. He also wrote to the Lord Chancellor on the subject of the magistrates' decision, and all through, from the reports in the local papers, he seems to have been taking a very active part in this matter. The correspondence with the Lord Chancellor is given as follows in one of the local papers:

"Mr. A. E. Witham has written to the Lord Chancellor, sending portions of the electrical case, and stating that it was a miscarriage of justice on the part of the magistrates. His Lordship at once communicated with Mr. Thos. Penny, who was chairman of the bench, enclosing Mr. Witham's letter, and in reply Mr. Penny sent his Lordship a full report of the case, and received the following reply:

"'House of Lords, Dec. 10, 1902.

"'Sir,—I am desired by the Lord Chancellor to thank you for your letter of the 8th inst., with enclosures. I now send you by his Lordship's directions a copy of a letter which he has caused to be written to Mr. A. E. Witham.—Yours faithfully, (Signed) "'R. C. NORMAN.

"'Thos. Penny, Esq., Parklands, Taunton.'

"'House of Lords, S.W., Dec. 10, 1902.

"'Sir,—With regard to your letters of Nov. 29 and Dec. 2, I am directed by the Lord Chancellor to inform you that he has communicated with those magistrates to whom you referred, and has received from them a complete report of the proceedings against the Taunton borough electrician, together with observations in reply to your charges. His Lordship is surprised that you should not have placed him in possession of all the circumstances of the case. Had he known them he would not have considered it necessary to intervene in any way. As it is, however, the result of the enquiry that he made in consequence of your statements, which now appear to his Lordship to be partial and misleading, has been to satisfy him that the charges of prejudice which you have put forward are unfounded.

"'His Lordship has directed a copy of this letter to be sent to Mr. Thos. Penny, the presiding magistrate.

(Signed) "'R. C. NORMAN.

"'A. E. Witham, Esq., 2, Windsor-terrace, Taunton.'"

The moral of this correspondence is that the gentleman in question is addicted to half-truths. In general, the only harm in dealing with half-truths is in the being found out, and the right course for every man to take after the finding out is to avoid at all hazards the dealer in half-truths. Mr. Thornhill, in explaining the system pursued to his Council, says, among other things (*vide Somerset County Express*, Dec. 13, 1902):

"The practice that I have authorised to be adopted with reference to the testing and adjusting of meters since I have been electrical engineer has been that, if my attention were called to the meter on any premises registering an appreciable difference from that in the corresponding previous year or years, to cause the meter to be tested, and inform the person who was to test the meter about the number of units which the meter registered slow as compared with the corresponding period. My intention in giving this figure

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was, unless there were very exceptional circumstance, the meter should not be put on more than the amount consumed during the corresponding period, but, on the other hand, if, upon testing, the meter would not justify such an amount being put on, the person instructed to do the testing and adjusting should act accordingly and not put on the full or (if the meter was all right) any increase. He should make enquiries which might account satisfactorily for the difference in the consumption. This practice was in vogue when I entered the service of the electric light company, and continued until I was appointed as your chief engineer in 1899. I am not aware whether the practice was strictly right or not (I think now it would have been more satisfactory if the consumer's attention had been called to any alteration), but during the time that I acted under Mr Cousens in testing and adjusting the meters I never altered the reading of any meter unless I was satisfied that such alteration was fair as between the Corporation and the consumer, and in making the alteration I had in mind the amount consumed in the corresponding period and what the test would justify my doing. In altering the meter I was careful that it should be altered so that the consumer would not have to pay for more energy than had (as far as I could fairly judge) been consumed. No meter was ever altered by me with the idea of prejudicing any consumer. . . Witham left the employ of the Town Council early in August, and about the end of the month I had an interview with his father. This interview was at the request of Mr. Witham, sen. (in whose waste-paper basket some of the slips given by me to his son were found). At this interview Mr. Witham appeared to be annoyed at his son having to leave the works and being out of occupation for the time being. On the morning following the interview, I received a letter from Mr. Witham, sen., of which this is a copy: '2, Windsor-terrace, Taunton, Aug. 30, 1902.—Dear Mr. Thornhill,—Last evening you and I had a very serious conversation. Of course, you will require some little time for due consideration, and therefore I named Wednesday, 3rd prox., for your decision. Several gentlemen (large consumers of electric light) will meet me on Thursday next, and your reply or non-reply to this will guide their action. I do not write this as a threat, but (without prejudice) I hope you will accept what I intimate, as I mean it—viz., it is not my wish to injure you, but that which I want, and which I demand, is justice.—I am, dear Mr. Thornhill, yours very faithfully (signed), A. E. WITHAM.' I treated the letter with contempt, and immediately communicated with the chairman of the committee. I should like to say, further, that no suggestions have been made by the chairman or any other member of the committee to me as to altering any meter, or as to the method to be adopted in adjusting meters. I can only add that if the Council or the Electric Light Committee desire, or I am given an opportunity in a court of law, any further explanation as to my conduct in the matter I shall be happy to furnish or give it."

The substance of the conversation between Mr. Thornhill and Mr. Witham, sen., was given by Mr. Thornhill to his Council on Dec. 9 as "to the effect that if he (Mr. Thornhill) did not take Witham's son back, or get him a similar job, he (Mr. Witham) would make it hot for him (Mr. Thornhill)." We neither know Taunton, Mr. Thornhill, or Mr. Witham. Our position is that a professional man has been attacked in, according to our opinion, an unjustifiable manner, and it is necessary at once for his professional colleagues and the papers representing the profession to unmistakably resent such attacks. There is no system infallible, and any busybody can find matters requiring consideration and perhaps alteration. Attention called to defects, but called in a proper manner, would receive attention. The members of councils, instead of seeking notoriety or the clap-trap applause of the gallery by siding with the busybodies and querulous complainers, should inform themselves from authoritative sources before making speeches and quoting figures gleaned from the hearsay evidence of outsiders.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MOTOR.

SIR,—I suggested 40 cells as being the most practicable, and therefore running the motor at a potential of 80 volts. For a motor it is questionable whether regulating cells are necessary, as battery should not fall in voltage below $1{\cdot}9 \times 40 = 76$.

If 60 cells are used and charged in two lots, there will have to be an average of $110 - \left(\frac{2+2{\cdot}6}{2} \times 30\right) = 41$ volts taken up by resistance. To charge in two lots will entail considerable loss of energy, waste of time, and complicated connections. When cells are charged two rows in parallel, the result is generally very unsatisfactory, it being difficult to keep the current in each row normal.

A description of the cell mentioned by "M. Gregory" would be interesting. He says: "each containing one square foot of positive plate surface . . . "; and, further, "the current will be . . . 48 amperes." Now, to discharge an ordinary accumulator cell at a greater rate than about eight amperes per square foot of positive plate—*i.e., four amperes per square foot of positive plate surface*—will result in a short life of the battery. The meaning attached to "total current = 55 × 8 = 440 amperes" is rather involved.

General practice points to a charging and discharging rate of about eight amperes per square foot of positive plate and a capacity of from 90 to 100 ampere-hours per square foot of positive plate. 7 × 6 is evidently a misprint for 746.—Yours, etc., M. M.

TUNBRIDGE WELLS TELEPHONES.

SIR,—I enclose correspondence which has taken place between myself and the town clerk, which explains itself. The refusal of the Telephone Committee to give me access to the construction account, which is supposed to have been expended in accordance with my estimates, but which there is very good reason to believe has not been so spent, is very significant, and calls for a good deal of explanation.—Yours, etc., A. R. BENNETT.

Glasgow, Dec. 15, 1902.

"65, Renfield-street, Glasgow,
"Dec. 2, 1902.

"W. C. Cripps, Esq., Town Clerk, Tunbridge Wells.

"*Telephones.*

"Dear Sir,—I should be glad if you would name an early day on which, in company with the borough accountant, I can go through the capital account of the telephone department, with all its accompanying vouchers since its commencement.

"When the department was organised, it was arranged that I should be furnished with a weekly statement of work done and wages spent, and a monthly statement of the financial position of the undertaking, including particulars of the position of the capital account. It was also arranged that all payments for work done and material supplied should be certified by me.

"These arrangements were departed from at an early date, and since February last I have not been furnished with any of these statements, notwithstanding that I have frequently applied for them and complained of their absence. For a long time I have not been asked to certify for any payments, and large sums have been paid away without my knowledge or approval for work for which it is now sought to hold me responsible.

"Orders for work and material have been given without reference to me. Much work has been carried on which was never included in my estimate, and which was totally unnecessary. I have been kept in ignorance of the financial position, and all control of the work has been taken out of my hands.

"I am indirectly informed that the capital account has been debited with charges having no bearing on construction, and that the amount alleged to have been spent in construction has not been so spent. It is for the purpose

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of ascertaining the real facts of the case that I now apply for access to the books and vouchers. I also desire to be furnished with proper information as to the cost of the various construction jobs. It is not a fact that the prices estimated were insufficient; they were in all cases calculated to afford a liberal margin, and the causes of the loan proving inadequate must be sought in the original policy of expansion adopted by the Telephone Committee. I do not blame the progressive members of the committee, as their plan was unquestionably the correct one, and they could not foresee that the enterprise would be cut short before the results of their foresight could become apparent. The policy of the Telephone Committee has been exactly paralleled by the policy of the Post Office in connection with their London telephone exchange and by the Glasgow Corporation. In both cases large sums have been spent in anticipation of future requirements. If the Post Office telephone undertaking in London were burdened with interest and sinking fund in the same way as the Tunbridge Wells enterprise has been burdened, its first year of working would show an enormous loss; and if there is any logic in the determination of the Tunbridge Wells Town Council to sell its undertaking to its enemy at a break-up price, a public agitation ought to be immediately started to compel the Post Office to sell its London undertaking to the National Telephone Company also. The Postmaster-General would have no difficulty in defending himself against any such ridiculous proposal; yet the circumstances are exactly analogous to those at Tunbridge Wells, except that the Post Office system is now actually being worked at a loss, while the Tunbridge Wells system is not and never has been. The substitution of small underground cables for the overhead lines which were originally estimated for—for which change of plan I was in no way responsible—and the wayleave difficulties which led to much of the work being reconstructed several times over, also caused greatly increased expenditure. In none of these matters had I a controlling voice. No engineer can build two miles of railway for the cost of one, and no contractor can lay double the quantity of cable contracted for without doubling his charges, and the attempt to saddle the responsibility upon myself is unjust and despicable.

"I would also remind you that I have complained many times of the extravagant scale of working expenses. The undertaking, in spite of my frequent protests, has been managed with a reckless disregard to financial results, and the circumstances not only do not prove that my estimates were inadequate, but quite the contrary. I have several times pointed out that six or seven officials were employed to perform work which in another municipal telephone department, having a greater number of subscribers and more responsibility, has long been satisfactorily performed by three.

"I trust that you will arrange for me to go through the books at the earliest possible moment, and am, yours faithfully, (Signed) "A. R. BENNETT."

"Town Clerk's Office, Tunbridge Wells,
"Dec. 3, 1802.

"*Tunbridge Wells Telephone Account.*

"Dear Sir,—I beg to acknowledge the receipt of your letter of the 2nd inst., which I will lay before the Telephone Committee at their next meeting.—Yours truly,
(Signed) "W. C. CRIPPS, Town Clerk.
"A. R. Bennett, Esq., 65, Renfield-street, Glasgow."

"65, Renfield-street, Glasgow,
"Dec. 6, 1902.

"W. C. Cripps, Esq., Town Clerk, Tunbridge Wells.
"*Telephones.*

"Dear Sir,—I am in receipt of your letter of Dec. 3, informing me that my letter of the 2nd inst. would be laid before the Telephone Committee. I beg to express my regret that my letter is not to be laid before the Town Council itself. Recent events have conclusively shown that there is no effective Telephone Committee in existence. Otherwise the Corporation undertaking, which that committee was supposed to have under its control, would not have been privately sold without any reference to it. I am afraid that if my letter is laid before the committee nothing more will be heard of it, and I accordingly reserve my right to publish this correspondence.—Yours, faithfully, (Signed) "A. R. BENNETT."

"Town Hall, Tunbridge Wells,
"Dec. 11, 1902.

"Dear Sir,—By the instructions of the Telephone Committee I send you at the foot hereof copy of a resolution which was passed by them at their meeting to-day:

"'Letters from Mr. Bennett of Dec. 2 and 6 were laid before the committee Resolved unanimously: "That, having regard to the terms in which such letters and Mr. Bennett's communications to the public Press have been couched, the letters be simply acknowledged, and that the town clerk be instructed to send Mr. Bennett a copy of this minute."'—Yours faithfully,
(Signed) "W. C. CRIPPS, Town Clerk.
"A. R Bennett, Esq., 65, Renfield-street, Glasgow."

REVIEWS.

Encyclopædia Britannica. Vol. XXX. Published by Adam and Charles Black, Edinburgh and London; and the *Times*, Printing House square, London.

This volume of the "Encyclopædia" (K—MOR) opens with a prefatory essay on the "Modern Conditions of Literary Production" by Augustin Birrell, K.C. This essay clearly shows the modern tendency in literary work. Electrical engineers will find in this volume a comparatively large number of subjects treated which are auxiliary to their profession. Amongst these is the article on "Light," by G. C. Knott, D.Sc.; that on "Liquid Gases," by James Dewar, F.R.S.; on "Lubrication," by Osborne Reynolds, etc. Also, it contains some complete treatises on "Magnetism" and on "Terrestrial Magnetism." The two authors responsible for these respectively are Dr. Shelford Bidwell, F.R.S., and Dr. Charles Chree, who is now continuing his investigations on the latter subject at the National Physical Laboratory. The information given on "Liquid Gases" is bound to be to a certain extent old, but the article is of great interest to any engineer who has not kept himself well up to date with the important investigations carried on in this direction at the Royal Institution. The average man will perhaps at once turn to the last paragraph, which deals with the industrial application of the liquefaction of gases. In this respect Prof. Dewar acknowledges that little can as yet be reported. He finally disproves the vain hopes of certain inventors that the liquefaction of air was equivalent to the discovery of perpetual motion. There is a chance, in his opinion, that where economy is of little account, liquid air might be utilised as motive power. Thus, for driving submarine boats, and at the same time for providing a supply of oxygen to the crew, it has advantages. It might, of course, be used for this latter purpose in the submarines now being experimented with, in which electric accumulators provide the power required for submarine journeys. Liquid-air machines have been used to a limited extent for obtaining oxygen from the atmosphere The fact that nitrogen boils away more quickly than the oxygen results in the remaining liquid becoming more and more rich in oxygen. Up to the present the commercial use of liquid air for obtaining oxygen for metallurgical and other operations is only prevented by the cost. The author refers to the explosive for mining purposes which can be made by mixing powdered charcoal and liquid oxygen. The advantage of this explosive is that if the fuse fails, the cartridge becomes inoperative after a short time, owing to the evaporation of the oxygen. The article on "Lubrication" is a *résumé* of the theory of the subject as developed since the historic researches of Mr. Beauchamp Tower in 1883. The article shows the mistaken ideas which were accepted as gospel before that date, and the more exact theories that the observations of this gentleman and other experimenters have warranted of recent years. As is frequently the case, epoch-making discoveries were made by two authorities at practically the same time. Engineers used to forced lubrication will be

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surprised to find that the essence of their practice can be expressed in differential equations, some of which are by no means easy of solution. Of the two articles on "Magnetism" and "Terrestrial Magnetism" respectively, the first is of the utmost importance to the dynamo designer and commercial man, while the second is on a matter with which the pure scientist is most concerned. In fact, the magnetic observatories have much to complain of in the way they have been treated by the electrical engineer installing electric trams with earthed return circuits. A list is given in this latter article of four different observatories which have been completely upset in this way, and others, as one can well understand, are in danger of a similar fate. To tramway engineers, who look upon terrestrial magnetism with disdain, the article in the "Encyclopædia" will be instructive, as showing what a vast amount of organised research has been carried out in this subject. The simultaneous observations in stations a great distance apart on the periodic variations in the earth's field, afford considerable proof as to the way in which the field fluctuates. It seems from such results that the most characteristic movements in either the horizontal or vertical component occurs simultaneously over very large areas, such as the whole of Europe. With stations so far apart as Kew and St. Petersburg considerable differences in detail are observed, and between stations in Melbourne and London the differences in curves are even more pronounced. An interesting *résumé* is given of the research work by Profs. Rücker and Thorpe on the "Terrestrial Magnetic Field in the British Isles." These gentlemen are inclined to believe that subterranean mountains can be located from the behaviour of the magnetic needle. Another experimenter in Germany has found that a magnetic ridge line runs approximately parallel to a line of no deflection of the plumb-line, which is confirmatory of the above. Interesting results are given of a small area, 3 miles long by 1¼ miles wide, near Port Walcott, off the North-West Australian coast, where extremely wide variations in the magnetic elements were found by Captain Creak. The declination actually varied from 26deg. west to 56deg. east, and the inclination from 50deg. to nearly 80deg. within this small area. The various theories to account for the annual and daily variations are fully discussed, and are worthy of careful study. The article on "Magnetism" is quite as full as the one above referred to, and has been brought by the author well up to date. A good part of this deals with abstract questions of theory, but there is a great amount which is essential to complete the knowledge of any electrical engineer having to do with original design. The present volume contains, as is usual, a vast amount of general information of indirect use to the engineer, but amongst this cannot be classed the article on "Metallography." This is of supreme importance nowadays, as was clearly shown by an interesting paper read this year before the Iron and Steel Institute.

THE INSTITUTION DINNER.

On Wednesday last, at the Hotel Cecil, the fourteenth annual dinner of the Institution of Electrical Engineers took place, with Mr. James Swinburne, the president, in the chair. Due either to the magical number, 14, or more probably to the influence of the President, the dinner was the most enjoyable one that has taken place for years. The radical improvement was due to the reduction of the toast list to about one-half its ordinary length, and by confining the able speakers to which the remaining toasts were entrusted to five minutes each. The dinner was also remarkable for the large number of eminent gentlemen connected with the law who were present as guests of the Institution These included Lord Justice Cozens-Hardy, Mr. Justice Bingham, and a number of King's counsel who have distinguished themselves in electrical cases. The local sections of the Institution were well represented by their chairmen.

The evidence of the PRESIDENT'S originality was first given by an ejaculatory grace, and he further distinguished himself by proposing the health of the King in a novel way. Having remarked that kingship was of savage origin, Mr. Swinburne explained how vastly we had improved our kings century by century. This toast and the other loyal toast of the Queen and other members of the Royal family were then duly honoured.

Mr. J. BALFOUR BROWNE, K.C., proposed "The Institution of Electrical Engineers" in a humorous speech, in which he explained the useful connection between members of the Bar and the electrical profession. Electrical engineers were compared to bees collecting honey to be consumed by others. He had pleasure in coupling with the toast the name of the President, for whose abilities he had such respect that he believed that Mr. Swinburne, if he had not been such a distinguished electrical engineer, would have been a successful lawyer.

MR. JAMES SWINBURNE, in reply, referred to the outbreak of engineers in Egypt thousands of years ago, at which time large irrigation works were successfully carried out. He attributed the want of permanence of the Egyptian civilisation to the fact that although engineers were then at the head of affairs, they were also half priests, which prevented progress. Since those times little had been really done in engineering until about two centuries ago, when printing and other inventions in manufacturing were first introduced. The civilisation resulting from this latter outbreak of engineers was more permanent, because of the complete intercommunication which it had established between the various parts of the world. Mr. Swinburne went on to lament that engineers were not now in control of the Government, and to criticise the present system of government by majority. He said that even a limited liability company, which was the worst-managed class of undertaking, would not put up with the system of popular control adopted as the Government of the country.

Mr. ROBERT HAMMOND, the treasurer of the Institution, then proposed "The Law," and spoke in high terms of the purity of our legal system.

The Right Hon. Lord Justice COZENS HARDY thanked the previous speaker for his kind remarks, and said while the judges were quite independent of the Executive and of the Government, they valued extremely highly the appreciative sympathy of their fellow-countrymen. An invention which he thought would find the approval of the Courts would be one which was capable of reducing the length of patent law cases, and also of curtailing counsel's speeches. He could promise those who attempted to establish such a patent that the Courts would not object to its validity, either on the grounds of previous knowledge or of want of utility.

Mr. J. M. ASTBURY, K.C., also replied.

The last toast, "Our Guests," was proposed by Mr. ROBERT KAYE GRAY, and responded to by Mr. W. H. MAW, the president of the Institution of Mechanical Engineers, and by Mr. W. R. BOUSFIELD, K.C., M.P.

The PRESIDENT then announced that the meeting was "adjourned for a year into the other room." The other room was the Victoria Hall, where Mr. Harry Ivimey gave some humorous sketches. The early adjournment, at about 10.15, enabled the members to meet more freely than is possible if the proceedings are lengthened out over the dinner table. This innovation was much appreciated by all present, and we should think it is likely to be repeated another year.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting of the Institution on Dec. 11 the following candidates were balloted for :

Member.—A. G. Way, Westminster Engineering Company, Limited, Willesden, N.W.

Associate Member.—G. F. A. Norman, G.E. Power Company, Germiston, South Africa.

Associates.—H. Bourne, 60, Clifton-road, Rugby; F. Bruce, 2, York-buildings, Hastings; F. J. Humphrey, 7, Creffield-road, Colchester; R. F. Morris, 5, Foregate-street, Worcester; F. O. J. Roose, Corporation Electricity Works, Bournemouth; J. C. Serjeant, Chemins de Fer de l'Etat, Alexandria, Egypt.

Student.—M. G. Tweedie, Erleigh, Herschel Park, Slough,

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TRADE NOTICES AND NOVELTIES.

Electrical Switchgear.

We illustrate herewith a few of the specialities manufactured by Messrs. Brook, Hirst, and Co., Northgate Electrical Works, Victoria-road, Chester, a firm devoting their attention until quite recently almost exclusively to private installation work and the wholesale supply of special switchgears to manufacturers of dynamos and motors, but now doing good work also in a wider field, including the supply of central-station switchgears—a departure in regard to which we wish them every success.

Referring to the accompanying illustrations, Fig. 1 shows the lighting and traction switchboard which they have recently supplied for the new municipal electricity supply station, Gravesend, under construction at their Chester works. This illustration incidentally serves to show the business-like equipment of the erecting shop at the Northgate Electrical Works.

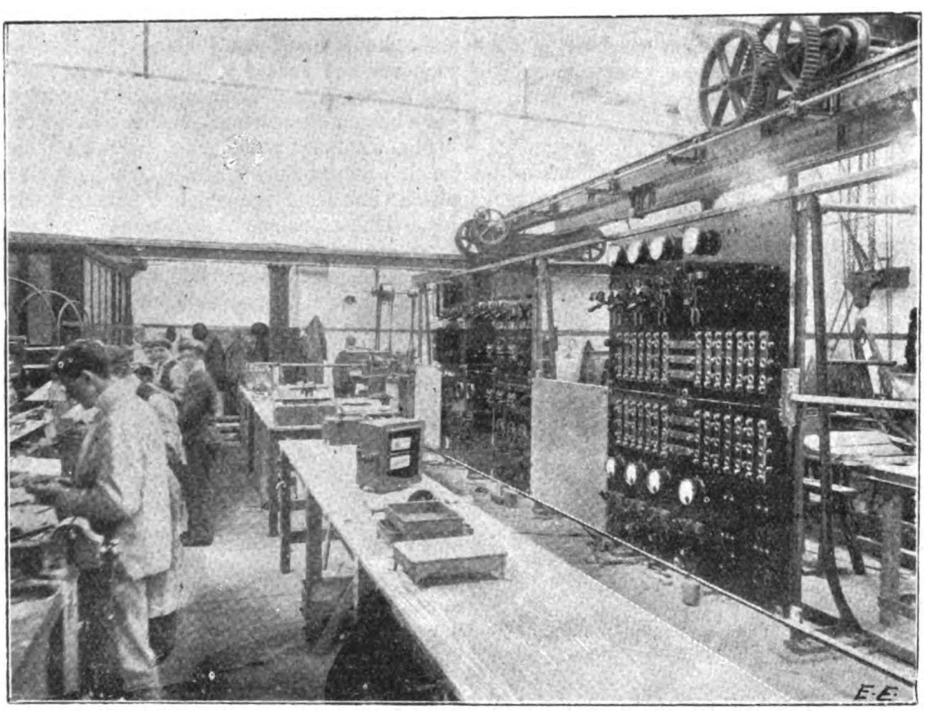

FIG 1.—Gravesend Switchboard in Erecting Shop, Northgate Electrical Works

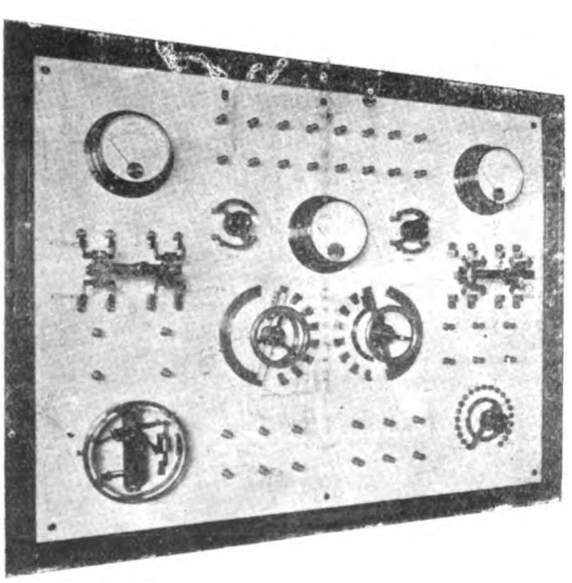

FIG. 2.—Switchboard for Controlling Small Installation.

The next illustration (Fig. 2) shows the firm's standard type of switchboard for controlling a small installation with compound-wound dynamo and a battery of accumulators. It may be mentioned that the switches on this board are so arranged that the dynamo can only be connected to the battery as a shunt machine, and to the lights as a compound-wound machine.

Fig. 3 illustrates a two-way quick-break knife switch of the firm's K type, with carbon breaks. This switch is claimed to be very suitable as a main dynamo switch in a combined lighting and traction station, being used to connect the machines to either the lighting or traction 'bus bars. The switch has a clean lightning break both ways, and is held in a vertical "off" position by a spring and plunger, the latter protruding through the bearing casting into a socket in the handle lever.

The firm's C type iron-clad motor-starting rheostat, with "no voltage" and "overload" release, is shown in Fig. 4. One of the principal features of this rheostat is that the contact lever can be released at any period of its travel over the stops, should an overload occur or the current be cut off from the motor. The magnet arm is fitted with a worm-wheel segment engaging with a worm on the spindle of the operating hand-wheel; the switch can only therefore be used to slowly start the motor. The method of operating the switch is as follows: the contact lever being in the "no circuit" position, the hand-wheel is turned in the direction which will make the magnet arm travel towards it. As soon as the lever and magnet arm touch the shunt circuit of the motor is made, and the keeper on the lever engages with the magnet. The hand-wheel is then rotated in the opposite direction, the magnet drawing the contact lever over the stops, and the resistance is gradually cut out. The overload arrangement consists of an electromagnetic coil in series with the main current to the motor. Should an overload occur the force of the current in this coil raises an iron core against two contacts connected to the ends of the coil of the lever-retaining magnet, and the coil being short-circuited the magnet is de-energised, and the lever flies back to the open circuit position, inserting the resistance as it does so. The method of short-circuiting the terminals of

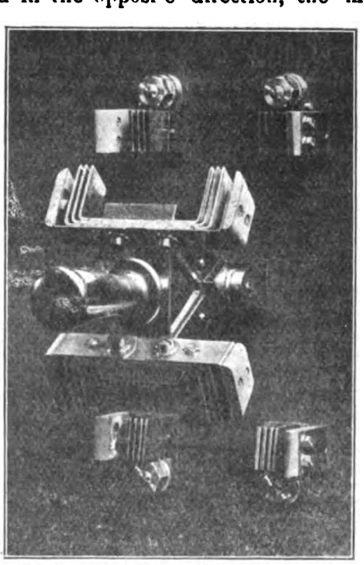

FIG. 3.—Two-Way Quick-Break Knife Switch.

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the retaining magnetic coil is very positive, as the overload current in the series coil causes the core to press tightly against the contacts. A scratching contact is made between the core and the latter, a good clean surface, which is very essential, being the result. To release the switch by hand, a plunger extending from the bottom of the overload arrangement is tripped, the core being raised against the contacts, with the same result as when an overload occurs. It is claimed that this type of starter fulfils all the requirements for a switch to start a motor, which cannot by any possibility allow the operator to accidentally damage the motor when starting.

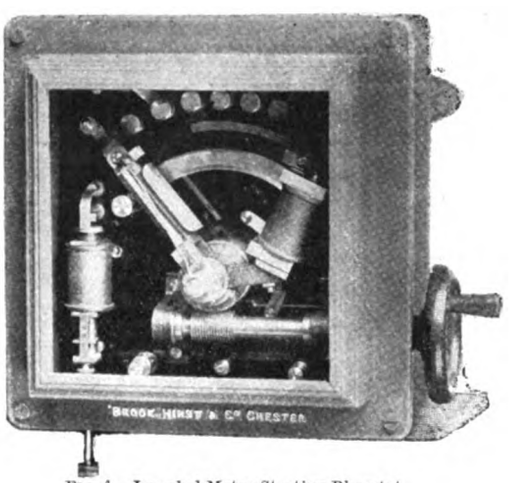

FIG. 4.—Ironclad Motor-Starting Rheostat.

Our last illustration (Fig. 5) shows Messrs. Brook, Hirst, and Co.'s laminated edge-type circuit breaker, which is intended for the protection of circuits subject to repeated and violent overloads, the parts being made especially heavy to stand constant use. The design of this switch appears to be excellent both mechanically and electrically.

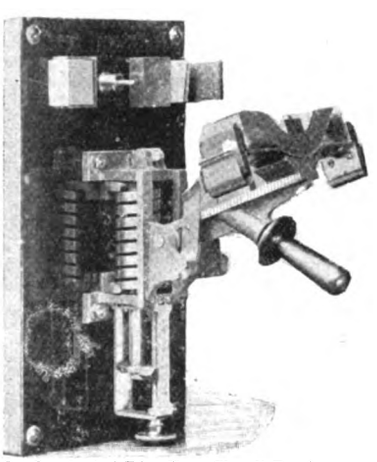

FIG. 5.—Laminated Edge Type Circuit Breaker.

In the foregoing we have dealt with a few only of the specialities described in an exceedingly well compiled and illustrated little catalogue recently issued by the above-named firm, and in which will be found further information relating to the apparatus herewith illustrated, besides numerous other well-designed articles for which the company find a rapidly increasing demand. At present the firm have in hand two traction switchboards for the Chester Corporation and one for the Wrexham tramways respectively.

NEW COMMITTEES.

BECKENHAM.—*Tramway*—Councillors Grant, Richardson, Payne, Culver, Grose, Liddle, Pawley, Greetham, and Parnacott.

COLNE.—*Electrical Sub-Committee*—The Mayor; Alderman Foulds; Councillors Hewitt, Holgate, and Paterson.

ECCLES.—*Works and Lighting*—Alderman Meller and Councillors Oldfield and Pearson, and the chairman and vice-chairman of the Public Lighting and Electrical Supply Committee.

HARROGATE.—*Lighting Sub Committee*—The Mayor; Aldermen Chippindale, Hudson, Simpson; Councillors Davidson, Houfe, and Turner.

HEYWOOD.—*Electric Lighting*—Councillor Popple, chairman.

WALSALL.—*Electric Lighting*—Mr. Alderman William Brownhill, chairman, and the Mayor, vice-chairman. *Tramways*—Councillor Cope, chairman; Councillor Zeller vice-chairman.

APPOINTMENTS VACANT.

City Electrical Engineer, Dundee Town Council. £400 per annum, Dec. 27. See advertisement.

Clerk and Canvasser, Bermondsey Borough Council Electricity Department, £2 per week, Dec. 21. Leeds City Tramways. See advertisements.

Switchboard Attendants, Falkirk Town Council, 25s. per week, Dec. 19; Peterborough Corporation, 25s. per week, Dec. 20.

Assistant Electrical Engineer, London County Council Tramway Department, £500 per annum, Jan. 5, 1903. Kirkcaldy Town Council, £100, Dec. 24. See advertisements.

Electrical Engineers, Elland Urban District Council, Dec. 22. Morley Town Council, Dec. 27. See advertisements.

Senior Electrical Engineer, Sanitary Commissioners of Gibraltar, £300 per annum, Jan. 20, 1903.

Arc Lamp Repairer, Burgh of Partick. Particulars may be obtained from Mr. H. B. Maxwell, burgh electrical engineer, Partick. See advertisement.

Mechanical Electrical Engineer, Croydon Mental Hospital, 35s. per week, Dec. 30. See advertisement.

Foreman Electrician. See advertisement.

Skilled Mechanic, as instructor, Dec. 29. See advertisement.

Engineer, for private generating plant. See advertisement.

LEGAL INTELLIGENCE.

THE FERRANTI ELECTRICITY METER.

The Court of Appeal, composed of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, delivered judgment in the case of Ferranti *v.* the British Thomson-Houston Company on Monday, the arguments in which were heard on the 19th ult. The action was brought by the plaintiff, Mr. S. Z. de Ferranti, for alleged infringement of his patent No. 701 of 1887, relating to improvements in electricity meters, by the defendants, the British Thomson-Houston Company. In the Chancery Division Mr. Justice Swinfen Eady gave judgment in favour of the defendants, and this appeal was by the plaintiff. The facts of the case were reported in our issue of Nov. 21.

Lord Justice Stirling delivered the judgment of the Court dismissing the appeal. He said that much depended upon the construction of the words in the plaintiff's specification. Having regard to various passages in the specification, their Lordships thought that the direction in the words in question, as applied to meters of the kind invented by the plaintiff, was intended to mean that the branch circuit should pass from the main conductor to earth or to the return conductor without passing through the mercury bath. It appeared to the Court that the patentee regarded this direction as essential to the working of his meter. There was nothing to show that it ever occurred to him to consider whether the current through the additional coil might be admitted into the bath under any conditions, or, if so, what they were; certainly no suggestion on the subject was to be found in the specification. If the statical friction between the mercury and the bath could be overcome by the use of a coil, the current through which did pass through the bath, and the meter could thereby be made to start and work accurately, it seemed to their Lordships that such user (not being colourable merely) would not fall within the scope of the plaintiff's patent. The defendants did not use a meter in which the current to be measured was made to pass through a bath of mercury. But notwithstanding this, they might be guilty of infringement, for it was stated in the specification that "the same improvement is applicable to all motor meters—that is, motor meters in which the movement is obtained from the current to be measured." Assuming that the defendants' meter was a motor meter of the kind referred to, what was it that they had done? In their meter the current to be measured passed through fixed coils and acted on a branch or shunt current passing from the main to the return conductor through a rotating coil, whose revolutions were recorded. In this form of meter there was statical friction, just as in the plaintiff's form, and to overcome it the defendants used an additional coil, placed, not in the current to be measured, but in the branch current just spoken of. It would be observed, however, that in this arrangement there arose a difficulty precisely analogous to that which was met when, in a meter of the kind invented by the plaintiff, the current through the additional coils was permitted to pass through the mercury bath, for the current in the coils, added to the defendants' meter, acted upon the current passing through the rotating coil whose revolutions were recorded, and might produce motion in it, though no current might be passing to any lamps. In fact, it was admitted by Mr. Dugald Clerk, the plaintiff's witness, that this arrangement of the defendants' was electrically equivalent to the use, in connection with a mercury meter, of a current which did not enter the additional coils until after it had passed through the mercury bath. Nothing had been done by the plaintiff's specification towards the removal of this difficulty, but the defendants had found the way of getting over it. This appeared to consist in a delicate adjustment of the additional coil in such a way that the force exerted by it on revolving coil was insufficient of itself to overcome the friction, but was sufficient to start the meter when combined with the force produced by the smallest current passing to the lamps—*i.e.*, a single lamp current. If the force exerted by the additional coil was more than sufficient to overcome the friction, then the result would be that the revolving coil would begin to rotate, and the customer would be charged with current not used in the production of light, as had been pointed out by Mr. Dugald Clerk in his evidence. On the other hand, if the force exerted by

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the additional coil, together with that produced by a one-lamp current, were insufficient to start the meter, the customer would not be charged with current which he was using. Mr. Clerk stated that the necessary adjustment was a fine one. In those circumstances their Lordships agreed with Mr. Justice Swinfen Eady in thinking that the defendants had not infringed, and consequently the appeal failed, and must be dismissed, with costs. The learned judge had decided in favour of the defendants on a further ground—namely, that the plaintiff's invention was limited to "current meters," properly so called, as distinguished from "energy meters," and the defendants' meter belonged to the latter class. As at present advised, their Lordships were not satisfied that this latter ground of decision could be supported; for though the defendants' meter was an energy meter, it was, in fact, used for measuring current, and could only be so used by reason of the pressure in the shunt current being kept practically constant. It was unnecessary, however, to express a concluded opinion on this point.

The appeal was dismissed, with costs.

ACTION AGAINST THE LONDON UNITED TRAMWAYS.

Mr. Justice Darling and a common jury on the 11th inst. heard the case of Willsmore *v.* the London United Tramways Company, which was an action to recover damages for personal injuries.

Mr. Kemp, K.C., for the plaintiff, said that on the evening the accident occurred Miss Willsmore got into an omnibus belonging to the London General Omnibus Company at the Marble Arch to go home. The vehicle had got safely as far as Shepherd's Bush Green, along the Uxbridge-road, when it was overtaken by a car belonging to the defendant company. The plaintiff's case was that the car was proceeding at a high rate of speed, and did not ring a warning to the omnibus to get off their lines, with the result that the car caught the tail of the omnibus. The collision threw the plaintiff off her seat. The back of her neck and shoulders were severely bruised, and although no bones were broken, she was sufficiently injured to be unable to fulfil some engagements she had as a singer, and it was some weeks, in spite of medical care and a change to the seaside, before she could sing again. There was no question of contributory negligence here, and all the jury would have to decide was whether the defendants' servants had been negligent.

The jury, without leaving the box, found for the defendants, and judgment was entered for them accordingly.

DUBLIN TRAMWAYS.

In the Nisi Prius Court, Dublin, last week, Mr. Justice Madden and a city special jury heard the case of Thomson *v.* Dublin United Tramways Company. The action was brought by Joseph Thomson, an ex-sergeant of constabulary, to recover a sum of £1,500 for personal injuries alleged to have been sustained by reason of the defendant company's negligence. Defendants denied that they were guilty of negligence, and further pleaded that the plaintiff was guilty of contributory negligence. The alleged occurrence took place in Earl-street while an incoming tram was at a siding, and when the plaintiff was getting off the top of the tram. He fell to the ground, and sustained the injuries complained of.

The jury found for the defendants on all points—that the defendants were not guilty of negligence, that the tramcar did not move, that the plaintiff was guilty of contributory negligence, and that the defendants could not have avoided the accident by reasonable care or diligence.

Judgment was accordingly entered for the company.

TUBE RAILWAY COMPENSATION.

In the London Sheriffs' Court on Monday, before Mr. Under-Sheriff Burchell and a jury, Messrs. Bowden Bros., of Brompton-road, claimed compensation from the Great Northern, Piccadilly, and Brompton Railway in respect of property which the company seeks to acquire in constructing its tube railway.

Mr. Boyd, K.C., in opening the case, said the premises had been acquired for a site for a station for the new tube railway—one of the schemes in which Mr. Yerkes was largely interested. On these premises Messrs. Bowden had for some years carried on the business of fine art dealers, and they acquired the building on a lease for 26½ years from Christmas, 1898, at a rental of £220 per annum.

The jury heard expert evidence and awarded £7,000 compensation, with £1,100 for stock and £500 for fixtures.

COMPANIES' MEETINGS AND REPORTS.

AUTOMATIC TELEPHONE.

An extraordinary general meeting of this Company was held on Saturday at the Cannon-street Hotel, Mr. Max Margowski presiding.

The **Chairman**, after expressing regret at the absence of the chairman of the Company, who was at present in Australia, said that at the last meeting, when their chairman addressed the shareholders, they were informed that at the suggestion of the Board the chairman went to Paris to see the working of Monsieur Gustave Seligmann-Lui's model, which that gentleman stated was in perfect working order. He must confess that the chairman's statement was rather sanguine, because when they received the model and invited their own engineer to examine it to see if it was in compliance with the contract, it did not appear to be complete and in working order. The shareholders would remember that the directors gave an undertaking last year that they would not part with any of the Company's funds unless the model was in complete working order. He was pleased to tell them that they had carried that undertaking out. When the model was brought over here it was not in a condition in which they could show it to technical people, and unless they could make an instrument of commercial value it was no use the directors spending their money upon it. Prof. Silvanus Thompson had recommended a practical gentleman to see the directors, and they had engaged his services with a view of perfecting the machine. That gentleman had been able to design an apparatus which several of the shareholders had had an opportunity of seeing. Since it had been known in certain quarters that the Company were in a position to substitute automatic telephones for the present system they had received many enquiries respecting it, and at the present moment very important negotiations were pending, and therefore he urged the shareholders not to refer to that matter, as it might injure the Company. In addition, the directors were in treaty for the sale of their patents, and on Thursday last one of the Colonial Government engineers called at the office of the Company to ascertain whether they could deliver or instal an exchange for which they had lately tendered. Therefore the Company's patent was not a mere speculation. They had left the speculative stage and were now entering upon the practical stage of the business, but to carry on the concern it was necessary that the Company should have its own plant and factory capable of turning out telephonic machines. He believed that their factory would be self-supporting from the beginning. To properly equip with plant and machinery the factory in an up-to-date manner further working capital was required, for which purpose it was proposed to reconstruct the Company. He might state that they had received a large number of proxies from the shareholders in support of the scheme, which, including the votes of the directors, would amount to over 200,000. He did not think until late last month that it would have been necessary to reconstruct, but it had become necessary because he had not been able to make other financial arrangements. He concluded by moving resolutions to voluntarily wind up and reconstruct the Company.

Mr. Cameron seconded the resolutions, which after a lengthy discussion, were carried.

BASTIAN METER.

In their report for the 12 months ending Feb. 28, 1902, the directors state that the sole selling agency of the British Electric Meter Company, Limited, was not cancelled until Jan. 19, 1902, and during nearly the whole of the first period of 12 months the Company's operations were considerably hampered by the unsatisfactory nature of that arrangement, and were disorganised owing to the negotiations for its termination. The loss of £635. 8s. 10d. may fairly be attributed to these causes. A profit of £930. 9s. 4d. has been earned during the ensuing six months (at the rate of nearly 5 per cent. on the issued capital of the Company), and the continued expansion of the business indicates that this profit will be considerably increased by the end of the financial year, and that the anticipated benefit to this Company by the acquisition of the control of the sales department will prove fully justified. The increase in the British and foreign sales are both equally satisfactory, and that the Bastian meter is a practical success is proved by the numerous repeat orders and testimonials constantly received by the Company. The value of the goodwill has certainly increased, and the value of the patents has been well maintained by the addition of patents for important improvements in details of construction of the meter. An important number of new customers have been obtained during the year. The market in Spain has been opened up, and meters supplied to Madrid, Seville, Carthagena, Burgos, and many other towns, but the directors are of opinion that a large trade can only be safely conducted by manufacturing in the country, and negotiations for the sale of the Spanish patents are well advanced. Satisfactory orders are also being received from Belgium, and steps are being taken that the Company's interests be efficiently represented in South Africa. The Bastian meter, specially designed for use on electric tramcars, is just being put on the market, and the directors anticipate a large sale, as it supplies a distinct want.

PROFIT AND LOSS ACCOUNT (SIX MONTHS ENDING AUG. 31).

Dr.	£	s.	d.
Depreciation of plant, tools, office furniture, etc.	19	8	0
Debenture interest	124	17	5
Audit fee	15	15	0
Balance to balance-sheet	771	6	5
	£931	6	10

Cr.	£	s.	d.
Balance, being profit after paying for materials, wages, and expenses, and providing for bad debts	930	9	4
Transfer fees	0	17	6
	£931	6	10

METROPOLITAN DISTRICT RAILWAY.

A special general meeting of the shareholders in this Company was held at the Westminster Palace Hotel yesterday at noon, Mr. R. W. Perks, M.P., presiding, for the purpose of considering the provisions of the Metropolitan District Railway (Various Powers) Bill and the Metropolitan District Railway (Works) Bill.

The **Chairman**, in moving that the consent of the shareholders be given to the promotion of these two measures in the ensuing session of Parliament, at once described the main propositions of the Various Powers Bill. In the first place, it was proposed to construct three short lengths of railways—viz., between Studland-road and Turnham Green, between Gloucester-road and Earl's Court Station, and between Mark-lane Station and the Tower Station, on either side of the City

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Lines and Extensions Railways, for the purpose of forming a station under Trinity-square, Tower-hill. The first of these new railways would run parallel to the London and South-Western Railway between Studland-road and Turnham Green, over which this company had been accustomed to run for many years. They were also taking power, if necessary, to agree with the London and South-Western Railway to widen their railway, and thereby obtain four ways of line instead of two. With electric traction, and a rapid service of trains from Harrow, Ealing, Hammersmith, and Richmond it would be obviously impossible to carry the traffic over two single lines. Having described the other main provisions of the Various Powers Bill, he mentioned that the directors were coming to a friendly agreement with the London United Tramways Company, and that they would work in friendly relations with that company, instead of in competition as heretofore. He also stated that Mr. Clifton Robinson, the managing director of the London United Tramways, had that morning been appointed to the Board of the Metropolitan District Railway Company. One result of a friendly agreement with the London United Tramways Company would be the issuing of through tickets over the two systems. With the introduction of electric traction on the District Railway the trains would be almost too long for some of the stations, and powers were therefore being sought to extend these where necessary. Every electrical train would consist of seven coaches, each 50ft. in length. The front and end coaches of each train would be motorcars, and there would also be a motorcar in the middle. The directors were not asking Parliament for a settlement of the fares question, as the Company already held powers to enforce certain fares and to charge a uniform rate if desired. They would carry their passengers at rates quite as low as the Central London Railway, and they had made the amplest possible provision for the carrying of the working classes at the lowest rates. Referring to the Works Bill, the main object of this measure was to obtain powers to extend the authorised scheme for a deep-level line, the proposed extensions being from Earl's Court to Hammersmith in the West, and from the Mansion House to Whitechapel in the East. This deep-level railway, however, would only be constructed in the event of the traffic on the District Railway increasing to such proportions that an outlet for part of it would have to be found by the opening of another line. It would then be an entirely separate undertaking from the parent railway, with a separate capital. In conclusion, the chairman expressed gratification at the temporary defeat of the powerful combination for securing the Piccadilly and Strand routes for underground electric railways, and stated that the Works Bill which this Company were promoting would enable them to better meet the opposition with which they were threatened from the City to the West.

Major Isaacs seconded the resolutions, which were agreed to unanimously.

An extraordinary meeting was held immediately afterwards for considering a resolution authorising a new issue of ordinary stock.

The **Chairman** explained that this new issue was necessary in order to make provision for the payment to the Construction Company in respect of the electrical equipment of the District Railway. That company under their agreement were entitled to an issue of £50,000 of ordinary stock at 25 per cent. and £133,000 debentures at par.

In reply to a shareholder,

The **Chairman** stated that the Harrow-to-Mill Hill and the Hounslow-to-Mill Hill sections would be ready for electrical operation immediately after Christmas, but the introduction of the electric service was dependent on the completion of the power-house at Chelsea. With regard to the main line, it was hoped to have the trains running electrically in about 15 months' time.

The resolution was unanimously carried, and the meeting closed.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The third annual meeting of this Company was held on the 12th inst. at Westinghouse-building, Norfolk-street, Strand, Mr. George Westinghouse, chairman of the Company, presiding.

The **Chairman,** in moving the adoption of the report, stated that manufacturing operations on a considerable scale were now being conducted at the Company's works in Manchester, where all further orders for electrical machinery, steam-turbines, and gas-engines would be executed. These orders included the eight 5,500-kw. turbines and generators for the Underground Electric Railways Company of London, Limited (including the District Railway), and the three 3,500-kw. turbines and generator for the Metropolitan Railway Company, besides the entire steam and electrical apparatus for the Clyde Valley Power Company. There were now employed in the works at Manchester about 3,000 operatives, who, under experienced supervision, were rapidly becoming familiar with new methods of manufacture. There was every reason at present to expect that the costs and rate of production would be entirely satisfactory. He then referred to the Company's relations with the American companies. During the past year the business of those companies had so increased as to make necessary the purchase of additional land and the erection of further workshops, which would nearly double the present output capacity, in order to meet existing demands. This increased capacity, it was hoped, would provide in a small measure for the requirements of some of the principal steam railways which were planning to extensively use electricity for the operation of suburban traffic, especially in and near New York. The developments of these several American companies in the matter of new designs of apparatus, new methods of operation and of manufacture, had been particularly important during the past year, and especially in respect of the construction and use of gas-engines and Parsons steam-turbine engines. The Parsons steam-turbine for the driving of electric generators was an ideal device, and so long as steam was depended upon, its use for power purposes could be widely extended, and the Company had, therefore, made the manufacture of this type of engine a special feature. It was the conviction of their chairman that the gas-engine would also prove the most important instrument for the cheap production of power, particularly if a simple and effective device be found to remove tar and dust from ordinary soft coal producer-gas. Such a device would soon be available to this Company, the application of which would make the gas-engine branch of the business large and profitable. Reverting to the subject of the report, it would be seen that it was proposed to increase the preference share capital to a total of £2,000,000—*i.e.*, to authorise a further issue of 200,000 £5 preference shares to rank *parri passu* with those already issued, and if so authorised, the directors would forthwith offer 100,000 of such new shares to the present proprietors at £5. 10s. per share. They had already secured such a volume of business as to justify the profitable use of this additional working capital. He mentioned that shortly before sailing from New York the Board of the American company authorised him, at his discretion, to take all of the 100,000 shares proposed to be issued which might not be applied for by the proprietors at £5. 10s. per share, which authority he should take pleasure in exercising, for such action would assure to this Company a premium of £50,000 on the issue of the 100,000 new preference shares. Referring to the contract for the electrification of the Mersey Railway, he stated that this work had progressed favourably, and the plant would be ready for operation early in January, about the time named in the contract for the completion of the work. Discussing the present position of electric traction, he said it was quite clear that the rate of development of electric traction in Great Britain would depend largely upon the facility with which the required capital could be raised, the machinery constructed, and the plants established. The fact that the North-Eastern Railway, instead of building its own plant for the manufacture of electricity, was proposing to take a supply from the Newcastle-on-Tyne Electric Supply Company, would undoubtedly draw attention to and establish the fact that the great railways could avoid a large expenditure of fresh capital by securing a supply of electricity from companies already having the required parliamentary powers, or from other corporations yet to be formed. Besides the North-Eastern Railway, the Lancashire and Yorkshire Company had announced its intention to electrify its line between Liverpool and Southport, while the Great Eastern and London and Brighton Railway Companies had given notice of their intention to apply for parliamentary powers for like purposes. In conclusion, he referred to the good services rendered by the staff during the past year.

Mr. J. F. Mason seconded the motion.

A **Shareholder** suggested that the best way to make the proposed new issue would be to offer it *pro rata* to each individual shareholder.

The **Chairman** replied that it was not practicable conveniently to allot the shares exactly *pro rata*, but as nearly as possible as that would be the object of the Board.

The motion was unanimously agreed to, and a special resolution authorising the increase of the capital as recommended was afterwards carried.

This was confirmed at a separate meeting of the ordinary shareholders held immediately on the conclusion of the general meeting.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

In the absence of the Hon. Henry Marsham, Major Leonard Darwin presided over the ordinary general meeting of this Company, held at the offices, Cannon-street, on Tuesday.

The **Chairman,** in proposing the adoption of the report (*vide* last issue), stated that their cable ship "Silvertown" had just landed the Californian shore-end of the cable which would connect San Francisco with the Sandwich Islands. She was now engaged in laying the cable towards Honolulu, about 200 miles being "paid out." During the financial year under review the Company's "Dacia" and "Buccaneer" had had employment, and the latter was now engaged in cable repairs on the West African coast. The general business had shown a falling off in value, although not so much in bulk. The lower selling prices were responsible for this to a great extent, but there had also been some shrinkage in business. The works at Silvertown and Persan were in excellent order. It was probable that the Board might have to increase the accommodation at the Silvertown works to enable them to handle the goods with greater dispatch than they were now able to do. The shareholders would appreciate the necessity for these changes when he informed them that the Company had about 4,200 employés, and the number was ever growing.

Mr. Abraham Scott seconded the motion.

A **Shareholder** asked for an explanation of the enormous increase of the stock-in-trade, from £364,000 to nearly £827,000, the latter amount representing nearly the total share capital of the Company. He also put various other questions to the chair.

The **Chairman** said he thought he had answered in great part the question as to the increase in the stock-in-trade. The Company had at the present moment a cable which was being laid, and there was a large stock-in-trade in connection with that cable. On the other side, there was a large increase in the "debts owing by the Company and amounts received on account of partly executed contracts." When the cable was thrown overboard and altogether paid for the two items would shrink to their normal amounts. With regard to the debentures and shares in other companies, it was perfectly accurate that there had been a sale of certain shares in other companies. This sale had been effected at a moderate profit. The ordinary trade had not been quite up to the usual level. The fact that certain shares in other companies had been sold at a profit explained, in a measure, the satisfactory state of the report. The directors had been asked why nothing had been written off for the depreciation of the steamships, all of which had been actively employed during the year. The

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dir ectors had given the matter their consideration, and they thought that the steamships were fully worth to the Company the amount at which they were placed in the accounts. The managing director informed him that between one-eighth and one-tenth of the item was the proportional value of the steamships. As to the auditors' remark that the reserve fund fully covered the amount of £46,000 shares held in other companies, he thought that those gentlemen had shown a very cautious disposition, and, of course, the amount very fully indeed covered the item. There was no outstanding liability on any of the shares, and he felt convinced that they were fully worth the amount at which they were set out in the accounts.

The resolution was then carried.

An extraordinary general meeting was then held.

The **Chairman** remarked that, under present existing conditions of business, it was desirable, and indeed essential, that the Company should have power to hold interests in and to assist in the formation of other companies. The Board, however, had been advised that it was open to serious doubt whether the Company had power to hold shares and securities in other companies, and they were further advised that the proper course for the Company to take was to apply to Parliament to confer upon them the desired power. After explaining in detail other powers which the measure would confer, he moved a resolution approving a Bill proposed to be introduced in the ensuing session of Parliament.

Mr. George Henderson seconded the motion, which was carried.

ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING.

The ordinary general meeting of the shareholders in this Company was held at Salisbury House on Tuesday, Lord Arthur Butler presiding.

The **Chairman,** in moving the adoption of the report, which appeared in our last issue, explained that, although the accounts dealt with a period of 18 months (to Sept. 30 last), the directors had been able to bring the general balance-sheet down to the end of November. An abundant supply of water for the boilers had been obtained from the Company's own wells, which made them independent of the public water supply, and thereby saved them some hundreds of pounds per annum. When the line was opened and the traffic began to develop, it was found that the 40 cars supplied under the contract were inadequate to meet the requirements, and 20 new cars were ordered, 10 of which were delivered and were running during last summer, and 10 more would be ready next season. After stating that the maintenance of rolling-stock at Thanet must always be an expensive matter, as the sharp curves and steep gradients involved constant use of the brakes, and consequent wear and tear of wheels and rails, he said the shareholders would readily understand that there was exceptional difficulty in making arrangements for the traffic of the district served by the Company's tramways, for while there was great pressure during the summer months, the traffic during the winter months was very small. As an instance of this, he mentioned that the passengers carried in the winter months, October, 1901, to March, 1902, were 1,233,095, and in the summer months, April to September, 1902, 3,339,402. The Company experienced a considerable loss on last winter's traffic, owing to their want of experience of the requirements at Margate and Ramsgate. Guided by what they learnt last winter, they were now working the traffic at a reduction varying from £70 to £100 per week as compared with the corresponding period last year. Practically the present receipts were the same as those of the previous year, with the exception of the last fortnight, when they showed a decrease owing to the very inclement weather. The directors had hoped that the summer's traffic would have been considerably in excess of that of the previous year, but owing to the weather the Company had had a most unfortunate season. In August, their busiest month, there were no fewer than 17 wet days, which had lost the Company £1,000 in traffic receipts. The Board were, however, hopeful that in the future the supply of current required for lighting purposes in the winter would to a great extent make up for the lessened receipts from traffics during that season. The installation of the public lighting at Margate had unfortunately had to be postponed, owing to the fact that the negotiations with the Corporation had not been definitely concluded. The Company were, however, laying the distributing mains to enable them to provide for the private lighting, which they hoped shortly to be in a position to supply.

Mr. Henry Brown seconded the motion, which was carried.

SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER.

The ordinary general meeting of the shareholders in this Company was held on Friday last at the Law Association Rooms, Liverpool.

Sir John Willox, M.P., presided, and in moving the adoption of the report he detailed the progress of the Company, pointing out that during the 1½ years that had elapsed since the Company got to work a substantial part of their programme had been realised. They aimed at establishing a complete and continuous network of tramways in the district of South Lancashire, available for passengers, parcels, and goods, and looked with confidence to the co-operation of local authorities in making the service really useful to the community. The Company's system brought mills, factories, collieries, etc., into immediate contact with each other and with the port of Liverpool, and, traversing as it did prosperous industrial districts where there was an unlimited quantity of raw material and manufactured goods to be handled, they could look forward to securing a large share of goods traffic besides that of passengers. So far their experience had been fairly satisfactory despite many difficulties, and there was every reason to believe that the receipts the year round would be good and the expenses moderate enough to allow a fair margin of profit.

Mr. E. K. Muspratt seconded the motion, which was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Wigan.—The Corporation invite tenders for a supply of cable. Tenders by Dec. 29. See advertisement.

Bucharest.—The Postal Telegraph Department require tenders for 50,000 kilos of galvanised iron wire. Tenders by Dec. 29.

Swindon.—The Corporation invite tenders for the wiring of the town hall for the electric light. Tenders by Dec. 29. See advertisement.

Wigan.—The Corporation invite tenders for an extension to the switchboard at their central electric supply station. Tenders by Dec. 29. See advertisement.

Glasgow.—The Corporation invite tenders for the supply of 100 electric motor equipments and spare parts for same. Tenders by 11 a.m. on Jan. 5, 1903. See advertisement.

Lowestoft.—The Corporation invite tenders for motorcars, trucks, motors, and equipments, and track sweeping and watering car. Tenders by Jan. 7, 1903. See advertisement.

Stepney.—The Electrical Committee invite tenders for a 500-kw. combined steam-engine and multipolar direct-current dynamo. Tenders by Jan. 16, 1903. See advertisement.

Trujillo (Caceres, Spain).—The Municipality of the first-named town require tenders for an electric lighting installation. Tenders by Dec. 26. Details may be obtained from the Mayor.

Bristol.—The Electrical Committee invite tenders for surface condensers, etc., for the second instalment of their Avonbank electricity works. Tenders by Jan. 6, 1903. See advertisement.

Sunderland.—The Corporation invite tenders for the supply of a Lancashire boiler, 28ft. by 8ft. 6in. diameter, with fittings, etc., complete. Tenders by 12 noon on Jan. 2, 1903. See advertisement.

Blackpool.—The Electricity and Tramways Committee invite tenders for the supply and delivery at the electricity works of overhead tramway equipment and cable. Tenders by Dec. 24. See advertisement.

Wallasey.—The Urban District Council invite tenders for engine and dynamo for traction purposes, Lancashire boiler, condensing plant, and water-cooling tower. Tenders by Jan. 15, 1903. See advertisement.

Burnley.—The Health Committee invite tenders for the supply and delivery of steel steam-piping required for conveying steam from the refuse destructor boiler to the electricity station. Tenders by Dec. 20. See advertisement.

Walsall.—The Corporation invite tenders for the supply of 28 double-deck tramcars with electrical equipment. Specification, etc., may be obtained from Mr. Alexr. Wyllie, borough electrical engineer, Wolverhampton-street, Walsall. Tenders by 29th inst.

Hebden Bridge.—The Urban District Council invite tenders for gas-engines for direct coupling to dynamos; dynamos, booster, and balancers; storage battery, switchboard, travelling crane, and supply and laying of cables. Tenders by Dec. 22. See advertisement.

Blackpool.—The Tramways Committee invite tenders for laying about one and a quarter miles of double line at Lytham-road South. Specification, etc., can be obtained from Mr. John S. Brodie, borough engineer and surveyor, Town Hall, Blackpool. Tenders by Dec. 22.

Sidmouth.—The Urban District Council invite tenders from electrical engineers and others for the lease for a period of 42 years of a provisional order for the supply of electricity for lighting, heating, and power throughout their district. Tenders by Dec. 20. See advertisement.

Partick.—The Town Council invite tenders for the supply of 200 arc lamp columns, arc lamps, fittings, etc., supply, laying, and jointing of necessary, cables, feeders, joint-boxes, etc. Specifications, etc., can be obtained from Mr. H. B. Maxwell, burgh electrical engineer, Partick. Tenders by Jan. 6.

Stoke-upon-Trent.—The Corporation invite tenders for the supply and erection of boiler-house plant, steam dynamos (single-acting engines), balancer, reversible boosters (hand-regulated), switchboard, battery, street mains and accessories, travelling crane, and workshop machinery. Tenders by Jan. 14. See advertisement.

Brighton.—The Council invite tenders for the construction of the permanent way of the tramroads in London-road, St. Peter's-parade, and Old steine, etc., including the bonding and all contingent works, and paving with wood the whole of the area of such roads, including the tramway tracks. Tenders by Dec. 23. See advertisement.

La Valette.—The Municipality invite tenders for the establishment and working for 99 years of a tramway between La Valette and Senglea Cospiena, Vettoriosa and Casal Zebbug. Deposit £300. Tenders by Nov. 25 to Wm. Casolani, receiver-general and director of contracts, La Valette. Plans and particulars will be ready by March 1, 1903.

Barrow-in-Furness.—The Corporation invite tenders for the supply and erection of two 250-kw. engines and generators, generator and traction feeder switchboards and Board of Trade panel, and steam and exhaust pipes. Specifications, etc., can be obtained from Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness. Tenders by Jan. 5.

Blackpool.—The Cleansing Committee invite tenders for the supply and erection of high-speed engine, 240 b.h.p., two 20, two 10, and one 5-b.h.p. motors, main switchboard, wiring, and lamps, and overhead traveller in connection with the refuse destructor extensions. Specifica-

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tion, etc., may be obtained from the office of the Cleansing Superintendent, 21, Birley-street, Blackpool. Tenders by Dec. 30.

Clacton.—The Urban District Council invite tenders for the supply and erection of boiler-house plant, two Economic boilers with fittings and accessories, steam and exhaust piping, two high-speed engines, two 100-kw. dynamos, balancer and boosters, switchboard, street work, underground cables, switch pillars, etc., accumulators, travelling crane, and rails. Tenders by Dec. 22. See advertisement.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply, delivery, laying, erection, and connecting-up, etc., of high-tension cables, low-tension cables, telephone, and test wires, etc., extra high-tension switchboards for main generating station and four sub-stations, and low-tension switchboards. Tenders by Jan. 5. See advertisement.

Bradford.—The Corporation invite tenders for supply of miscellaneous stores required by the tramways department during year ending Dec. 31, 1903, as follows: poplar wood blocks; iron, brass, and bronze castings; motor grease and lubricating oil; cleaning materials; river sand; bearing metal. Forms of tender, etc., may be had on application at the Tramway Offices, 5, Forster-square, Bradford. Tenders by Dec. 20.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 2,245 tons of steel girder tramway rails, 1,470 tons of slot rails, 580 tons of conductor tee rails, together with the fishplates, and bolts and nuts required in connection with the reconstruction (for electrical traction) of the County Council tramways. Specifications, etc., may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on 22nd inst.

Devonport.—The Corporation invite tenders for the supply of materials in connection with and the execution complete of the overhead equipment of about 2 miles 4 furlongs 3 chains of double trolley line, together with incidental works. Specification, etc., may be obtained on application to Mr. C. Chadwell, 20, Victoria-street, Westminster. Copies of the drawings may be inspected daily between 11 a.m. and 5 p.m. on application being made to the Resident Engineer, 40, St. Aubyn-street, Devonport. Tenders by 9 a.m. on 29th inst.

Bulawayo (Rhodesia).—Tenders are invited by the Municipal Council for the establishment and working of an electric tramway system for that municipality. A limited number of copies of a draft agreement upon which the Council is prepared to grant the right, together with plan of township, suggested route, and other details, can be obtained upon application to Messrs. Davis and Soper, 54, St. Mary's-axe, London, E.C., London agents of the municipality, by whom sealed tenders, endorsed "Tramways," will be received up to noon on Feb. 26.

London, S.E.—The Camberwell Borough Council invite tenders for the maintenance of electric bells and private telephones, and maintenance of electric light storage batteries at Church-street baths from April 1, 1903, to March 31, 1904. Particulars may be obtained from Mr. W. Oxtoby, borough engineer, Town Hall, Camberwell, S.E. Samples may be inspected at the Grove Vale Depôt, opposite East Dulwich Station. The committee will not consider any tender except on the authorised form of tender, which must be delivered at the Town Hall by 5.30 p.m. on Jan. 12 and 7 p.m. on Jan. 6 respectively.

Wellington (New Zealand).—The City Council invite tenders for the complete supply and installation of electrical tramways, other than buildings; the supply, delivery, and erection of certain tramcars and electrical equipment; plant and materials for the power station; supplies and the erection of plant for the power station; materials for the permanent way; supplies and the construction of the permanent way; material and fittings for the overhead equipment and feeders; and erection and maintenance of all materials, etc., for the overhead equipment and feeders. Tenders by Jan. 21. See advertisement.

Sydney (N.S.W.).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on Wednesday, Feb. 4, 1903, from persons desirous of contracting for the supply and delivery of an additional subscriber's section of the present metallic circuit branching system multiple telephone switchboard at the Central Exchange, General Post Office, Sydney, New South Wales. Sealed samples, specification, and general conditions may be seen at the office of the Chief Electrician, General Post Office, Sydney. Specification and general conditions may also be seen at the General Post Office, Melbourne, Brisbane, Adelaide, Perth, and Hobart. The tenderers must state the shortest time within which the switchboard can be delivered at the Central Exchange, General Post Office, Sydney.

RESULTS OF TENDERS.

Saltburn.—The tender of Hutton and Walker has been accepted for the lighting of the parish church: wiring £150, fittings £100. 3s.

West Hartlepool.—The Town Council have accepted the tender of the British Thomson-Houston Company, Rugby, for the supply of motors.

Faversham.—The tender of the Portsmouth municipal telephone for the erection of a telephone to the isolation hospital, at £8. 5s., has been accepted.

Derby.—The Co-operative Society have decided to instal Willans's engines for direct coupling to dynamos of Mather and Platt's make for supplying power to their new premises.

Bradford.—The British Thomson-Houston Company of Rugby, have secured a repeat order from the Corporation for 11,000 British Thomson-Houston Edison incandescent electric lamps.

Durham.—The Binchester Colliery have decided to instal a compound 360-h.p. Willans engine for direct coupling to a multiphase generator of the Allgemeine Elektricitäts Gesellschaft type.

Portsmouth.—The Town Council have accepted the tender of Easton and Co. for the supply and erection of an electric lift capable of carrying five persons and travel at the rate of 125ft. per minute, at £419. 10s.

Steamer Supplies.—Messrs. H. Binko and Co., of 34, Leadenhall-street, E.C., have been favoured with a renewal of their contracts for electric supplies with the New Zealand Royal Mail Steamship Company, White Star line, and another leading mail steamship company.

Bury St. Edmunds.—The Town Council have accepted the following tenders: Messrs. Fowler, for the supply of a Belliss engine and a Fowler dynamo, £964; Cole, Marchant, and Morley, for surface-condensing plant and oil trap, £484; H. G. Frost, for the work of extending the generating station, £442.

Bradford.—The Corporation have accepted the following tenders for the supply of electric motors for 12 months: Keighley Electrical Engineering Company, Vulcan Works, Keighley, 30 4½-h.p.; Rhodes Electrical Manufacturing Company, City Electrical Works, Bradford, 24 7-h.p.; Phœnix Dynamo Manufacturing Company, Joseph-street Works, Bradford, 15 10 h.p.

Liverpool.—The Lancashire and Yorkshire Railway Company have accepted the tender of Yates and Thom, Blackburn, for the supply of the engines and boilers required in the conversion of the Liverpool and Southport line from steam to electricity. We understand that about a dozen engines of the low-speed type, varying in capacity from 1,200 h.p. to 500 h.p., will be required.

Tramcars.—Messrs. Witting Bros., 49, Cannon-street, London, E.C., have recently placed an order for 50 double-deck car bodies, capable of seating 55 passengers, with G. F. Milnes and Co., of Hadley, and also 50 trucks with fixed wheel base with the Brush Electrical Engineering Company, of Loughborough, these trucks being of their standard type and furnished with steel-tyred wheels.

Ipswich.—The Council have confirmed the acceptance of the tender for the switchboard of the Allgemeine Elektricitäts-Gesellschaft, of Berlin (trading in England as the Electrical Company, Limited, 25, Victoria-street, Westminster, S.W.), at £2,833, and the tender of the British Electric Equipment Company, of London, for the overhead work, subject to any modification in the design of the trolley poles which the committee may determine upon, at £9,301.

Lourenco Marques.—Messrs. Macartney, McElroy, and Co., contracting engineers, London, have obtained the contract to equip Lourenco Marques, Delagoa Bay, with a complete system of electric tramways, including powers, rolling-stock, track, and overhead lines. The contract is estimated at about £100,000. Messrs. Macartney, McElroy, and Co. undertook to complete the work in three-quarters of the time a German firm required, while their tender was below that of the Americans.

Various.—Messrs. R. Carr and Co. have the contract for the necessary cast-iron pipes in connection with the traction work at Barrow-in-Furness, which is being carried out by the British Insulated Wire Company, and also the sub-contract for the cast-iron bases in connection with the lighting and traction work at Buenos Ayres. We are also informed that the same firm are supplying the refined Trinidad bitumen for embedding the cables underground at present being laid by the contractors, the Anchor Cable Company, at Bexley, Kent, considerably over 100 tons being required for the work. They are also supplying the underground conduits for the Anglo-Portuguese Telephone Company, who are relaying their telephone system throughout Lisbon and Oporto.

Southampton.—The following tenders have been received for carrying out the whole of the proposed works in laying foundations for the electricity station and chimney shaft, Western Shore, and other works in connection therewith: H. Stevens and Co., £2,280 (withdrawn); F. Osman, £2,761 (accepted); Jenkins and Son, Limited, £2,864; F. Grace, £3,223; B. Cooke and Co., Westminster, £3,351. 5s.; Coston and Co., Limited, £3,370; Haslemere Builders, Limited, Surrey, £4,390; R. Wilkins and Sons, Bristol, £4,879. Borough engineer's protecting estimate, £3,031. 14s. 2d. Mr. F. Grace also submitted an alternative tender to execute the foundations of the building and chimney shaft in Hennebique's ferro-concrete work for the sum of £3,012.

Brighton.—The following tenders have been recommended for acceptance for the supply of material apparatus in connection with the municipal telephone system: Henley's Telegraph Works Company, conduits, £5,514. 18s. 4d.; British Insulated and Helsby Cables, cables, £2,452; Armstrong, Addison, and Co., poles, £1,031. 10s. 6d.; International Electric Company, insulators, £247. 13s. 7d.; Millars' Karri and Jarrah Forests (1902), Limited, arms, £80. 11s.; Buller's, Limited, ironwork, £132. 1s. 8d.; T. W. Lench, Limited, bolts, £22; T. Bolton and Sons, copper wire, £277 13s. 4d.; W. F. Dennis and Co., bronze wire £234. 3s. 4d., iron and steel staywire £38. 15s., insulated wires £200; International Electric Company, lightning arresters, £304. 1s. 8d.; Atlas Carbon and Battery Company, primary batteries, £70; Ericsson Bell Telephone Company, instruments £2,546. 17s. 6d., switch tables £1,274. The following tenders for the construction of the necessary switch-room on the site at the Pavilion granted by the Council have been received: A. Crowhurst, Chichester, £907; W. A. Field and Co., Brighton, £930 (recommended for acceptance); Payne, Norman, and Co., Brighton, £984; Box and Turner, Ardingly, £1,057; Sattin and Evershed, Brighton, £1,084; J. Longley and Co., Crawley, £1,149. The engineer having advised that it will be cheaper for the erection of the overhead work and the fixing of the subscribers' instruments to be carried out by workmen in the immediate employ of the Corporation, rather than that any of the tenders for this work should be accepted, the committee will recommend the Council to reject all the tenders for the erection of the overhead work and the fixing of the subscribers' instruments. The following are the particulars of the most favourable tenders for the performance of this work: Reid Bros., execution of

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overhead work £4,354. 10s. 9d., fixing of subscribers' instruments £302.

London County Council.—The Fire Brigade Committee have received the following tenders for the supply of the necessary wiring and fittings for the electric lighting, and for the necessary electric bell installations at the Clapham and Highbury fire stations now in course of erection :

Clapham station.			
F. J. Coleby and Co. (a)	£233	0	0
Southern Electrical Installation and Wiring Company, Limited (b)	320	3	0
Wenham and Waters, Limited	323	15	0
E. Thornton	324	16	0
J. Bakewell and Co.	328	18	0
Barlow Bros. and Co.	340	0	0
Lawrence and Co.	340	0	0
Nunn, Watts, and Co.	340	0	0
W. Mossop and Co.	387	16	0
A. E. Bennett and Co.	394	10	0
Jackson Bros.	415	18	6
W. G. Murrin	554	10	0
Highbury station.			
F. J. Coleby and Co. (a)	176	5	0
A. H. Marshall (b)	230	0	0
Nunn, Watts, and Co.	235	0	0
Barlow Bros. and Co	250	0	0
Southern Electrical Installation and Wiring Company, Limited	257	0	0
Lawrence and Co.	260	0	0
J. Bakewell and Co.	275	0	0
Wenham and Waters, Limited	281	10	0
W. Mossop and Co.	288	12	0
H. Sutton and Co.	290	9	7
Jackson Bros.	302	6	0

(a) Recommended for acceptance providing enquiries are satisfactory. (b) Recommended for acceptance in the event of result of enquiries proving unsatisfactory.

BUSINESS NOTES.

TRACTION.

Bournemouth.—Penny stages on the tramways have been adopted by the Town Council.

Rugby.—The question of the proposed tramways was discussed by the Urban District Council in committee last week.

Fareham.—Plans of the proposed Gosport, Fareham, and Cosham electric tramways have been approved by the District Council.

Hull.—The negotiations between the Tramways Committee and their employés with reference to certain alleged grievances are still going on.

Ponteland Light Railway.—Satisfactory progress is being made with the work of constructing the new light railway from Gosforth to Ponteland.

Milan.—The tramway employés here have struck work, demanding improved conditions of labour. One hundred cars are running under police protection.

Maidstone.—The Light Railway Commissioners have decided to submit an order to the Board of Trade for a light railway from Maidstone to Barming.

Aston.—The District Council have approved the Bill being promoted by the authorities outside Birmingham to obtain running powers for tramways into the city.

Chester.—The question of the proposed light railway from Chester to Birkenhead has been referred to a special meeting of the District Council to be convened.

Portsmouth.—Several proposals for popularising the tramways are before the committee, among them being the questions of cheap tickets and a continuous service.

Egremont.—Notice has been given by the proposed West Cumberland Electric Tramway Company with reference to the supply of electricity in this district.

Bradford.—In consequence of the number of unemployed in the town, it is probable that the construction of certain new tramway sections will be hurried on.

Houghton Regis.—The interests of this district in the Luton, Dunstable, and district electric tramways district have been left in the hands of the County Council.

Wigan.—Negotiations are proceeding between the Corporation and the Hindley and Ince Distr,ct Councils in reference to the purchase of the tramways in those districts.

Hebburn.—The District Council have resolved to ask the Felling Council to receive a deputation in reference to trams in view of the two authorities taking joint action.

Brighton.—Application is to be made to the Board of Trade for their consent to the laying of part of the tramway on the Old Steine at a space of 3ft. 6in. from the kerb.

Warrington.—The Rural District Council have agreed to an extension of time for the construction of the tramway to Winwick by the South Lancashire Tramway Company.

Rochester.—A petition to the House of Commons for leave to bring in the Rochester Corporation Tramways and Improvements Bill was sealed at the last meeting of the Corporation.

Jarrow.—A conference between the Electricity Committee and representatives of the British Electric Traction Company with reference to the tramway scheme has been arranged for.

Smethwick.—The Town Council have sealed a petition in favour of the Bill being promoted in Parliament by the British Electric Traction Company to secure running powers into Birmingham.

Parkstone.—The Board of Trade have confirmed the order granted by the Light Railway Commissioners giving powers to construct an electric tramway line through Parkstone, a suburb of Bournemouth.

Morecambe.—A special meeting of the Town Council is to be called to consider a proposal to take over the undertaking of the Morecambe Tramway Company with a view to converting the system to electric traction.

Southampton.—The iron uprights and most of the overhead wires in connection with the tramway from Spring-road, Portswood, to Onslow-road are in position, and the laying of the track has now been commenced.

Lancaster.—The public inauguration of the electric tramway service will not be long delayed. A trial trip over the three miles constituting the two sections completed has been made with satisfactory results.

Wolverhampton.—It is stated that the negotiations between the Corporation and the tramways company will soon result in a through communication being opened between Wolverhampton and Darlaston *via* Willenhall.

Harrow.—The District Council have declined to join the Wembley Council in calling upon the Middlesex County Council to appeal to the Board of Trade against the recent decision of the Light Railway Commissioners.

Buxton.—The Urban District Council have unanimously decided to oppose the application for an order for the construction of an electric tramway from Chapel-en-le-Frith *via* Buxton to the Cat and Fiddle and Macclesfield.

Canterbury.—The Chamber of Trade have decided to make representations to the promoters of the proposed mono-railway from London to Dover in order that Canterbury may be made one of the stopping places on the line.

Sunbury.—The draft agreement with the London United Tramways Company was considered at the last meeting of the District Council, and it was decided to keep the company to the agreement in respect to the width of the roads.

Brockley.—The first of a series of public meetings in support of the movement for the construction of tramways from New Cross through Brockley to Sydenham was held on Friday, when a resolution was passed in favour of the scheme.

Handsworth.—By an almost unanimous vote the District Council have decided to throw in their lot with the British Electric Traction Company, and to support their Bill in Parliament for the construction of electric tramways in the district.

Walsall.—The electrical engineer has been instructed to specify for the new cars to be fitted with Messrs. Wilson and Bennett's patent automatic lifeguard, the cost of such guards, delivered and fixed to the cars complete, being £13. 10s. per pair.

Stourbridge.—A special meeting of the District Council was held on Monday to consider the statutory notices under the Light Railways Act, 1896, which have been recently given. The matter was eventually referred to the Railway Committee.

Reddish.—A number of Reddish workpeople are petitioning the Stockport Corporation Tramways Committee to grant weekly tickets from Lancashire Bridge, the top of Lancashire Hill, and Greg's-lane to the Houldsworth Arms at special reduced rates.

Morley.—The town clerk has been requested to write to the British Electric Traction Company enquiring if the company are now in a position to give any definite information as to when they will commence the construction of the light railways in the borough.

Accident.—Mr. Joseph Whittier, aged 38, superintendent of the overhead work in the Leeds Corporation tramways department, was engaged on a tower wagon or derrick used in tramway repairs on Wednesday, when he fell into the street and was killed.

Worcestershire.—The Highways and Bridges Committee of the County Council have agreed to accept £2,600 from the City of Birmingham Tramways Company toward the cost of reconstructing Hay Mills Bridge and a culvert across the Alcester road.

Ilford.—A special meeting of the Urban District Council is to be convened to consider the question of promoting a tramway scheme for Ilford. A similar proposal was defeated at the last meeting because only 10 voted for it and a two-thirds majority was necessary.

Tees-side.—A married woman has recovered £125 from the Imperial Tramways Company in respect of personal injuries sustained when alighting from one of the company's cars. The jury found that the car was improperly started before the woman had reached the ground.

Stoke Newington.—It has been referred to committee to consider and report on a notice of intention to apply to Parliament for an Act incorporating a company with power to construct railways from the City to Tottenham, Walthamstow, Epping Forest and Waltham Abbey.

Liverpool.—The proposal has been made that the Tramways Committee should take over the Overhead Railway and merge it into the tramway service. The committee, after considering the matter in private last Friday, resolved that they could not entertain the proposal.

Batley.—The work of the laying of the new tramlines has this week been completed with the exception of the portion in Halifax-road, and that is being delayed until the long-pending agreement

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between the Corporation and the British Electric Traction Company has been signed.

Leighton Buzzard and Hitchin Light Railway.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of a light railway in the counties of Bedford and Hertford, from Leighton Buzzard to Hitchin.

Llangollen.—Land is being acquired at Trevor for the erection of a generating station by the Shropshire, Worcestershire, and East Denbighshire Electric Power Company, who are seeking parliamentary powers to construct electric tramways at Hadley, Stourport, and in East Denbighshire.

Sowerby Bridge.—A small committee of the District Council has been appointed to meet the Halifax Tramways Committee, and request them to provide shelters at the tramway terminus at Tuel-lane and Wharf-lane for the benefit of passengers, also to extend the tramway system to the Council's boundary.

Italy.—A Rome message says that the Minister of Public Works has received the representative of a London banking firm which will shortly secure a concession for the construction of an electric railway from Rome to Naples. This will be the longest electric railway in Europe, since it will be 125 miles long.

Southport.—A new section of the electric tramways was opened for the public service on Saturday. It forms a large loop on the Kew Gardens route, branching off at St. James's-street, passing along Shakespeare-street, Duke-street, and Cemetery-road, and again joining the Kew Gardens line in Scarisbrick New-road.

Exeter.—The City Council have resolved that, in exercise of the approval of the Board of Trade, notice be served on the promoters of the Exeter Tramways Bill requiring them to sell to the Council the undertaking authorised by the Exeter Tramways Act, 1881, or so much of the undertaking as is within the city of Exeter.

Sheffield.—A special meeting of the City Council was held on Wednesday, when a proposal was under consideration to instruct the Finance Committee in preparing the estimates for the next financial year to include therein an estimate of the year's operations of the Tramways, Electric Light, and Markets Committees.

Cape Electric Tramways.—The directors of the Cape Electric Tramways, Limited, announce an interim dividend of 6 per cent., payable to shareholders registered on 24th inst. and to the holders of coupon No. 14 attached to share warrants to bearer. The transfer register will be closed from 24th to 31st inst. inclusive.

Gildersome.—A deputation representing Farnley districts has recently been appointed to meet the Leeds City Tramways Committee respecting the extension of their tramway lines to the city boundary in Whitehall-road, and at the last meeting of the Gildersome District Council a representative was appointed to join the deputation.

Canterbury and Herne Bay Light Railway.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of light railways in the county of Kent, in the county borough of Canterbury, and in the rural districts of Bridge and of Blean, and in the urban district of Herne Bay.

Poynton.—This place is at present concerned with the possibility of electric tramways being laid in their district. Application is being made in Parliament in the ensuing session with a view to obtaining an Act authorising the construction of tramways in Macclesfield and district. This will include Poynton. The local council are favouring the scheme.

Chelsea.—In order that the Council may secure a *locus standi*, the Council have formally dissented from the following schemes: Clapham Junction and Marble Arch Railways; Metropolitan District Railway (various powers); Great Northern, Piccadilly, and Brompton Railway (new lines and extensions); London County Council (tramways and improvements).

Gloucester.—At the last meeting of the Rural District Council there were laid on the table plans and a book of reference of the proposed electric tramway from Stroud to Cheltenham *via* Painswick, a Bill for which is being promoted in Parliament by a syndicate. The matter will come up for consideration at a special meeting of the Council to be convened.

Barcelona.—The tramway employés have announced that they will shortly go out on strike. This step, says Reuter, has been decided upon owing to the refusal of the central committee of the tramway company, which is domiciled in London, to grant the increase of wages asked for by the delegates of the employés who recently visited England.

Hove.—A special meeting of the Town Council has now decided to proceed with the Tramway Bill as a whole. The Council are opposing the application of the British Electric Traction Company for powers to lay down a system of tramways in the borough. The consent of the ratepayers to the Corporation Bill was obtained at a largely-attended public meeting held on Tuesday last.

Derby.—At the last meeting of the Town Council, the Tramways Committee were authorised to engage the services of Mr. C. H. Wordingham to report upon various sites for the proposed station for the generation of electric energy for tramway purposes, and also as to the desirability or otherwise of having a combined station for both the electric lighting and traction.

Greenock.—The regulations for the running of the tramways were considered and ultimately passed at the meeting of the Corporation yesterday week. At the same meeting the question of the speed at which the cars run was considered. The speed in the centre of the town is not to exceed six miles per hour, and outside the town, but within the burgh, eight miles an hour.

Lye and Wollescote.—Complaints were made at the last District Council meeting that the electric cars were exceeding the limit of speed set by the Board of Trade. The clerk was instructed to enquire of the traction company whether, instead of the usual copper wire, they were experimenting with a German cord wire. It was stated that there had been several breakages lately.

Wandsworth.—The Borough Council have decided to adhere to their decision declining to contribute £1,766 towards the cost of the proposed widening of Wimbledon-road to permit of the construction by the County Council of the suggested tramway from Garratt-lane to the county boundary, on the ground that the widening would be rendered necessary solely for the proposed tramway.

Urmston.—The Manchester Southern Tramway Company have informed the District Council that though the plans of the proposed tramway through Urmston provides for a double set of lines, it is only intended to use single lines. Unless the company are prepared to make the roads a minimum width of 32ft., opposition against the Bill will be lodged on behalf of the District Council.

Sutton Coldfield.—On Tuesday a special meeting of the District Council in committee was held for the purpose of considering the question of the construction of tramways in Sutton and district. The draft of the Birmingham and District Tramways Bill was debated on at considerable length. It was intimated that a town's meeting in regard to the Bill would be held in the middle of January.

Rhondda.—At a meeting of the Rhondda Urban Council on Friday, it was reported that the joint sub-committee of the Pontypridd and Rhondda Councils had met the proprietors of the Porth-Pontypridd tramways for the purpose of fixing a price for the taking over of the undertaking. The committee considered the company's figure too high, and it was decided to proceed to arbitration.

Dewsbury.—The British Electric Traction Company, who are constructing a system of tramways in Dewsbury, Thornhill, Ravensthorpe, and through Staincliffe to Cleckheaton, have made an informal trial trip from the car-shed at Saville Town, Dewsbury, to Thornhill. The date for the official trial has not yet been fixed, and it is anticipated that the cars will not be running for public traffic until January.

Manchester-Liverpool Express.—Surveys of land to be traversed by the Manchester-to-Liverpool mono-railway have now been completed, and arrangements are being pushed forward for commencing the construction of the line at a point near Warrington. The promised early commencement of operations is attracting large numbers of labourers into the villages outside Warrington in the hope that they may secure employment.

Ashton.—The Oldham, Ashton, and Hyde Electric Tramway Company have refused to agree to an increase in the minimum number of units of electricity from 350,000 to 450,000 as proposed by the committee, but are prepared to take an increased quantity of electrical energy on the terms and conditions provided for by Clause 10 of the agreement of Feb. 10, 1897. These terms have been accepted. Tenders are to be invited for the electric lighting of the car-shed.

"Tube" Ventilation.—Every effort is being made by the directors of the Central London Railway to improve the ventilation underground. The latest experiment is to substitute iron openwork panels for the present wooden ones in the doorways of the lift shafts, and the roofs of the elevators are being partly fitted in a similar fashion. It is thus made possible for a constant draught of fresh air to descend, instead of an intermittent air current, as has hitherto been the case.

Twickenham.—It was intimated at the last meeting of the District Council that the London United Tramways Company had deposited plans and sections in connection with the application intended to be made to Parliament in the ensuing session for a Bill to empower the company to make certain widenings of streets and roads within the district. The surveyor was instructed to prepare a report on the proposed street and road widenings, together with enlarged plans of such widenings.

Devonport.—The Town Council are applying for an order from the Light Railway Commissioners for an extension of the tramways to Crownhill. The contract for the construction of the tramway from St. Budeaux railway station to Saltash Passage has been let. A proposal of the Devonport and District Tramways Company to extend the existing single line in front of the public hall, Fore-street, a distance of 36ft., so as to give them greater facilities for workmen's car traffic, has been approved.

Keighley.—The estimate of the borough and electrical engineers of the cost of converting the existing tramways to electric tramways, and of constructing an extension of electric tramway from the top of Cavendish-street to the borough boundary at Stockbridge, amounts to the sum of £32,459. It is decided to make application to the Board of Trade on or before Dec. 23 for a provisional order to authorise the Corporation to carry out the conversion and to construct and work several new tramways.

Scarborough.—It has been informally reported to the Scarborough Corporation that tramways will be laid next year down Westborough as far as Huntriss-row, but that the company will not be able to carry them beyond that point before next season. With a view of alleviating the distress prevailing in the town, the Corporation have resolved that the borough engineer be instructed to proceed with various improvements and works auxiliary to the establishment of electric tramways without delay.

Additional Traffic Returns.—Anglo-Argentine, £583 increase; Barcelona Ensanche y Gracia, £52 increase; Barcelona, £104 increase; Brisbane, £166 increase (month of November, £10,291, increase £552); Buenos Ayres and Belgrano Electric, £10 increase (month of November, £13,698, increase £925); Calcutta, £579 increase; Cape Town (month of October), receipts £16,507, expenditure £8,727; Isle of Thanet Electric, £9 decrease; Mexico Electric (month of November), receipts £42,800, expenditure £24,800; Perth Electric, £131 increase;

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Port Elizabeth (month of October), receipts £3,832, expenditure £2,095.

British Electrical Friendly Society.—The first annual general meeting of this society was held on Monday at Essex Hall. Mr. Garcke, chairman of the Central Committee, presided, and drew attention to the fact that the high rate of sick pay granted by the society rendered it doubly necessary for every member to exercise the greatest vigilance in regard to sick claims. Later on in the proceedings it was stated that the rules had been drawn up with a view of ultimately extending the scope of the society so as to include a provident fund and a pension fund.

Paddington.—At Tuesday's meeting of the Borough Council, a letter was read from the London County Council pointing out that the Railway Commissioners had deferred the consideration of the Middlesex County Council's application to construct a light railway in Edgware-road from Cricklewood to Bridge-street, near Kilburn Priory, until the result of the London County Council's proposal to make a tramway from near the Marble Arch, along Edgware-road, to Cricklewood, had been decided. The Borough Council decided to adhere to their decision not to sanction the proposed tramway along that part of Edgware-road under their control.

Clacton-on-Sea.—The promoters of the Clacton and St. Osyth light railway order are objecting to the clause in the order under which they would be compelled to take electrical energy from the Council in the event of their being able and willing to supply it. The committee reported at the last Town Council meeting that both sides had been heard by the Board of Trade on the point, and the Board of Trade had decided to consider as to adopting one of the two courses: (1) to confirm the order embodying the clause in question; or (2) remit the order to the Light Railway Commissioners for further consideration. It was further stated that the promoters of the light railway had intimated their intention of opposing the Council's application to borrow £1,500 for electricity works.

Nottingham.—Several accidents have recently occurred on the Lenton Boulevard line of electric tramways, owing, it is stated, to the standards being placed in the centre of the roadway and to the gradient from the centre to the foot pavement being dangerous to cart traffic. A preliminary meeting of persons interested has been held at Old Lenton to consider steps to be taken to remedy the grievances. In the course of a discussion on the various points concerned it was unanimously agreed that the standards, and especially the one at the bottom of Willoughby-street, were a distinct encroachment on the public rights of vehicular traffic, and the fall of the road to the gutters was extremely dangerous, especially to coal carters. A deputation is to wait upon the Tramways Committee in the matter.

Leeds.—The problem of protecting passengers from bad weather when riding on the top of a tramcar has been taken up by the Tramways Committee. The design of a removable awning which has recently been undergoing tests in Liverpool is stated to have been improved upon by Mr. Joaquim Antonio de Macedo, the Portuguese vice-consul of Leeds. The committee have decided to give a trial to the invention, and a tramcar fitted with the Macedo cover is expected to be ready next month. At their last meeting the committee approved the recent report of the general manager in regard to various proposed alterations in the stages and method of collecting fares. The changes will come into force on March 26 next, including the new system of fare-collecting by ticket and that of overlapping stages.

Stretford.—The grant on Friday of an injunction restraining the Manchester Corporation and the Stretford District Council from taking possession of, removing, or otherwise interfering with the tramways within the Stretford district was followed on Saturday by the inevitable developments. Since the southern tramway routes have been electrified—that is, since Dec. 1—the Manchester Corporation have been running horse cars between the city boundary and the Cock Inn at Stretford. They have also been pushing forward the electrical equipment of the lines in the Stretford district, and it was expected that the permanent way as far as Trafford Bar would be completed in a few weeks and the whole of the work in two months. As a result of the injunction, however, the service of horse cars has been discontinued, and all work upon the roads has also been stopped.

Sunderland.—Mr. England reported to the last meeting of the Tramways Committee that the result of his negotiations with the postal authorities in regard to having letter-boxes on the cars, was that the Post Office would only consider the question of having letter-boxes on one car from each terminus at a certain time during the evening. The committee did not think the offer worth entertaining. The question of office accommodation was considered, and it was resolved to ask the Town Hall Committee to take immediate steps for providing better offices. A sub-committee of six was appointed to confer with a similar sub-committee from the Lighting Committee for the purpose of making arrangements for the visit of the Municipal Electrical Association, of which body Mr. J. F. C. Snell, the borough electrical engineer is president. The association's annual meeting is to be held in Sunderland in July next.

Torquay.—The Town Council met in committee last week to consider the applications of the three tramway companies for powers to run electric trams in the borough. It was ultimately decided to negotiate with the promoters on the following five points: (1) What price will each company be prepared to pay the Corporation for the electric power necessary to work the trams? (2) What condition will each company give with regard to the right of purchase? (3) Would each company be prepared to construct according to the specification of Kincaid, Waller, and Co., the experts recently consulted by the Corporation? (4) Would the companies be prepared to accept the routes, or such of them as might be approved by the Corporation, sketched out in the report recently made by Mr. Waller? (5) Was each company prepared to guarantee the construction and proper equipment of the tram service if it secured the powers.

Rowley.—At a meeting of the District Council on Tuesday the General Purposes Committee reported that certain alterations had been made in the scheme for the reconstruction of the tramway at Tividale by the Birmingham and Midland Tramways Company. The committee also reported that notices had been received of the proposal of the Dudley, Stourbridge, and District Electric Traction Company to apply for a provisional order for the extension of the Dudley and Halesowen and district light railways. The solicitor explained that two portions of the proposed tramways would run through districts for which the Council were applying for a provisional order. It was decided to oppose the application. It was also resolved to make application to the Light Railway Commissioners for the allowance of the costs, amounting to £557, respecting the application made in the session 1902 for a provisional order for light railways from Old Hill to Blackheath, and a committee was also appointed to deal with the construction of the proposed lines.

Edinburgh.—A special meeting of the Lord Provost's Committee of the Town Council has been held to consider the schemes for the construction of electric tramways between Edinburgh and South Queensferry and between Joppa and Musselburgh. The meeting lasted 1½ hours, and numerous points brought forward by the town clerk were discussed in connection with the plans of the proposed tramways. Among other points raised, it is understood, was the widening of the Dean Bridge, and a proposal that the tramway company should pay one-third of the cost, the town one-third, and the landed proprietors on the north side of the bridge one-third. A proposal was also made that the cable tramway from Comely Bank should run round by Blackhall, and from thence into the west end of the city, leaving the electric tramway to start from the village of Blackhall. One condition that was very strongly supported was that the electric current should be conveyed underground as far as the outskirts of the city. The town clerk was instructed to communicate with the promoters, and to call another meeting on the subject.

Burton and Ashby Light Railway.—In the House of Commons on Tuesday Sir Walter Foster asked the President of the Board of Trade whether his attention had been called to a scheme for making a light railway between Burton-on-Trent and Ashby-de-la-Zouch by the Midland Railway Company, which has been approved by the Light Railway Commission, and whether, seeing that a similar light railway scheme was rejected last quarter, after opposition by the Midland Railway, he can see his way to alter the terms so as to give the Derbyshire County Council, or the urban district councils through whose districts the line passes, the right to acquire the undertaking at the end of 35 years at cost price, as on the only similar line sanctioned in the county of Derby, instead of on the terms proposed—viz., the full value as a going concern, with the obligation to lease the line to the Midland Railway Company—seeing that the line is made for a considerable portion of its length on land belonging to the County Council. Mr. Gerald Balfour replied that the order referred to by the hon. member had not yet been made by the Light Railway Commissioners, and submitted to the Board of Trade for confirmation, as provided by the Light Railways Act. When it was submitted due notice would be published in the *London Gazette* and a local newspaper to enable objectors to the confirmation to lodge objections, which in due course would receive full attention from the Board of Trade.

Aberdeen.—The Corporation are applying for a provisional order for power to construct additional tramways—*i.e.*, a tramway from Victoria Bridge to Union-street *via* Market-street, Palmerston-quay, Upper-quay, and Guild-street to Bridge-street—the Corporation already possessing authority to construct a tramway from Victoria Bridge southwards into Torry. Another clause has reference to the construction of a double line on the existing track along part of Bridge-street and Union-terrace; while further powers sought in the matter of tramway extension are for the construction of a double line of track from Fonthill-road to Holburn-street, and for the doubling of the Rosemount section. In connection with the proposed Torry tramway, all the works connected with the tramway must be executed to the satisfaction of the engineer of the Harbour Commissioners, and any question of difference between the engineer of the Commissioners and the engineer of the Town Council shall be referred to and determined by an engineer to be appointed by the Board of Trade. The Commissioners may also make and enforce by-laws restricting the rate of speed of the tramways on the quays, and nothing in the order is to be held as abridging the Commissioners' rights to construct, alter, remove, and maintain lines of rails, sidings, and other conveniences for conducting the general traffic of the harbour, on the quays on which the tramway is proposed to be laid, subject always to the restrictions put upon the road authorities in regard to the matter of opening up the roadways for repairs, etc. Power is also requested to make additional crossings and to double tramway lines when and where found necessary.

Swansea.—The Corporation will presently be proceeding with tramway extensions from Bryn-road to Port Tennant, from Sketty to the docks, and from Carmarthen-road to Brynhyfryd, under powers obtained in the recent omnibus Bill. Further extensions towards Neath, to join up with a county line, another to Clydach, and a third to Fforestfach, are also contemplated, the necessary authority having been secured under the Light Railways Act. In addition, it has been decided to purchase from the British Electric Traction Company such sections of the existing tramways as can be so dealt with during next year. At a meeting of the Electricity Committee on Tuesday, the chief electrical engineer (Mr. Prusmann) presented a report on the result of the visit of a number of members of the Corporation to Paris with the object of investigating the working of the Dolter surface-contact system and electric tramways. The report deals at length with the various tests and inspections made. The line, says the engineer, was inspected under almost the worst possible conditions, many of the studs being under water and mud, and all the tests were carried out during a downpour of rain. The car carrying the deputa-

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tion to the end of the line ran perfectly smoothly, and a good speed was maintained. He also visited M. Dolter's laboratory, where he minutely examined the different parts of the studs and carried out further tests, which were perfectly satisfactory. The committee decided to defer the consideration of the report, and in the meantime to obtain from the four companies who have surface-contact systems—the Dolter, Schuckert, Kingsland, and Lorain—their price per mile for laying down the system, and the price per mile of electrical equipment.

London County Council.—At Tuesday's meeting of the London County Council the Highways Committee presented a report in which they stated that, in accordance with the resolution of the Council, notice has been given to the North Metropolitan Tramways Company of the intention of the Council to put in force the provisions of the lease granted to the company of the Council's northern tramways undertaking, which relate to the adoption of electrical traction for the working of these tramways. The committee stated that they have before them preliminary plans prepared by the Council's officers indicating the characteristics of the routes to be dealt with, in order to ascertain what system or systems of traction it will be advisable to adopt; and they are in communication with the company and with certain of the local authorities concerned in the matter. With a view to submitting to the Council, at as early a date as possible, definite proposals for the reconstruction of the lines, they have instructed the officers to proceed with the preparation of detailed plans and with the making of the necessary surveys on the general lines which they have approved. The engineer has represented to them that he will be unable, with his present staff, to cope with the very large amount of additional work which will devolve upon his department in connection with the matter; and having regard to the special character and to the magnitude of the work, they think that the best course to adopt will be for arrangements to be made for the employment temporarily of a further number of assistants in the engineer's department. In order to permit of the plans, estimates, etc., being prepared without undue delay, they asked the Council to pass a preliminary capital vote of £4,000 to cover the expenditure which has already been incurred, under resolutions of the Council, in connection with the preparation of the preliminary plans, etc., and also to provide for the requisite drawing and surveying staff in connection with the reconstruction of the portions of the Council's northern tramways, which it is proposed shall be worked from the electricity generating station to be established at Greenwich. In connection with the reconstruction of the tramways between Westminster and Tooting, the committee asked for authority to spend a sum not exceeding £1,370 for reconstructing two short connecting lengths of tramways close to the Elephant and Castle, and two across St. George's-circus, and for the doubling of the present single line at the Tooting terminus. They further recommended that the offer of Messrs. J. G. White and Co. to carry out the work at prices based upon their existing contract with the Council for the reconstruction of the Tooting-to-Westminster, etc., lines, be accepted, and that the work be carried out under the supervision of Dr. Kennedy, under his agreement with the Council. Messrs. J. G. White and Co., the contractors for the road work and platelaying in connection with the reconstruction of the Tooting-to-Westminster, etc., tramways have called attention to the fact that the amount of their contract — namely, £171,145—has been reduced by a sum of about £11,000 in consequence of a large portion of the paving of the tramway margins having, by arrangement, been carried out by the respective road authorities concerned. This arrangement was found to be economical and convenient where the road authorities concerned were themselves carrying out paving works outside the tramway tracks in the roads affected. The contract with Messrs. White and Co. provides for the retention by the Council of 10 per cent. of the amount of the contract, and they have asked that, in view of the fact that the work is now nearly completed, this percentage may be calculated upon the net value of the contract—that is, £160,000. The Highways Committee are advised that if effect is given to the suggestion the Council's interests will not be prejudiced in any way, and they recommended that the request be acceded to. The committee further reported that under the Act of 1902 they are taking the necessary steps to acquire certain property at Greenwich for the purposes of the electricity generating station to be established there.

LIGHTING AND GENERAL.

Barking.—Penny-in-the-slot electricity meters are now in use in the town.

Darlington.—Mr. Lunn, the engineer, has been requested to report on automatic electricity meters.

Richmond (Yorks).—An effort is being made to develop the telephonic communication in the town.

Hythe.—The Folkestone Electric Supply Company will shortly supply the borough with electric light.

Ossett.—A plot of land has been purchased for £1,200 as a site for refuse destructor and electric lighting station.

Ipswich.—Sanction has been obtained to the borrowing of £69,000 for the purpose of the electric lighting undertaking.

Wooler.—The electric light is being installed at Chillingham Castle. A telephone exchange will be opened at Wooler shortly.

Morley.—Mr. H. Drewett, the borough electrical engineer, has given notice to terminate his appointment under the Corporation.

Kilmarnock.—The Town Council have appointed Prof. Kennedy as engineer for the proposed electric lighting and traction scheme.

Stewartstown.—A canvass is being made *re* electric lighting, and a deputation is to visit Belfast to ascertain terms for an installation.

Kilmalcolm.—The company formed some time ago for the purpose of supplying electricity in Kilmalcolm has now applied for a provisional order.

Worksop.—After considerable debate last week the Council appointed Mr. A. Best, of Bradford, shift engineer at the electricity works.

Croydon.—Mr. Ducat has held an enquiry into the application of the County Council for sanction to borrow £45,406 for electric lighting.

Holyhead.—Mr. Price White, the electrical engineer, is preparing plans for an electric lighting scheme, which will probably be ready in January.

Canal Traction.—It is stated that the Birmingham Canals Navigation Company are investigating electrical haulage employed on the Continent.

Brighton.—Last night a long report by Mr. Bennett was received on the proposed municipal telephones. Details of tenders will be found in another column.

Hornsey.—A cable is to be laid to supply the new schools now being erected in Mattison-road, Harringay, and the houses in Duke's-avenue and Methuen-park.

Huddersfield.—Application is to be made to the Board of Trade for power to enable the Corporation to supply the urban district of Linthwaite with electricity.

Lichfield.—The Council will at their next meeting reconsider the position with regard to the powers obtained in connection with the supplying of electric light to the city.

Bristol.—The Docks Committee have received the usual notice from the promoters of the Somerset and District Electric Power Bill, and referred same to the town clerk for report.

West Indian Cables.—It is stated that Germany is planning the laying of cables from the Azores to Dutch Guiana in order to be independent of the English wires in time of war.

Another New Paper.—The latest technical paper is called *Le Distribuzione Elettrica*, published bi-monthly by A. Martelli, 4, Via Morigi, Milan, at 4s. 10d. per annum.

Eastbourne.—The Corporation has given instructions to Mr. G. S. Jinman to sell by auction on Jan. 19 the old electric light works in the vicinity of Ashford-road and Junction-road.

Rhondda.—A notice from the South Wales Electrical Distribution Company, stating their intention to lay their mains along the highways, is before a committee of the District Council.

Cannock.—Application is to be made to the Board of Trade to extend the time for utilising the powers under the electric lighting provisional order for a further period of 12 months.

Agencies.—A Dutch engineer desires to take up the general agency in Holland and Belgium of leading manufacturers of electrical and other goods. Particulars appear in another column.

East Barnet.—The New Barnet Tradesmen's Association have called a meeting to discuss the electric lighting scheme of the Council, and have invited the members of the Council to attend.

Eastern Extension, Australasia, and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended Sept. 30 of 2s. 6d. per share, free of income tax, payable Jan. 15.

Bo'ness.—The ratepayers in the east ward have resolved to offer objection to the passing of the provisional order applied for in the name of the Town Council requesting powers to light the burgh by electricity.

Morecambe.—An agreement has been entered into with the National Telephone Company, Limited, for placing wires under streets, in which it is stipulated that no work should be done in the streets between April 1 and Oct. 1.

Tunbridge Wells.—The Tunbridge Wells Corporation on the 16th inst. notified that, as soon as arrangements can be made, the National Telephone Company will afford full inter-communication service to all subscribers on both systems.

Illogan.—Application is to be made to the Board of Trade by the Urban Electric Supply Company, Limited, for a provisional order to authorise them to produce and supply electricity for all public and private purposes in the district.

Dover.—The Scavenging Sub-Committee is about to visit the Hackney and other destructors. The committee are considering the erection of a destructor at the electric light works and another at the pumping station at the pier.

Bridgwater.—The Somerset Drainage Commissioners are watching the Bridgwater Gas and Bridgwater Electric Lighting Bills, which are to be brought before Parliament. They have arranged to have a clause inserted in the Bills for their protection.

Woolwich.—The Borough Council are in favour of the renewal of the London County Council's application to Parliament for powers to enable metropolitan councils to wire and fit consumers' premises for electric lighting, and obtain loans for that purpose.

Hereford.—The Electric Lighting Committee in their report state that the business of the undertaking is proceeding in a very satisfactory manner, and the demand for current is increasing. They have determined to extend a main at a cost of £180.

London Gazette.—The partnership existing between A. L. Rhodes and S. W. England (trading as Rhodes and Webster and Rhodes Electrical Manufacturing Company), City Electrical Works, Paradise-street, Bradford, has been dissolved by mutual consent.

Sale of Plant.—The Dublin Corporation, being about to open their new electricity supply works, are prepared to sell by private treaty, either as a whole or in lots, the generating plant now running in their existing works. Particulars appear in another column.

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Greenock.—During November two applications for supply of electricity were made, bringing the total up to 305, which is equivalent to 39,929 8-c.p. lamps. The units generated numbered 60,789, 53,147 being sold, or 14,692 more than for the same period last year.

Keighley.—An increase of 6,826 units in the electricity sold during November, as against the same month of last year, is reported. An increase of 31,003 units has also been recorded in electricity sold during July 1 to Nov. 30 compared with the corresponding period of 1901.

Sir Hiram Maxim Electrical and Engineering Co.—We have received a circular giving illustrations of the late visit of the Shah of Persia to the works of this company, whose chairman, Mr. Jules de Meray, has just been made a Commander of the Order of the Lion and the Sun.

Long Eaton.—The Urban District Council on Tuesday formally inspected the electric light installation station, and the boiler fires were lighted. There are two engines, one of which is so far advanced as to be able to drive the dynamos for street and private lighting on Christmas Eve.

Edison and Swan United Electric Light Co.—The accounts for the year ended June 30 last show a debit balance to profit and loss of £2,068. Special charges, amounting, after deduction of £183 brought forward from last year, to £57,724, have been carried to a suspense account.

Southampton.—Sanction has been received to the borrowing of £3,092 for the extension of the electric lighting mains, and the sum of £4,315 for the purposes of the generating station. Sanction has also been received for the amount required for extending the tramways depôt at Portswood.

Removal.—The offices of the Typewriting Telegraph Corporation, Limited, have been removed from New Broad-street to 92, Queen Victoria-street, E.C. Messrs. Doherty and Donat have removed their offices from 82-83, Deansgate-arcade to Economic-buildings, Spring-gardens, Manchester.

Victoria Docks.—We are informed that the extensive dock premises of the Acme Wood Flooring Company, Limited, at Victoria Docks, are now being equipped with a complete lighting installation to the specification and plans of Mr. F. H. Taylor, the consulting engineer of the company.

Harrogate.—The Council have resolved that in future all cases where street-lighting is required are to be in the first instance referred to the electricity department with a view to such streets being lighted by electric lamps, provided the charges for so doing do not exceed the standard charges for such lighting.

Walton.—The Urban District Council have decided to apply to the Board of Trade, pursuant to the Electric Lighting Acts of 1882 and 1888, for a provisional order for the supply of electrical energy for all public and private works within the district, and the clerk is to take the necessary steps in reference thereto.

Tiverton.—The Lighting Committee having recommended the adoption of Messrs. Christy Bros. and Middleton's scheme for lighting the town by electricity, it has been referred to the Council in committee to consider Messrs. Crompton's and the borough surveyor's schemes in connection with that of Messrs. Christy.

Whitehaven.—The free wiring question is being considered. The second half of the battery will now have to be installed, at a cost of about £500, and it is proposed at the same time to erect a battery-room and also a suitable office for the use of the electrician. The estimated cost is £280, and plans have been prepared.

Dollar.—Messrs. Crompton and Co., Limited, have submitted a drawing of the town showing the running of the mains they propose to erect. The supply is to be by overhead mains on poles 40 yards apart. The company have decided to put down gas producers and gas generators for their dynamos for the electric supply.

Hammersmith.—The loan of £17,550 required for various electric lighting purposes has been completed At Wednesday's meeting it was reported that since the last Council meeting 15 additional consumers had been connected, representing a maximum of 429 8-c.p. lamps, and that the total number of consumers now taking current from the mains is 1,153.

Jedburgh.—A deputation from the Town Council has visited Hawick to inspect the electric lighting arrangements of the town. Messrs. Crompton and Co. are to proceed with the electric works at Jedburgh, and the Town Council have decided to take the current for street-lighting at so much per unit, the Hawick arrangement being a lump sum.

Long-Distance Telephone.—It is stated that the opening of the telephone wire between Rome and Paris, which is 1,187 miles in length, and which was completed two months ago, has been delayed, owing to an error on the part of the constructors in using wire only 4mm. in diameter. The delay also applies to the opening up of telephonic communication between Rome and London.

Epsom.—The electrical engineer in his last report states that the supply of electricity had been continuous, and that the machinery was in good working order. Four additional applications for energy had been received, making a total equivalent to 3,936 lamps of 8 c.p. for private lighting to date. Three extensions are to be carried out at an estimated outlay of £609 5s. 4d., the necessary guarantees having been obtained.

Penrith.—The tradesmen in the "compulsory area" are being circularised *re* electric lighting. The price of current will not exceed 5d. per Board of Trade unit for lighting and 3d. for motive power. Mr. J. Armstrong has been instructed to make a visit to each place of business. Enquiry is also being made as to whether the wiring of premises is required on the hire-purchase instalment plan extending over seven to ten years.

Leeds.—The Lighting Committee of the Corporation have authorised the preparation of two alternative schemes for the electric lighting of all the tramway routes within a mile radius of the centre of the city. The committee have also decided to proceed at once with the laying of the electric lighting mains already authorised, the idea being to, as far as possible, provide work for the unemployed.

Buralem.—A sub-committee of the Electric Lighting Committee has been appointed to confer with the Sanitary Committee with reference to the proposed new destructor. At a recent special meeting of the Electric Lighting Committee, Mr. C. E. Botley, C.E., of Hastings, attended and gave a detailed explanation of the report recently presented to the members of the Council by Mr. H. Peaty, gas manager, showing the advantage of using gas-engines as to the motive power for driving dynamos. The report was agreed to.

Fulham.—The Borough Council have agreed that Lochaline-street and Rannock-street be lighted with incandescent electric lamps at an estimated cost of £240, and that advertisements be issued inviting tenders for the work. The borough electrical engineer in his last report states that from Nov. 22 to Dec. 1, 1902, applications equivalent to 908 8-c.p. lamps had been received, making in all a total of 40,195 8-c.p. lamps, and that 617 services had been connected to the mains, representing an equivalent of 26,080 8-c.p. lamps.

Finchley.—The electrical engineer is about to proceed to Germany to inspect batteries in view of the lowest tenders for the item being those from German firms—viz., £800, £970, and £980, as compared with £1,290 and £1,295 from English firms. At the last Urban District Council meeting the Finance Committee reported with regret that, owing to the inability of the National Telephone Company, Limited, to give the Council the assurance that there will be no interference with the service when installed, in consequence of determination of wayleaves, etc., they are unable to recommend the Council to enter into the agreement which has been submitted by the company.

Catalogue.—From a new catalogue of Heathman's well-known patent extension ladders we note that the firm can now be reached by General Post Office telephone, 150 Putney. Many of Heathman's telescopic ladder towers are in use at electric lighting installations. At Battersea municipal buildings one is used for a man to clean lamps and ceilings 40ft. high; it can be moved about, raised, and lowered by one man, while by turning on its side it may be run through doorways only 6ft. 9in. high. When vertical closed it stands 14ft. 3in. high. There is a table at top on the guard rail above the platform for tools. The Great Eastern Railway Company have 13 for use at various stations to trim lamps.

Kirkcaldy.—At the last meeting of the Chamber of Commerce the secretary reported that, in reply to the complaint regarding inadequate telephonic communication between Kirkcaldy and Edinburgh and Glasgow, a communication had been received from the Post Office authorities to the effect that steps were being taken to provide additional trunk lines between those places. The work at the generating station is now nearing completion, and it is understood that the electric light will be turned on over the whole district for the first time probably on Christmas Eve. A large number of applications have been made to have the light supplied to shops and houses. A successful trial of street lighting was made on Monday.

Stock Exchange.—The Stock Exchange Committee has appointed Dec 29 as a special settling day for the British Electric Traction Company's further issue of 32,066 ordinary shares of £10 each, fully paid, Nos. 200,001 to 232,066; and Jan. 7 for the same company's further issue of 18,937 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 300,001 to 318,937. The committee has also ordered the above-mentioned securities to be quoted in the official list. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Blackheath and Greenwich District Electric Light Company's 50,000 7 per cent. cumulative preference shares of £1 each, and Typewriting Telegraph Corporation's 71,100 ordinary shares of £1 each, fully paid, Nos. 1 to 71,100.

Camberwell.—Permission has been granted to the Postmaster-General to open streets, etc., for laying underground telegraph wire pipes. With regard to an application of the London Electric Supply Corporation to the Board of Trade for an extension of its area of supply to the entire borough, the following report has been submitted: "The borough is at present supplied over nearly its entire area by the County of London and Brush Provincial Electric Lighting Company, Limited, and in a small portion by the Crystal Palace and District Electric Lighting Company, Limited. The London Electric Supply Corporation at present has powers to supply, and is supplying, that portion of the borough north of the London, Brighton, and South Coast Railway line throughout. This Council last year applied to the Board of Trade for a provisional order sanctioning the purchase of the London Electric Supply Corporation's order by this authority, but the conditions imposed in the order by the Board of Trade were such that it was deemed advisable not to proceed further with such order. The application now being made by the London Electric Supply Corporation, Limited, is, in the opinion of the Electricity Committee, one that should be supported by this Council in the interests of the borough. The committee recommend that the Board of Trade be informed that this Council consents to the application of the London Electric Supply Corporation to the Board of Trade, session 1903, for the production and supply of electricity in the borough, the acquisition of land, arrangements with local authorities, transfer of powers, construction of works, breaking-up and other interference with streets, levying rates and charges, and other purposes under the Electric Lighting Acts, 1882 and 1888, within so much of the metropolitan borough of Camberwell as is not included in the area of supply under the London Electric Supply Corporation Electric Lighting Order, 1899, and the London Electric Supply Corporation Electric Lighting Metropolitan Order, 1890.

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Eccles.—The borough electrical engineer has been instructed to report fully his recommendations for improving the street-lighting. The report is also to deal with the proposals now made for increasing the demand for electric current, including the proposed adoption of a system of prepayment meters. The Council are ordering 100 Nernst lamps for public lighting.

Athletics and Ping Pong.—The second annual meeting between football teams from Glover's and Royce's took place on Saturday last at Trafford Park, where the cable-makers won easily by three goals to love. Both teams and officials were entertained to tea by Mr. E. A. Claremont, and afterwards a ping-pong match took place between selected members of the teams, when the dynamo-builders took their revenge by three sets to two.

"Agricultural Annual and Mark Lane Express Almanac."—The "Agricultural Annual and Mark Lane Express Almanac" for 1903 is now in its eleventh year. In form the annual is similar to last year's issue, and the size is practically the same, but its contents are, if anything, above the high standard attain d in previous years. This marvellous sixpennyworth is published at the offices of the *Mark Lane Express*, 1, Essex-street, Strand, London, W.C.

Colne.—The electrical engineer, Mr. A. G. Cooper, in his last report stated that the whole of the generating plant was in good working order. Since the commencement of supply of electricity, in September last, lamps and motors had been connected equivalent to 4,020 8-c.p. lamps. The number of units sold since last September was 26,479. A deputation has been reappointed to attend the next conference on municipal telephones to be held in Burnley.

Southwick.—The Urban District Council have adopted the following proposition: "That this Council, in conjunction with the Urban District Councils for New Shoreham and Portslade-by-Sea, agree to joint opposition to the Brighton Electricity Bill, unless the Brighton Corporation insert a clause to the effect that the price to be charged for the supply of electricity in the urban districts of Shoreham, Portslade, and Southwick be the same as that in force at Brighton."

Swindon.—Notice has been given that the Corporation propose to charge for current according to the actual amount of energy supplied, as recorded by meter, as follows: for lighting purposes 5d. per Board of Trade unit or 2d. per Board of Trad unit for all current consumed plus a capital charge at the rate of £7. 10s. per kilowatt of maximum demand per annum; for motive purposes 2½d. per Board of Trade unit, less a discount of 5 per cent. on accounts if paid within 14 days of demand.

Middlesbrough.—The electrical engineer (Mr. Taylor) in his last report states that the number of units supplied during November was 51,000, against 42,200 in November last year. The total revenue was £704, as against £671 last year, while the expenditure was £275, against £276, in spite of the units being 10,000 extra, leaving a profit of £429. Last year 17,000 lights were connected, as against 25,800 at present. The average price for the month was 3½d., as compared with 3⅝d. last year.

St. Pancras.—A communication is to be sent to the Postmaster-General pointing out the seriousness of the unemployed question, and further stating that the Council have given permission to the Post Office to open up a large number of streets in the borough for the purpose of laying telephone wires, and asking that the work may be undertaken at once. The Electricity and Public Lighting Committee also are to press forward as quickly as possible their plans for the further extension of mains.

South Wales Electrical Power Distribution Co.—Mr. Robert Forrest has accepted the chairmanship of this company, rendered vacant by the death of Mr. Archibald Hood. Mr. W. W. Hood has joined the Board, and Mr. E. P. Martin, one of the original directors, who resigned his seat at the beginning of the year through ill-health, has now rejoined his former colleagues. Sir William Thomas Lewis, besides being an original director of the company, is also acting as one of the trustees for debenture holders.

Cardiff.—The Electrical and Lighting Committee have decided to extend the electric lighting mains for 1,500 yards, on obtaining a five years' guarantee. The total works cost for the month of October is reported as £647. 16s. 10d., or ·921d. per unit. The total revenue cost charges for the same period, including loan charges, was £1,480. 7s. 10d., or 2·103d. per unit. For November the total works cost was £731. 7s. 6d., or ·811d. per unit, and the total revenue cost, including loan charges, was £1,561. 5s. 5d., or 1·732d. per unit.

Heywood—According to the last report there are 72 consumers on the books of the Electric Lighting Committee, and the number is increasing week by week. There are also 60 motors either working or about to commence working almost immediately. If all the consumers were taking power at once the works would have to supply 4,200 8-c.p. lamps per day. From the commencement of the works up to Sept. 30 the consumption was 32,991 units. From the commencement of October to Dec. 9 the consumption was 23,183 units.

American Pacific Cable.—The *Daily Telegraph's* New York correspondent wires as follows: "'In memory of John W. Mackay, I christen thee "Pacific Cable." May it always carry messages of happiness.' It was with these words that Miss Lucille Gage, the 11-year-old daughter of the Governor of California, yesterday named the Trans-Pacific cable, which is to connect America with Honolulu, the Philippines, and China. The landing and splicing of the shore end at San Francisco was accomplished without a hitch, and was witnessed by nearly 40,000 people."

X-Rays.—The *Daily Telegraph* is responsible for the following: "An order from the Japanese Government for a quantity of X-ray apparatus has been received by a Philadelphia firm. The representative of the Mikado recently purchased an X-ray machine, which, he explained, was to be utilised in the Government mints in Japan for the detection of dishonest employés. The machine was used to examine suspects as they left the mint daily, and it revealed the presence of coins that had been consigned for safe keeping to the guilty ones' stomachs. The test was so satisfactory that the Japanese Government has ordered several outfits."

Tipton.—An awkward deadlock has arisen between the District Council and the Midland Electric Supply Corporation in reference to the supply of electric current within the parish. The *Wolverhampton Express* says the Council withdrew a Bill they were promoting on their own account on condition that the corporation should supply them with current in bulk, the District Council intending to supply private customers. Now, however, that the Midland Corporation have obtained their Bill they contend that it gives them a monopoly to supply private customers, decline to admit the right of the Council to do so, and refuse the matter to be arbitrated upon.

Bognor.—At the last meeting of the District Council a letter was read from the secretary to the General Post Office stating that as 25 subscribers had been obtained to the proposed Post Office telephone exchange for Bognor, it was intended to proceed with the matter forthwith, and asking that the Council would give an assurance to afford all reasonable facilities, including the grant of wayleaves on the roads, under the usual conditions. The Council having gone into committee on the subject, it was resolved that the agreement with the Post Office be not entered into until some definite information was forthcoming as to the time the service would be established.

Lowestoft.—The Electric Light Committee in their last report state that during the past month 12 extra consumers had been connected to the mains, representing 393 8-c.p. lamps, which brings out a total of 310 consumers, representing a load of 16,288 8-c.p. connected to the mains. An extension is to be made to supply one 2½-h.p. motor and 12 lamps, also a cable to the new Board school. The committee have authorised the engineer to purchase two pairs of cable stands at a cost not exceeding £6. 10s. each; also new files up to the value of £5; and sundry lengths of cable. The matter of the new tramway switchboard required at the electric lighting station having been discussed, the committee came to the conclusion that the first scheme submitted by Mr. Hawtayne was the better one.

Brixham.—The ratepayers met on Tuesday to consider a proposal to authorise the District Council to proceed with the proposed electric lighting scheme. The Council have adopted an arrangement with Messrs. Crompton and Co. whereby the Council are to obtain a provisional order for electric lighting and let it to the company. A three-wire, low-tension, direct-current system is recommended. The total cost of works is estimated at £9,129. Estimating the cost of generation at 2½d. per unit, and that 60,000 units per year are sold, the cost of generation works out at £625. Interest and sinking fund amount to another £600, making the annual charge £1,225. The supply of 60,000 units at 5½d. per unit would yield £1,375, showing a profit of £150. It was agreed that the Council proceed with Messrs. Crompton's scheme if possible.

Lignolite Flooring.—Messrs. L. L. Bernhard and Co., 69, King William-street, E.C., on the 12th inst. gave an interesting exhibition of a composite flooring which is new in this country. The material is called "lignolite," and consists of sawdust mixed with some liquid chemicals, including a red ochre colouring matter. It is laid moist at a thickness of ⅜in. upon the boards or concrete foundation of floors, and hardens absolutely after having been down 48 hours. It is specially recommended for floors of warehouses, hospitals, restaurants, etc. The cost is stated at 5s. per square yard laid down, and owing to the comparative warmth of the material and the absence of dust, oilcloth might be dispensed with. The material is capable of being very highly polished, and is, we are told, bacteria-proof. At the same place we noticed a new kind of sparklet and a portable siphon which ought to come in handy during field work.

Venezuela.—Two of the Englishmen reported as having escaped arrest by the Venezuelan Government, says the *Daily News*, are officials connected with the Venezuelan Telephone and Electrical Appliances Company, whose telephone system extends throughout nearly the whole of the country. One of them, Mr. Edgar Allan Wallis, is manager of the company, and for years past he has been on very friendly personal terms with President Castro, who always protected the company's property as far as possible. But the President could not control the actions of marauding bands, who cut and destroyed miles of telephone wire. During the recent civil war the revolutionists practically commandeered the telephone system. The Venezuelan Government has not paid the company for the use of the system for many years past, and the amount due is now a very large one. So far all applications for payment have proved fruitless.

Personal.—We are informed that Mr. Jul. H. West has opened an office at 20, Helleschestrasse, Berlin S.W. 11, as consulting engineer on all matters regarding telephones, telegraphs, and electrical signalling, etc., for the preparation of schemes, arbitrations, patents, etc. We learn that Mr. Herbert Laws Webb, a son of the late Mr. C. F. Webb, well known as the pioneer submarine cable engineer, is at present staying at 8, Queen Anne's-gate, S.W. Mr. H. L. Webb was himself engaged in cable work for some years previously to taking up his residence in New York, where for the past 13 years he has been actively engaged in telephony. On several occasions Mr. Webb has visited Europe to report to the American telephone companies on the progress of telephony, and he has twice made a complete tour of the Continent to inspect the principal telephone systems, so there are probably few men having a wider experience of telephone work on a large scale.

Teddington as a Seaport.—A £3,000,000 scheme is to come before Parliament next session embodying a project for constructing a canal from Teddington to the English Channel. The canal is to be 70ft. wide, margined with trees and ornamental shrubs. To retain the necessary depth of water there are to be 12 locks, each 25ft. deep. One side is to be devoted to business, the other to pleasure. On one

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bank there will be the towing path, where electric locomotives will ply, hauling the barges and boats conveying cargo, while on the other will be a wide, well-kept road. Hotels will mark convenient stages, and there will be repairing shops for motors and cycles. Pleasure boats, launches, and private barges are to be permitted to use the canal, and it is suggested that a line of small steamships may run *via* the new waterway from London to France. The canal is to be deep enough to permit torpedo-boat destroyers to make the voyage from London to Southampton.

Dalkeith.—Messrs. Crompton and Co., Limited, have forwarded details of the proposed scheme for the electric lighting of the burgh. The underground mains are to consist of single bitumen-insulated cables laid in pairs in specially treated wooden troughing filled in solid with pure bitumen and covered with substantial tiles. For the most part they will be laid under the roadways to avoid the cutting of the cement pavements. A number of pillars will be erected on the pavements for the purpose of dividing up and inserting fuses in the feeders and distributors, so that in the case of a branch main developing a fault that particular section only will be automatically isolated. The houses will be connected with the mains by means of twin cables insulated with bitumen, and the whole will be steel armoured. The overhead mains will consist of bare copper wire supported on insulators fixed to steel poles 40 yards apart. Houses will receive their light by bare copper strained from the nearest pole to insulators fixed on to the dwellings. Messrs. Crompton and Co. propose to at once extend the overhead mains beyond the compulsory area. A suitable site has been secured by the company in Croft-street for the generating station.

Stoke-on-Trent.—At the last meeting of the Rural District Council Mr. G. R. Peers, electrical engineer, Manchester, submitted a scheme for the electric lighting of Bucknall. He suggested that the site of the station should be the present sewage works, as it could be worked at a less cost than if they put down a separate generating plant on another site. Assuming that they used the steam from the sewage works boilers he estimated the cost of the electrical plant, together with engine-house and switchboard, would amount to £1,750. If they had to provide another boiler this estimate would be increased by £250. The cost of the cables for the street lamps would be £1,449, or a total, excluding a boiler, of £3,199. The plant would light the whole of the street lamps, and 800 lamps in addition fitted in private houses, shops, etc. For laying the cables for the private supply the cost, including consumers' connections and meters, would be £620. He estimated the cost of maintenance at £425 per annum, while his estimate of the income was £501. The consideration of the scheme was adjourned until the next meeting; in the meantime application is to be made for sanction to use the sewage works site for the electric lighting station.

Bath.—The Electric Light Committee in their report submitted on Tuesday stated: "The report of the Works Committee upon the subject of arrangements for additional stand-by plant was read, and Mr. Hatt reported that he had had an interview with Mr. Manville in company with Mr. Teague in London, and that an offer had been obtained from the County of London and Brush Provincial Electric Lighting Company, Limited, to supply two motor-alternators on hire for six months at a cost of £250, with *pro rata* payment per month after that period, also a charge of £30 for removal and return, with an option to purchase within the six months for £1,182. 10s., the hire to be merged in case of purchase." Mr. Manville is to be engaged to advise the authority at an early date with a view to deciding upon the exact work which should be carried out forthwith, Mr. Teague being associated with him in the execution of the work. Notices having been given by the Somerset Electric Supply Company of intention to apply in the next session of Parliament for power to supply electricity in the county of Somerset, Mr. Manville is to be asked to advise upon the matter. Notice of the following motion has been given: "That in view of the very large expenditure contemplated by the Electric Lighting Committee for extending the continuous-current system in Bath, all the recommendations for extensions and the engaging of expert advice be referred back to the said committee for further consideration."

King's Lynn.—The electrical engineer in his last report states that during the month he had received 13 applications for a supply of electricity, and seven already connected had increased the number of their lamps. Since the last meeting the increase was equal to 434 lamps, making a total of 14,285 of 8-c.p. or equivalent from private consumers, the total number of lamps connected, including street lamps, being equal to 16,495. He also reported that he had received an application for one 1½-h.p. motor. The working expenses for October, as compared with the corresponding month last year, were: units generated 34,222, last year 33,510; units sold to private consumers 14,938, last year 11,438; units sold at power rates 413, last year 45; cost of fuel, stores, repairs, and wages in station £108. 16s. 3d., last year £137. 11s. 9d.; cost per unit generated 0·762d., last year 0·985d.; wages of lamplighters and outside staff *£23. 5s. 10d., last year £17. 3s. 8d. (* Includes cost of removing lamps in Railway-road and South Everard-street, and fixing Nernst lamps in Gaywood-road.) He also reported that the plant had been maintained in efficient working order, and is working satisfactorily. With regard to the proposed extensions, he deemed it advisable to let the report which the committee had authorised him to prepare stand over until January next, and he would then be in a position to state definitely the maximum load that he had had on the plant during the winter, and also to better estimate the probable load next winter.

Hackney.—At last night's meeting a report was received upon the report of the consulting engineer with regard to the progress of supply and the necessity for increasing the generating plant, together with the estimated cost (£25,500) of generating set complete, with foundations, condenser, pipework, switchboard, and cable connections. The cost of the above work being a charge upon the capital account, it will be necessary to make application to the London County Council for their sanction in writing to the borrowing of the necessary money, which the committee asked for authority to do, the repayment being spread over the longest possible period which can be obtained. It was suggested that the Electric Lighting Committee should approach the consulting engineer with a view to obtaining a reduction in his commission on these additions to the plant, taking into consideration the large sum payable under this head on the initial outlay. The total amount of the capital expenditure authorised up to date on account of the electricity undertaking and dust destructor works is £294,427 (exclusive of the above amount), and loans amounting to £263,000 have been taken up. Application is to be made for a loan of £150 for building a concrete tunnel at the electricity works to prevent the recurrence of breakages of the pipes connecting the larger condenser to the cooling pond under the roadway between the works and the pond. It was also proposed that the portion of Chatsworth-road, from Brooksby's-walk to Millfields-road, be lighted by 10 arc lamps in substitution for the present 15 gas lamps in that portion of the road.

Bury St. Edmunds.—The engineer in his last report states that as the present plant runs fully loaded up every night, it is of the greatest importance the committee should recommend the Council to sanction extensions to the generating station, the purchase of another engine and dynamo, and a surface-condensing plant, in order to enable the electric lighting department to cope with the work of the coming year. He recommends that a surface-condensing plant be put down as early as possible. As to the engine and dynamo, reported to be most urgently required, it was recommended this combined set should be of 100-kw. size, as although it is 66 per cent. larger than the present sets, the cost would be very little more, and the steam consumption would be nearly 10 per cent. less. As the generating station needed enlargement, plans had been prepared for extension, showing that although the engine-room would be completely finished in a permanent manner, there would be space left for yet another dynamo and engine if required. In order to keep the circulating water cool, it would be necessary to construct a cooling pond between the engine-room and the engineer's residence. It was estimated the cost would not exceed £50. It was pointed out that once the suggested extensions had been carried out and the additional plant installed, there would be no further expenditure of capital for many years. The engineer considered that everything in connection with the system was very satisfactory, although the plant was running "full up" every night, and applications for 60 8-c.p. lamps had been received during the month. Further details *re* tenders appear in another column.

Sunderland.—The enquiry referred to in our last issue into the application of the Corporation for leave to borrow £74,000 for electric lighting has been held. The Town Clerk said the undertaking had so extended that it was now requisite to lay mains to develop the system in the northern and south-eastern parts of the town. These were so far from the generating stations, however, that it was necessary to adopt the high-pressure or three-phase system, and it was proposed to have four sub-stations to transform the high-tension current to a lower one. Some £7,000 of the new loan was for works already carried out, or what the Local Government Board called "excesses." The remainder, with the exception of £6,000, was for the extension of the undertaking for general purposes. The £6,000 referred to was for supplying power at the docks. Mr. J. F. C. Snell having given particulars of the scheme, the enquiry closed. The County of Durham Electric Power Supply Company have written to the Electricity Committee of the Corporation offering to supply electricity in bulk, making what use they could of the two existing Corporation stations at Sunderland, and deriving the remainder of the power from their station on the Tyne. The company stated that they could supply electricity at least 20 per cent. cheaper than the Corporation, but they did not indicate whether their estimate takes account of interest and sinking fund. The Corporation would continue to supply light to customers and the tramways, but the company would supply the power customers, such as shipyards, engine-works, and other large industrial concerns. The committee have referred the matter to the borough electrical engineer for report.

Electrical Power in Mines.—The United National Colliery Company recently placed with Messrs. Bruce Peebles and Co., of Edinburgh, an order for electrical hauling and pumping plant, the power for which would be taken from the South Wales Electrical Power Distribution Company. This first instalment of plant consisted of a 100-h.p. three-phase motor and pump and a 150-h.p. three-phase hauling gear. Since then an order for an additional 535 h.p. has been placed with the same company. The new plant consists of two 150-h.p. three-phase hauling gears, each capable of taking 20 loaded trams a distance of 2,000 yards at a speed of 10 miles per hour. The motors of the hauling gears are controlled by the latest type of liquid reversing switches, so arranged that the loaded train of trams can be started on the steepest gradient from rest with a high rate of acceleration and without jolting. Four additional three-phase motors and pumps have also been ordered—two of 50 h.p., one of 25 h.p., and one of 10 h.p. By June of next year the colliery will be equipped with 800 h.p. of three-phase electrical plant. The South Wales Electrical Power Distribution Company are building a sub-station at Wattstown, wherein will be placed the apparatus by which the 11,000-volt current will be transformed to the 500-volt current that will be taken down the pit. All the mains and transformers are being put down in duplicate, and provision is being made for the further extensions that will shortly be required. From their Pontypridd generating station the power company will also supply the New Windsor Colliery Company's pit at Aber with energy for underground pumping and for a variety of other purposes on the surface. Underground there will be a 100-h.p. three-phase motor and pump, and on the surface, for a start, some half-dozen or so three-phase motors driving mortar mixers, saw benches, and other machines.

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PROVISIONAL PATENTS, 1902

DEC. 3.

26599. Improvements in automatic electric railway signalling. Arthur Moore Thompson, Holly Bank, Crewe.

26602. Improvements in or connected with trolley poles for electric traction. Thomas Fletcher, 57, Barton-arcade, Manchester.

26647. Improvements in electric recording instruments. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

26663. Improvements in electrically-propelled vehicles for the transport of goods on electric tramway and railway systems. Charles Revill Bellamy, 34, Castle-street, Liverpool.

26668. Improvements in and connected with controlling arrangements for electric motors and motor circuits. The Johnson-Lundell Electric Traction Company, Limited, 45, Southampton-buildings, Chancery-lane, London. (Robert Lundell, United States). (Complete specification.)

26673. Improvements relating to devices for the measurement of electrical energy. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Riccardo Arno, Italy.)

26694. Improvements in electrical appliances for controlling and lighting gas burners. Henry Langdon Down, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Carl Franzen, Germany.)

26706. Improvements in and relating to electrical resistances. Edward Neville Bray, Fred. R. Markham, F. E. Reiss, and Bray, Markham, and Reiss, Limited, 18, Southampton-buildings, Chancery-lane, London.

DEC. 4.

26717. Electric locomotives. James Swinburne, 82, Victoria-street, London.

26718. Improvements in dynamo-electric machines and motors. James Swinburne, 82, Victoria-street, Westminster, London.

26735. Improvements in electric light pendants and electroliers. Clifford William Kemp, 24, Temple-row, Birmingham.

26746. Improvements in electric motors. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Dec. 26, 1901, being date of application in United States). (Complete specification.)

26764. Improvements in regulating electric generators. Henry Leitner and Richard Norman Lucas, Rose Villa, Byfleet, Surrey.

DEC. 5.

26818. Improvements in incandescent electric lamps and in collars for the same. Noel Cleminson, 5, John Dalton-street, Manchester.

26822. The hoop self-acting and electric motor. Thos. Burns, 18, Princess-street, Newcastle-upon-Tyne.

26868. A new or improved device for use in or with electrolytic apparatus. Arthur Wright, Norfolk House, Norfolk-street, Strand, London.

26870. Alternating-current motor. Max Déri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

26876. An improved system for the electrical transmission of type-recorded messages. Walter Samuel Steljes and the Typewriting Telegraph Corporation, Limited, 1, Queen Victoria-street, London.

26877. Improvements in and relating to coin-freed machines for giving electric shocks. The New Polyphon Supply Company, Limited, and Arthur Ficker, 1, Queen Victoria-street, London.

DEC. 6.

26899. A method of including mica in the insulation of cables for transmission of electrical energy. Theophilus Henry Vigor, 121, Broadfield-road, Catford, London.

26906. Improvements in junction frog plates for use on the overhead system of electric tramways. David Blythe Foster, 39, Stratford-street, Leeds.

26917. Improvements in switching mechanism applicable for intercommunication telephone systems. Max Byng and George Lee Anders, 71, Queen Victoria-street, London.

26918. The automatic trolley guide for electric cars. Jesse Greenhalgh, Henry Greenhalgh, John Thomas Howcroft, and Henry Fielding, 58, Manchester-road, Hyde, Cheshire.

26967. Improvements in automatic pressure regulators for electric collectors. Coloman de Kandó, 18, Buckingham-street, Strand, London. (Complete specification.)

26970. Improvements in electrical apparatus for registering the discharge of liquids by pumps. The Liquid (Electric) Register Syndicate, Limited, and Hans John Stephen Cassal, 4, South-street, Finsbury, London. (Complete specification.)

DEC. 8.

27001. Improvements in and relating to electric bells and telephones. Otto Nolte and Curt Hagar, 62, St. Vincent-street, Glasgow.

27056. Automatic electric safety signalling apparatus for railways. Léopold de Melier de Labarthe, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

26999. Improvements in and connected with electromotors and similar electrical apparatus. James Wright MacFarlane, of the firm of Watson, Laidlaw, and Co., 154, St. Vincent-street, Glasgow.

DEC 9

27072. An improved form of current-carrying wire for use in overhead electric traction; also applicable for haulage purposes. John Whitehead, 60, Newhall-street, Birmingham.

27073. Improvements in electrical conductors. Joseph Barton Scammell, 56, Leadenhall-street, London.

27074. Improved electrical cut-out or fuse holder. Frederick Hagger Headley, 10, St. George's-crescent, Liverpool.

27088. Improvements in electric signalling in connection with tramways. Hugo Hirst and William Wood, 71, Queen Victoria-street, London.

27089. Improvements in electric power transmitters for sewing machines and the like. Julius Rosenberger, 57, Barton-arcade, Manchester.

27090. Improvements in apparatus for working railway points and signals by electric power. Francis William Webb and Arthur Moore Thompson, Holly Bank, Crewe.

27096. Improvements in combined switch and fuse. Harry A. Hornsby, Charles Noah Van Cleef, Edward William Anger, jun., and Martin Newgard, 62, St. Vincent-street, Glasgow. (Complete specification.)

27133. Improvements in enclosed electric arc lamps. Victor Reclus, Henry Charles Felix Marie Petitdidier, and Théodor Mario Schmitt, 11, Southampton-buildings, Chancery-lane, London.

27150. Improvements in and relating to electrical sparking plugs for explosion engines. Claude Jean Ramonéda, 60, Queen Victoria-street, London.

27,161. Improvements relating to electricity meters. William Edward Evans, 27, Chancery-lane, London. (Allgemeine Electricitäts-Gesellschaft, Germany). (Complete specification.)

27168. Process for manufacturing the current-conducting connection between the filaments and the conducting wires in electric incandescent lamps. Josef Plechati, 40, Chancery-lane, London.

27179. Improvements in the reduction of compounds by electrical heating and in apparatus therefor. Edward Goodrich Acheson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

27180. Improvements in accumulators or secondary batteries and the preparation of electrodes therefor. Carl Freiherr Auer von Welsbach, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 1, 1903.

1901.

25227. Fittings for electric installations in buildings. Meehan. (Date applied for under International Convention, May 16, 1901.)

25374. Electric clocks and timepieces. Lowne.

25391. Breaking systems for electric railways. British Thomson-Houston Company, Limited. (Case.)

26033. Electrical indicators. Marshall and Woods.

26136. Ground detectors for electric circuits. British Thomson-Houston Company, Limited. (Badeau.)

26197. Electric arc lamps. (Batault.)

26510. Insulator applicable to overhead tramway wires. Penny.

26517. Apparatus for electrically igniting miners' safety lamps. Best.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated and Helsby Cables, Ord., 1-70,000	5 ..	7½-8
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
—— (1902 Issue)	100 ..	100-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	102-104
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	2¼-3
—— 5 per cent. Debentures	100 ..	101-106 p.c
Edison and Swan United, "A" Shares, 1-89,261	3 ..	¼-½
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1½
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102

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Name.	Amount paid.	Last price.
	£	£
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16¼-17¼
—— 4½ per cent. Preference	5	5¼-5¾
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20¼-21¼
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105

Electric Lighting and Supply.—

Blackheath & Greenwich District Ordinary 1,201-101,200	1	¾-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	110-113
Bournemouth and Poole, Ordinary	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	10-11
—— Debenture Stock, Red.	100	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	101-104
Brompton and Kensington, Ordinary	5	10-10¼
—— 7 per cent. Preference	5	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1,20,000	5	6¼-7¼
—— Nos. 20,001-30,000	5	6¼-7¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
,, ,, ,, £10 Ord.	6	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-108
Charing Cross and Strand	5	9¼-9½
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5¼-5½
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	103-106
Chelsea Electricity Supply	5	5¼-6
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	9¼-10¼
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	124-129
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104-107
County of London and Brush Provincial, Ordinary	10	9¾-9⅞
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6¼-6¾
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	3	1¾-2¼
—— 6 per cent. Pref.	5	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	95-98 xd
Metropolitan, Ordinary	10	15¼-16¼
——3½ per cent. First Mortgage Debenture Stock	100	109-114
——3½ per cent. Mortgage Debenture, Red.	100	98-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6¾
Notting Hill Electric Lighting	10	14¼-15¼
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Sharps Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	3-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8¼-8½
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3¼-4¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3¼-4¼
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	5	6-6¼

Name.	Amount paid.	Last price.
	£	£
Electric Railways.—		
Central London, Ordinary	100	106-109
—— 4 per cent. Pref.	100	106-108
—— ,, ,, deferred	100	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-119
City and South London, Consolidated Ordinary	100	75-76
—— 4 per cent. Debenture Stock	100	115-118
—— 5 per cent. Pref. Stock '91	100	128-131
—— ,, ,, ,, '96	100	127-130
—— ,, ,, ,, '01	100	123-127
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	93-96
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	4¼-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100	127-132
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-3¾
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,500	10	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12¾-13¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12-12¼
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅜-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2¼-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4¾-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¼-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98
Imperial Tramways, Ordinary	all	22-22¼
—— 6 per cent. Cum. Pref.	all	14¼-15¼
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4¾
—— 4 per cent. Debenture Stock	100	95-98
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	11¼-12
—— ,, ,, ,, ,,	10	11¾-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	105-107
—— ,, ,, Prov. Crts.	100	105-107
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	2¼-3¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¾-10⅞
—— 5 per cent. Cum. Pref.	10	11¾-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8¼-8½
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	18s.	14/16-15/16
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	90 p.c.	90 p.c.
Telephones.—		
National Telephone, Preferred	100	92-94
—— Deferred Stock	100	62-64
—— 6 per cent. Cum. First Pref.	10	12¼-13¼
—— 6 per cent. Cum. Second Pref.	10	11¼-12¼
—— 5 per cent. Non. Cum. Third Pref.	5	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100	95-98
—— 4 per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	¾-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week Ending	1902.	1901.	Increase or decrease. Week.	Current year.	Miles of single track open. 1901.	1900.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 29	839	628	+ 211	+ 6,630	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	Dec. 13	4,649	4,201	+ 448	+17,572	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	,, 12	598	616	− 18	+ 3,920	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	,, 11	228	221	+ 7	+ 376	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	,, 13	142	135	+ 7	− 166	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	,, 14	1,459	1,305	+ 152	+ 4,611	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	—	—	—	—	—	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57[a]
Bristol Tramways Company	,, 12	3,871	3,716	+ 155	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	8,675	2,010,873	323,044[h]	1·03	6·46	—	[a]4·65
Central London Railway	,, 13	7,329	6,858	+ 471	+12,225[h]	12	12	,, 31	335,086	41,188,389	1,243,730[a]	1·88	64·23[a]	27,823	34·89[a]
City and South London Railway	,, 14	3,877	3,460	+ 417	+22,126	12½	9½	,, 31	62,601[a]	7,008,842[a]	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	,, 11	348	368	− 20	+ 5,923	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	} 7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	,, 13	149	167	− 18	+ 17	4½	—	,, 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	,, 14	75	70	+ 5	+ 93[h]	6½	6½	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	,, 12	3,227	3,285	− 58	} +2,857	46	46	,, 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	,, 12	684	690	− 6											
Dundee City Tramways	,, 3	814	667	+ 147	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	,, 13	11,516	10,189	+1,327	+ 5,625	104	95	,, 31	582,146[e]	155,243,378	11,935,099	0·90	11·71	5,597	7·51
Halifax Corporation	—	—	—	—	—	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	,, 13	880	825	+ 55	—	48	48	Sept. 30	29,061[h]	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	,, 13	1,612	1,568	+ 44	+ 2,888	19	9½	,, 30	72,331[h]	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	,, 6	9,032	8,817	+ 215	+36,487	93	78	Dec. 31	87,707	21,065,999	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	,, 14	1,369	1,336	+ 33	− 582	15½	15½	June 30	69,152	8,426,976	787,010[a]	1·97	21·07[a]	4,450	15·94[a]
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 14	3,754	—	—	—	46½	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82[f]
Southampton Corporation	,, 11	734	725	+ 9	—	11	—	,, 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	,, 14	962	999	− 37	—	19	17	,, 31	57,307	13,569,808	1,170,207	1·01	11·75	3,380	6·3 [1]

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. [a] Train mile.
[h] Half-year's figures. [c] Include rail and tram. [d] Total receipts. [e] Electric traction only. [f] Including one section of horse traction.

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NOTES.

Scientific Laboratories in the Philippines.—A proposal, which, if carried out, will provide exceptional opportunities for scientific study in the tropics, is projected by the U.S. Government in Manila. A bureau of Government laboratories has been established in the Philippine Islands, and arrangements are being made for erecting a large building and equipping it with modern appliances for scientific work. The resources of the islands themselves will be one of the first investigations undertaken by the bureau.

Lighthouse Communications.—Last week in the House of Commons, Mr. Gerald Balfour, in reply to a question, said that during the present year electrical communication had been established between two more lighthouses and the shore. The signal stations at Fastnet snd Tuskar had not been completed. He was considering the question of making these lighthouse communications available for private purposes, but the whole matter had been somewhat delayed by questions concerning the development of wireless telegraphy.

Behaviour of Bromine.—The following experiment, made with the purpose of observing the behaviour of bromine to high-pressure electric discharges, is described by Mr. K. Kellner. Pure, dry, and air-free bromine is enclosed in double-walled tubes, similar to ozone tubes, and submitted to an alternating current at 250,000 to 300,000 volts pressure, obtained by means of a Tesla transformer. After some hours, a sulphur-yellow, crystalline deposit appears on the walls of the tube, and when small quantities of bromine are used the whole may be transformed into the new substance. The author states that the glass itself takes no part in the change.

Coventry Engineering Society.—Mr. J. A. Jeckell, the manager of the Coventry electric light undertaking, delivered a lecture to the Coventry Engineering Society on Friday evening on "The Generation and Use of Electrical Energy," in the course of which he commented favourably on the use of the maximum-demand system of charging. Mr. Jeckell afterwards exhibited slides showing the station at South Shields, which, he said, was admitted by Continental engineers to be one of the most, if not the most, up-to-date station in the United Kingdom. At the close of the lecture Mr. Jeckell was accorded a hearty vote of thanks. On Saturday the society visited the Coventry electric light station and inspected the works and plant.

Electricity and Plant Life.—Some interesting experiments recently conducted by Dr. Lemstrom, of Helsingfors University, prove that electrical discharge exerts a considerable influence on the growth of plants. The experiments consisted in sowing wheat barley and rye in pots which were electrically connected to the earth. Above the pots a network of wires connected to a Holz machine was so placed that a discharge could be passed through the earth on which the seeds were sown. These discharges were made five times a day. The result was that after eight weeks those plants that had been stimulated by the electrical discharges were found to be 40 per cent. longer than those of ordinary growth. The increased growth varied with the nature of the plant operated on, but in every case the electrical discharge was found to stimulate growth.

Royal Meteorological Society. — A paper by Mr. H. H. Clayton was read at the last meeting of this society on "The Eclipse Cyclone of 1900." The author, in a former paper, discussed the meteorological observations made along the path of the total solar eclipse in the United States on May 28, 1900, and stated that he found that a cyclone followed in the wake of the eclipse—though the changes were very minute and feeble—the fall of temperature developing a cold air cylone in an astonishingly short time, with all the peculiar circulation of wind and distribution of pressure which constituted such a cyclone. This theory was not readily accepted by meteorologists, and Prof. Bigelow, who had discussed all the observations received by the United States Weather Bureau, thought that they scarcely confirmed Mr. Clayton's conclusions. The author now examined Prof. Bigelow's discussion, and pointed out that the observations really confirmed his own statements.

Electrical Traction on the North-Eastern Railway.—About six weeks ago we described in a note some experimental cars which are to be tried on the North-Eastern Railway, on which petrol engines are to be used as the prime mover. Further information now to hand discloses the fact that the engine in question will be of the Napier type, capable of generating 85 b.h.p. This engine will drive a dynamo which will provide electricity to the two motors geared to the car axles. The excitation of the dynamo can be varied over wide ranges, so that when starting up a large current at low voltage can be provided. Each of the cars will carry 52 passengers, and will have storage for enough petrol for a five hours' run. The two cars of this type now being constructed at York are to be used on the line between Hartlepool and West Hartlepool, where the North-Eastern Railway has suffered from keen competition by electric tramways.

Metallic Films by Cathode Projection.—In a recent issue of *Comptes Rendus* Mr. M. L. Houllevigne describes a method for obtaining metallic films on glass or other substances. The most approved method is to place the plate which is to receive the film upon the anode, and mount the cathode above it in such manner that at a pressure of a few hundredths of a millimetre the dark cathode space just touches the plate. The current first of all clears the cathode of occluded glass. The process is particularly long in platinum, and especially in palladium. Then the substance of the cathode itself is projected and deposited partly upon the glass plate and partly upon the anode. The deposits may present all degrees of transparency and opacity, accordingly as to whether the operation is continued for hours or for days. Bismuth so deposited does not show any change of resistance in a magnetic field, and is, therefore, probably perfectly amorphous. Iron shows magnetic rotary polarisation, but the author has not been able to fix the double refraction announced by Righi.

The Electromagnet in Surgery.—Mr. Stephen Mayon describes in the current number of the *Lancet* a method of removing small metallic foreign bodies from the stomach by means of an electromagnet aided by X-rays. The electromagnet is 2in. in length and $\frac{5}{8}$in. in diameter, and is placed in an ordinary stomach tube with a narrow silver band on the outer side of the stomach end of the tube. When the tube containing the magnet, protruding $\frac{1}{4}$in., is passed into the stomach, the X-ray is applied, and the operator is thus able to bring the magnet into contact with that part of the foreign body most suitable to draw into the tube. The current is then allowed to flow through the magnet and the foreign body is drawn into the tube by means of the connecting wires. When the foreign body is shown by the X-ray to be in the tube, the whole is withdrawn together. The author has used the method in practice, we understand, with success, and he recounts the case of a boy two years old from whose stomach a large-

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sized hairpin was withdrawn in the manner described above. The patient left the hospital the same day.

Wireless Telegraphy.—Mr. Marconi is reported to have established wireless communication with Cornwall from Cape Breton with complete success. The inaugura-tory messages included one from the Governor-General of Canada to his Majesty the King couched in congratulatory terms, and another to the King of Italy. Reverting to our previous notes on the subject of wireless telegraphy in France, it is now reported from Paris that the police autho-rities have stopped the erection of a wireless station at Cape La Hogue which Mr. V. Popp had commenced. As we stated last week, wireless telegraphy in France, as in this country, is a State monopoly, and no private individual or corporation may establish such a service without the authorisation of the Government. This the French Govern-ment have no intention of giving, and Mr. Popp's scheme for exploiting his system in that country to the exclusion of all others signally fails The same thing is liable to happen in England should any corporation attempt to set up a wireless system, as the State enjoys the monopoly of the commercial use of telegraphy in Great Britain and Ireland under the Telegraph Acts.

Glasgow Corporation Lectures.—The Glasgow Town Council have inaugurated a scheme by which the working of the various Corporation undertakings are to be explained to the inhabitants by lectures delivered in the City Hall. Mr. John Young, general manager of the Glasgow tramways, delivered last week a lecture on the subject, being one of the series arranged on the above lines. The figures given by him in the course of the lecture are most interesting and show that the tramway revenue has increased from £226,414 in 1894-5 up to £614,413 in the last financial year. In the same time the number of passengers carried has increased over 300 per cent. He estimated that during the present year they would carry 170,000,000 passengers, which was about the number carried by all the Scotch railway companies put together. He also showed that the capital expenditure outstanding was only that of the electric tramways, as they had wiped off all expenditure relative to horse traction. Other interesting figures were given to show that the undertaking was being worked with a profit to the city in spite of the low fares charged.

Ultra-Violet Light Screen.—Prof. Robert W. Wood presented a paper to the recent autumn meeting of the National Academy of Sciences at Baltimore under the title of "A Substance with Remarkable Optical Properties, and Screens Transparent only to Ultra-Violet Light," in which he announced a discovery which is said to be of great value in science and a notable achievement for the author. He first described Tyndall's experiments with a screen that cut out all the visible rays of the spectrum, as well as the ultra-violet rays, and let through only heat rays. For the past 30 or 40 years eminent physicists all over the world have been trying to find a similar screen that would cut out all the heat and all the visible rays and let through only the ultra-violet rays. Prof. Wood has for some time known that the substance called nitroxo-dimethyl-aniline would keep out all the visible and heat rays, except some red and violet, and that it would also let through the ultra-violet, and he now claims to have discovered that much sought screen. This he has done by combining the known substance with cobalt glass, and has obtained a screen that lets through only ultra-violet rays. One striking peculiarity of the nitroxo-dimethyl-aniline, which Prof. Wood specially emphasises in this paper, is the fact that it gives a spectrum 30 times as broad as that produced by ordinary quartz.

Tube Ventilation.—On Thursday last the *Daily Mail* published a report of an analysis, made at their expense by Dr. D. A. Sutherland, F.I.C., F.C.S., of the atmosphere in the Central London Railway. The report covers a series of analyses made at different times in the day, commencing at 8.50 a.m. and going on till 7 o'clock at night. The figures show that while in the early morning little complaint could be made of the state of the air, at night the atmosphere in the carriages was highly charged with carbon dioxide. The maximum amount found was 20·46 volumes of carbon dioxide in 10,000 volumes of air. This result was found in a carriage conveying people home from the City. At all times the air in the carriages was, as is to be expected, much more impure than that on the platform. An article appeared in the same issue of our contemporary illustrating the way in which the trials were made. In this reference is also made to the proposed means to remedy the present state of affairs. Amongst these is a large fan which the company are erecting at Shepherd's Bush to entirely renew the air in the tunnel at night. The artist illustrating this fan is evidently no engineer, as he has shown the intake and delivery tubes connected together, and the fan turning the air at one side.

An Electric Fire-Pump.—Rouen, in France, lays claim to the possession of the only electric fire-pump in use at the present time. From particulars to hand the main outfit appears to be of an extremely simple character, consisting of a centrifugal pump and an 8-h.p. electric motor which gives normally 2,000 revolutions per minute. A continuous current at 525 volts is required, which is usually taken from the street mains. To start the pump it is only necessary, after making the electric connections, to close the circuit and start it running slowly with the rheostat. The time necessary for this operation is given as about one minute. About 220 yards of hose is ordinarily carried, and the distance to which the water can be thrown is nearly 38 yards. The whole equipment can be placed on a hand-cart or on a two-wheeled wagon drawn by one horse. The total weight, with accessories, and two men on the seat, is about 2,292lb. The dimensions of the motor and pump are about 39in. in length, 19in. wide, and about 19in. high. Behind the machine is a reel, capable of hold-ing 330 yards of hose if required, and other appliances, including a ladder. This electric fire-pump was designed by Captain Robert Lefebvre, of the Rouen Fire Brigade. We know of several electrically-driven fire-pumps used for protecting special buildings in this country, but the differ-ence in electric supply prevents their general use.

Brussels-Antwerp Express.—Schemes for the con-struction of an electric railway between these two impor tant towns are still being considered by the Government. The matter is greatly complicated by the fact that the present undertakings are in the hands of the Government, and hence any concession granted is likely to seriously reduce the receipts of the Government line. There are three schemes now under consideration to provide in some way or another for compensation to the Government for the competition. In one case an actual guarantee is given to make up any loss of receipts sustained in consequence of working the new railway between the two cities. In another the Government is asked to guarantee 2½ per cent. on the capital of the new company, who in return offer the Government no less than 50 per cent. of their net receipts. This percentage of receipts is to be given if the mean speed made on the journey averages 62 miles an hour. At lower speeds a lower proportion of receipts is to be handed over. The conclusion of the whole matter is that competition between the Government and a company is not advisable, and that the Government are likely to overweight the

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company with financial obligations, which will seriously retard the successful development of the new line. In fact, the situation at present is a striking example of the arguments brought against municipal trading in this country.

The Potentials of Alloys.—In a former paper Mr. F. Haber showed that there are two kinds of alloys of sodium with lead or tin. Those containing small quantities of sodium evolve hydrogen slowly when placed in contact with water, and in a solution of lithium chloride in methyl alcohol at – 89deg. show the same potential as lead. Those containing more sodium are pulverised in contact with water and show a higher potential. In a more recent paper abstracted in the current number of the Chemical Society's *Journal*, it is shown that the low potential of the less concentrated alloys is due to the formation of a superficial layer of lead (or tin) in contact with the cold liquid, the alloy then behaving as if it consisted of lead (or tin). In contact with a concentrated solution of sodium hydroxide at the ordinary temperature, this does not occur, the potential being much higher. Alloys of other metals which form compounds exhibit analogous phenomena: for example, the alloys of zinc and copper containing more copper than corresponds with the formula Zn_2Cu have the same potential as copper. Frozen sodium amalgam also behaves in this way, for a similar reason. The potentials of the alloys rise in steps which appear to correspond with (*a*) pure lead, (*b*) a mixture of Pb and $PbNa_x$ which decomposes water slowly, (*c*) a mixture of $PbNa_x$ and $PbNa_y$ (the latter compound exhibits the phenomenon of pulverisation), and (*d*) pure sodium. The values of x and y are not known. The tin alloys are quite similar to those of lead.

A Non-Active Metal for Storage Batteries.—Mr. Henry H. Lloyd, an Englishman residing in the States, claims to have discovered an improved non-active metal for use in storage batteries. It consists of rolled antimonious lead, which may be made by melting lead and antimony, of which latter there should be present an average of 12 per cent. by weight, and then casting the alloy. This is then subjected to repeated cold rolling or equivalent forging, and the result upon it of this process is to materially change its characteristics and to make it especially useful for storage batteries. Cast antimonious lead has been tried before for storage batteries, but in its then state it was found not to be suitable to the purpose. However, according to this invention, the rolling process has the desired effect, the use of the resultant metal making possible the production of types of batteries characterised by lightness, durability, and strength, which could not heretofore be made. For example, extremely light plates could not be made on cast antimonious lead supports, because of the weight of the latter necessary for sufficient mechanical support. However, by the use of rolled antimonious lead supports it is said that such light plates can now be satisfactorily made. As a holder for the electrolyte, it also possesses the mechanical strength that is lacking in pure lead, and it further resists the action of the acid better than pure lead. We understand that the improved metal is covered by patents in the States, which have been secured by a battery company which proposes to use the metal commercially.

Electricity on Shipboard.—Mr. F. O. Blackwell recently read a very instructive paper before the United States Society of Naval Architects and Marine Engineers, in which he advocated an increased use of electric motors on ships, particularly vessels of war. The system especially favoured by the author is the three-phase generator driven by the steam-turbine. Induction motors would replace the present steam auxiliaries with very few exceptions, and the Ward-Leonard system is proposed as a substitute for the steam steering gear now found of these vessels. When more than one speed is called for, variable-speed induction motors could be used, the changes in speed being secured by means of a rheostat in the secondary, and by commutating the primary winding so as to obtain different polar groupings. To simplify the lighting it is suggested that this load be carried on one phase of the system. This would also enable the potential of the lighting circuits to be kept constant irrespective of the motor load, but would make necessary the use of a special potential regulator. The author claims as the great advantage of adopting steam-turbines as the prime mover the fact that the plant could be installed in one-third the space now required, and with half the weight of the direct-current systems now generally employed. An alternating system is advocated because the author holds that alternators are better suited than direct-current generators for the high speeds obtainable with the steam-turbine as the prime mover. There is little doubt but that the steam auxiliary in our warships will be entirely abandoned for the electric motor in the near future, and in this connection the above paper is well worthy of careful study.

Compounding Alternators.—The United States Patent Office has granted Mr. Chas. P. Steinmetz two patents relating to a method for compounding single or polyphase alternators, whereby the excitation of the generator is increased with increased load or lagging current, and decreased with diminished load or leading current. To accomplish this, a current derived as described below is supplied to the alternating-current side of a rotary converter, from the direct-current side of which the exciting current is drawn. For example, by the application of the method to a single-phase alternator, in series with one of the alternator main leads is the primary of a transformer, the secondary of which is connected at one end to a separate generator winding. The other end of the latter is connected to a collector ring, and the other end of the secondary is connected to a second collector ring, the brushes of the two rings being connected with the rotary converter. By the use of a reactive coil (known also as an auto-converter) the auxiliary generator winding may be dispensed with. In this case a portion of the winding of the reactive coil is in series with one of the mains, the end of the other portion being tapped to an intermediate point of the armature winding, the primary of the transformer in them in the circuit between the top and reactive coil. By the composition of the two E.M.F.'s thus obtained in the compensating circuit—one the main and the other an auxiliary E.M.F.—a resultant exciting E.M.F. is secured, which will tend to increase in value with lagging currents and to decrease with leading currents, and changing both with the load and with the phase displacement. This, it is claimed, renders possible in practice the desired regulation.

Train-Lighting in Germany.—The State-controlled railways of Germany have up to the present not employed electric lighting for their passenger trains to any appreciable extent. About 1,500 mail vans, however, have been lighted electrically by means of accumulators, which are recharged at points on the route or the batteries are exchanged at these points for newly-charged cells. Even as recently as Jan. 18, 1900, the Minister of Railways expressed an opinion adverse to the introduction of electric lighting. Accidents to gas-lighted trains have caused a reaction, and now the authorities are taking the matter up keenly. We have before referred to the trials made on trains using a dynamo driven by a Laval steam-turbine as the source of

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power. This is specially suitable for trains which are not broken up. Other systems are now being tried by which each coach will have its own dynamo and battery, as is the case with trains lighted in this country on the Stone system. We gather that one of the equipments on trial, which employs a dynamo belt-driven from the carriage axle, is known as the Frankfort system, being the design of the Pollak Accumulator Company of that town. The means by which the voltage is kept constant in this system is not known to us at present. It may interest the German authorities to know that in England electric lighting of railway carriages has achieved a permanent success, as practically all new stock is equipped in this way. The one great advantage of having the dynamo driven from the axle of the coach is that the accumulators are always kept charged when the train is in use. In consequence of this there is no disorganisation when a rush of traffic occurs, as is the case with gas and oil lighting, which require periodic attention.

Motors for Machine Tools.—An interesting paper under this title was read at the last meeting of the American Institute of Electrical Engineers by Mr. F. O. Blackwell. From an abstract in the *Electrical Review* of New York, the author first described the different classes of work required of machine tools, and the various methods which can be used to obtain variable speed. The main question to be considered in the adoption of the variable-speed drive was how far could this method be used. The same horse-power is required to remove metal, independent of speed. Therefore, at low speed, secured by low voltage, a greater armature current is necessary. By the use of the three-wire system and the variable field a change of speed from 4 to 1 can be obtained. By the use of gears this can be made 16 to 1, or more. The use of the magnetic brake for throwing in the gears was also touched upon by the author. When a cone pulley is used with belts for variable speed the full output of the tool cannot be secured, and, moreover, the system is not flexible. The electric drive gives a greater output of the tool. The author then pointed out that on a three-wire system a motor twice as large as that found necessary for a two-wire system should be used, while for a four-wire system the motor should be four times as large. The three-wire system is generally available, and does not require two generators. The four-wire system requires two machines, one of these having two commutators, and involves an increased cost. He thought that the three-wire system was the best, using a field control of 2 to 1, giving a total range in speed from 4 to 1. He then showed diagrams illustrating the greater output procurable when electric driving is adopted, as the speed can always be kept as great as the tool will stand. In the case cited the time taken to remove a certain amount of metal was reduced from 60 minutes with the belt drive to 32 minutes with the electric drive.

Prospects for Light Storage Batteries.—The possibilities of a light storage battery are discussed by Norden in a paper which is abstracted by the *Electrical World* in its weekly "Digest." We gather from this that the author's opinion is that the lead accumulator has been so much improved in recent years that there is little room for further development. The light accumulator of the future, he thinks, must be a non-lead accumulator. He then discusses past trials with metals other than lead. The zinc-lead peroxide cell has a higher ampere-hour capacity per pound of weight, and its discharge voltage is higher by 25 per cent.; but the disadvantage is that during discharge the zinc goes into solution and during charge it is not so perfectly and cleanly redeposited, but is often spongy in form, causing short-circuits; local action at the zinc plate and other troubles cannot be entirely avoided, in spite of amalgamation. These disadvantages apply generally to any soluble electrode; he, therefore, claims as a principle that a soluble electrode is unsuitable for a storage battery. In the cuprous oxide-zinc accumulator there is the same trouble with the zinc, and the copper plate also has disadvantages, as the cupric oxide goes into solution and copper is then deposited on the zinc, causing a fatal local action. Metals like zinc are never deposited upon the opposite plate; he, therefore, claims as a second principle that two different metals in an accumulator are practical only if they are either both insoluble in the electrolyte or when dissolved cannot be deposited on the opposite plates. He considers the Edison accumulator a step in the right direction, although he does not think that it represents the definite solution of the problem of the light accumulator. The mechanical construction with the active material compressed in perforated boxes is not the best construction for utilising the total active mass, as the entering of the current into the interior of the boxes and the diffusion of the electrolyte into the pores is somewhat difficult. The capacity of the Edison cell per pound is too much like that of the lead cell. A new principle has not been found in the invention of the Edison accumulator. He finally points out the impossibility of predicting anything on the probable future development from a purely theoretical point of view.

Electrolysis of Alkali Chlorides.—In the December number of the Chemical Society's *Journal* will be found a good abstract of a paper on this subject by Messrs. F. Foerster and E. Muller. The authors confirm the observation made by Lorenz and Wehrlin that the E.M.F. required to electrolyse a solution of sodium chloride with a platinised anode is approximately 0·5 volt less than that required with a smooth platinum anode, but show that the only difference in the chemical behaviour of such anodes is that at the platinised anode oxygen and chlorate begin to be formed somewhat later and at a higher concentration of the hypochlorite than is the case at a smooth anode; thereafter the two behave similarly. Chemical experiments show that platinum black decomposes hypochlorous acid into oxygen and hydrochloric and chloric acids, but that the velocity of the change is far too small to explain the formation of these substance at the anode during electrolysis. The P.D. between a platinised platinum cathode and a concentrated solution of sodium chloride containing a little chromate is constant, for since hypochlorites are not reduced appreciably at such a cathode, it behaves like a normal hydrogen electrode. With a cathode of this kind and a platinised anode, the E.M.F. required to electrolyse a solution of sodium chloride is very little greater than that theoretically needed, $2{\cdot}23 + c\,r$, where 2·23 is the E.M.F. needed to decompose sodium chloride, c the current, and r the resistance of the solution. With a smooth anode, the E.M.F. is higher by a quantity which increases with the duration of the electrolysis to as much as 0·8 to 0·9 volt. A similar difference is found in all cases in which oxygen is evolved at the anode: for example, in the electrolysis of sulphuric acid or sodium hydroxide. These large differences cannot be explained by differences in the concentration of the solution in contact with the anode. An alkaline solution of potassium iodide (from which no oxygen is evolved during electrolysis) gave a difference of at most 0·07 volt between smooth and platinised anodes. The authors suggest that the difference may be due to the greater polarisation capacity of the platinised anode, owing to which the concentration of the occluded oxygen in it would be very much smaller than in a smooth anode.

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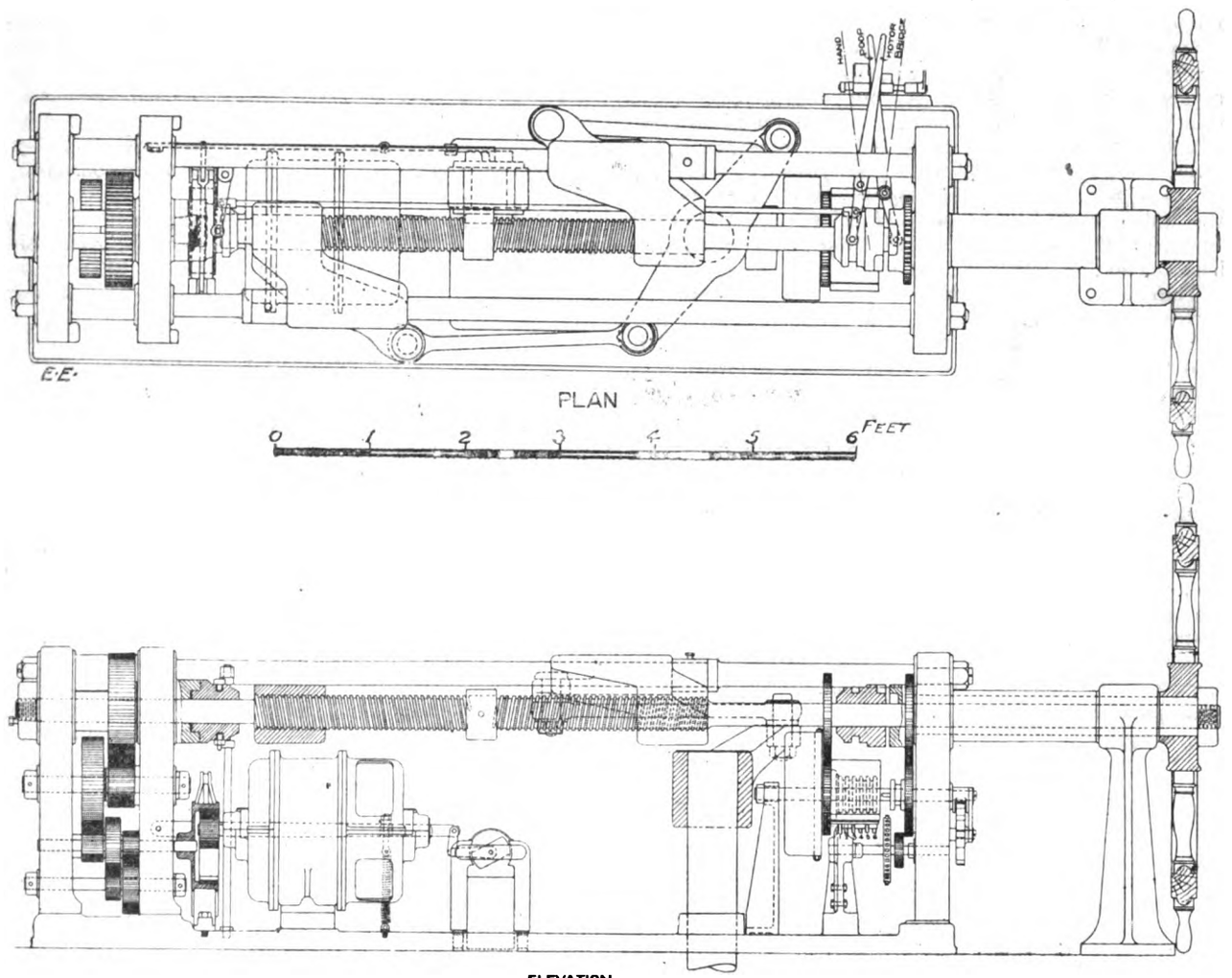
AN ELECTRIC STEERING GEAR.

Messrs. Siemens Bros. and Co. have recently equipped the Earl of Crawford's yacht "Valhalla" with an electrical steering equipment, which has proved satisfactory both to the owner and to the Admiralty experts who have witnessed trials with it. The steering gear (Fig 1) is of the type usually fitted on large yachts for hand steering, and has only been slightly altered so as to adapt it for electrical driving. It consists essentially of a solid cast-iron frame bolted on to the deck. The upper end of the rudder post passes through the base of the frame, and carries securely keyed to it a massive cross-piece. Above this and running fore and aft is a right and left handed screw, supported in the frame and carrying one right and one left handed nut, which are supported and prevented from turning by two guides



FIGS. 1 AND 2.—Plan and Elevation of the Electrical Steering Gear on the Steam Yacht "Valhalla."

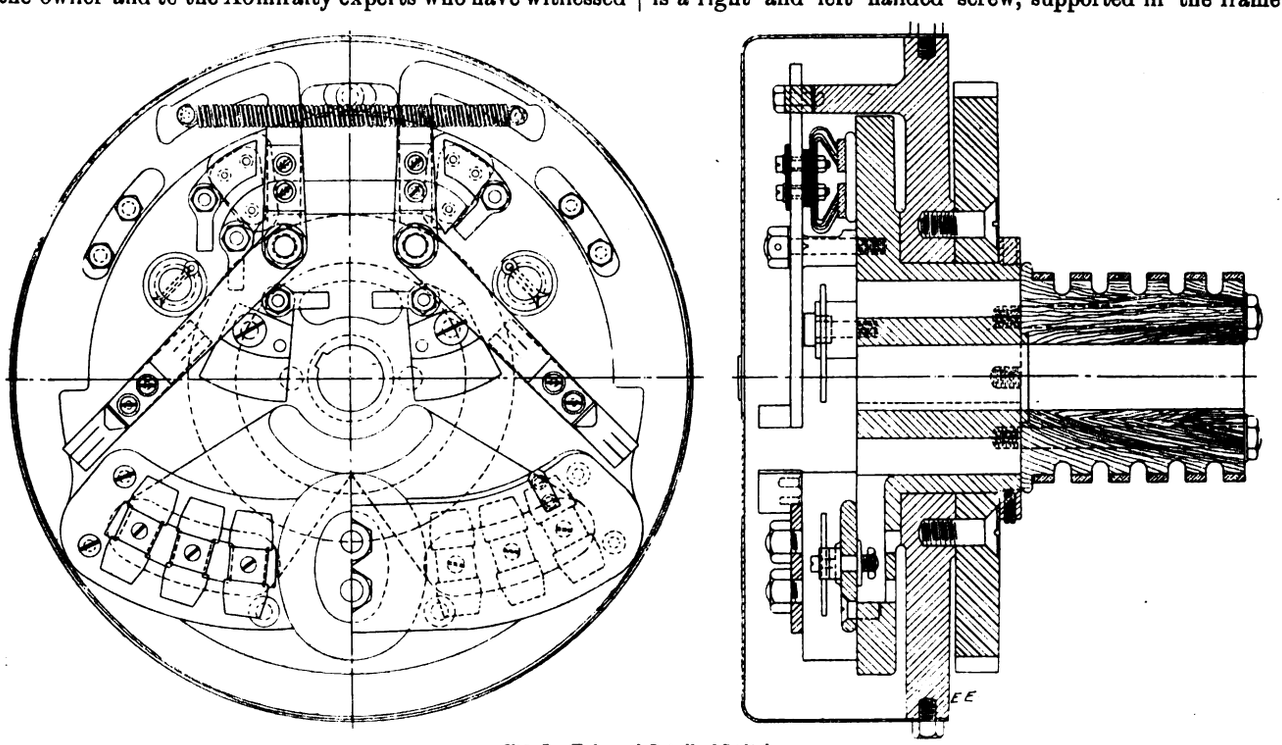


FIG. 3.—Enlarged Detail of Switch.

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running parallel with the screw. These nuts are connected by links, one to each side of the cross-piece on the rudder post, and by this means the turning of the screw operates the rudder. The steering wheel is large enough to be used in emergency for hand steering, and is carried on a sleeve on an extension of the screw, to which it can be connected by means of a claw clutch. A Siemens four-pole completely enclosed motor is arranged so as to drive the screw through several reductions of spur gearing, and through a claw clutch. This clutch is connected to that on the steering wheel in such a manner that both are operated by one lever, and only one can be in gear at a time. It will thus be seen that the screw which operates the rudder through the nuts and links is capable of being turned either by the electric motor or by the steering wheel, but not by both at once.

The electric motor (Fig. 2) is series wound, and is provided with a brake, pulley, and brake blocks, which are held off by an electromagnet in series with the motor and held on by a suitable spring. The brake is, therefore, put on and the motor promptly pulled up whenever the current is interrupted. The motor is controlled by two special starting switches, one for each direction of rotation, instead of using a single reversing switch, as by this means it is possible to get a very reliable quick brake action. The switches each have three contacts, so that resistance can be cut out in two steps, and the contacts are so shaped that the actual contact surfaces are not touched by the arcs, and, therefore, remain in good condition. The contacts are reversible and very easily replaceable, and a new contact can be inserted in a very few minutes. A powerful magnetic blow-out is provided on each switch, which is in operation on all the contacts. Although the current is quite small, being not more than 25 amperes at 100 volts,

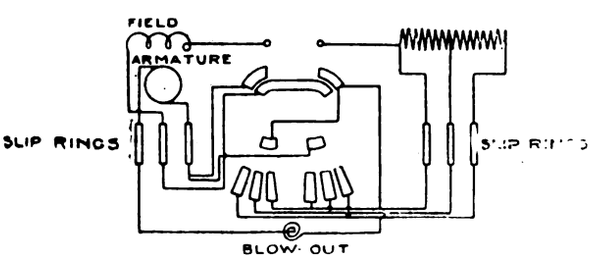

FIG. 4.—Diagram of Connections.

these ample precautions against arcing troubles have been taken because of the extremely frequent switching off and on which is required in the ordinary steering of a ship. They have proved quite satisfactory in practice.

The operation of the starting switches is accomplished as follows: The two switch arms (Fig. 3) are mounted on two pins on a metal disc and at equal distances from its centre. The disc is geared to the screw, and its motion is, therefore, proportional to that of the rudder. The switches have cranked arms, as shown in the drawing, which can be pushed so as to put the switches on or off by stops on a second disc mounted concentrically with the first. The second disc is in gear with the steering wheel, and its motion is, therefore, proportional thereto. The switching on or off is, therefore, the result of the difference in the motions of the two discs, which are proportional to that of the rudder and the steering wheel respectively. The cranked arm of each switch is so shaped that it clears the stops on the second disc when the motion is in one direction, but engages them when the motion is in the opposite direction. This ensures that one switch only is operative in each direction of rotation. Both switches are pulled to the off position by springs so as to get a quick break, but they are also pushed off positively by the stops, so that the breaking of a spring does not incapacitate the gear in any way, but only makes the break rather slower. The two discs are further provided with massive stops arranged to limit the difference of their motions to little more than the amount actually required to operate the switches. The gearing is such that 12 complete turns of the steering wheel move the rudder from hard-a-port to hard-a-starboard, a total angular distance of 80deg. A Geneva stop is provided on the second switch disc, which prevents the steering wheel from turning more than 12 complete revolutions. When the Geneva stop is reached the second disc is stopped, and the first catches it up, so that the motor is automatically switched off when the extreme positions of the rudder are reached.

The trials which have taken place on the "Valhalla" have proved quite satisfactory. The control of the ship was as perfect as could be desired, and gave complete satisfaction to the navigating officers.

The test imposed by them, which was considered the most severe—namely, throwing the rudder from hard-a-port to hard-a-starboard whilst steaming full speed astern—was accomplished with ease, and without excessive consumption of current.

The following are the leading particulars of the steam yacht "Valhalla": length, 239ft.; beam, 37ft. 6in.; draught when in trim, 18ft. 6in.; tonnage, 1,490; nominal horse-power, 500. The yacht was built by Ramage and Ferguson, of Leith, nine years ago.

HEATING OF TRANSFORMERS.

BY R. C. CLINKER.

The temperature which a transformer will reach when running for a considerable time on load is a feature of the design which is of the greatest importance, and deserves the most careful consideration. It is a well-known fact, and one fully appreciated by manufacturers and designers of electrical apparatus, that high temperatures increase the rate of deterioration of nearly all the materials usually employed for insulating purposes, and greatly reduce the effective life of the apparatus. Too little attention appears to have been given to the temperature of transformers, and many central-station managers would be greatly surprised if they realised the temperatures which are reached in the interior portions of the transformers on their systems.

It has been customary to measure the temperature of a transformer by placing a thermometer on the outside of the case or core or some other equally convenient place, and the fact that the heat is generated in the interior of the transformer seems to have been to a large extent overlooked. Hence there has been little inducement to manufacturers to make really cool transformers, and the majority have been built of such design as to prevent the heat from being freely communicated to the cases. Such transformers, from the tests made, apparently run quite cool, but, if properly tested, they would be found to reach in their vital parts temperatures which are far in excess of the safe limit for the materials comprising the insulation and also for the iron core.

I have frequently seen specifications drawn up by consulting engineers and sent out with requests for tenders, in which the clause relating to temperature rise is worded somewhat as follows: "After a full load run of —— hours, the temperature rise of any accessible part of the transformer shall not exceed —— deg. F." One naturally asks the question, "What is the meaning of 'accessible part'?" If this is taken to mean the outside casing, the terminals, or any parts which can be reached without removing the cover, the specification is manifestly absurd, as the parts which can be reached are not those which can be injured by high temperature, and while the temperature of the case and similar parts may be well within the limits of good practice, the parts of the transformer which are likely to be injured by excessive heating may reach a temperature which will ensure rapid depreciation and ultimate destruction.

The only reasonable and scientific method of testing the heating of a transformer is by measuring the rise of resistance of the coils. If this method were generally adopted, it is more than likely that a very large proportion of the transformers in use in this country would be found to reach a dangerous, if not a destructive temperature: although measured by a thermometer, applied after a few hours to the case, they may appear to be running cool.

It has been urged that the test by rise of resistance is too complicated and too difficult to make, and that the results obtained—unless the tests are carried out with

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the greatest care—are likely to be misleading. Such a test is, of course, complicated as compared with that of placing a thermometer on the case, but when compared with the tests which are carried out in connection with generators, motors, and other electrical apparatus, such tests are comparatively simple. A good bridge and the knowledge of how to use it is all that is required for making such a test, and if a bridge is not available, and the resistance is low, an ammeter and voltmeter may be used. The absolute accuracy of the instruments is a matter of comparatively little importance so long as their calibration does not change during the test, as the readings are not necessarily absolute, but only comparative.

The aim of the designer of good transformers should be to conduct away with as small a temperature gradient as possible the heat generated in the coils and core, and communicate it to the surrounding air, and special attention should be given to the design of the interior as well as the case, so as to increase the capacity of the transformer for radiating its heat. As long as engineers and central-station managers are content to measure the temperatures of their transformers by applying a thermometer to the case, so long will the manufacturers continue to design transformers which are inherently defective, in that they retain their heat instead of communicating it to the case.

If engineers and purchasers desire to secure good transformers, which will put them to the minimum expense for maintenance, they should be careful to specify that the temperature should be measured by the rise of resistance method, and should see that the manufacturers are forced to strictly adhere to the specifications, reserving the right to reject transformers the temperature of which is appreciably in excess of the limits set. If this is done, the manufacturers will be forced to produce better transformers, and while it may increase the price charged by manufacturers who are now building transformers of low grade, the purchaser will be certain of getting a good article, for which he should be willing to pay a fair price.

There are, of course, many other features which enter into the design of a good transformer. Efficiency, regulation, and insulation are all of great importance, but it is not necessary that any of these should be sacrificed in order to obtain low temperature, but it is necessary that the manufacturer should design his transformers on an honest basis, and endeavour to give to the customer the best article for the least money.

ON ELECTRONS.*

BY SIR OLIVER LODGE, F.R.S., VICE-PRESIDENT.

(Continued from page 813.)

Electric Inertia.—Whatever a charge may be, and whatever the hydrodynamic constitution of the ether, it must be able to maintain electric lines and magnetic lines, and to transmit energy wherever both sets of lines cross at right angles. An accelerated charge is equivalent to a changing current, for $\frac{d\,C}{d\,t}$ may be written $\frac{d^2\,Q}{d\,t^2}$. Whenever a current changes we have an E.M.F. of self-induction set up equal to $L\frac{d\,C}{d\,t}$. Considered from the point of view of a current constituted by a moving charge, this corresponds to a mass acceleration. And the electrical acceleration is opposed by the E.M.F., just as the acceleration of matter is opposed by its mechanical inertia. The coefficient of the electric acceleration represents, therefore, an inertia term, and is properly called electric inertia. By Lenz's law, the effect of induction is always to oppose the cause which produced it. In the present case the cause is the acceleration or retardation of the moving charge, and so in each case this is opposed by the reaction of the magnetic lines generated by it. Motion is opposed while it is increasing in speed, and it is assisted while it is decreasing in speed—an effect precisely analogous to ordinary mechanical inertia—and, therefore, force is necessary, and work must be done, either to start or to stop the motion of a charged body. An extra force, that is, by reason of its charge. Whatever the inertia the body may have, considered as a piece of matter, it has a trifle more by reason of its being charged. The value of this imitation or electrical inertia for the case of a charged sphere of radius a is

$$\frac{2\,\mu\,e^2}{3\,a}.$$ (See appendix.)

Since this is very important, I repeat: Just as a changing magnetic field affects an electrostatic charge—that is to say, generates a feeble field of electric force into the intensity of which the velocity of light enters squared in the denominator—so it is with a changing electric field: it generates a magnetic field proportional to its velocity of change; and if it is being accelerated, the magnetic field itself varies, and in that case generates an E.M.F. which reacts upon the accelerated moving charge, and always in such a way as to oppose its motion—by what is called Lenz's law, or simply by the law of conservation of energy: for if it assisted the motion, the action and reaction would go on intensifying themselves until any amount of violence was reached. The magnetic lines generated by a rising current—that is, by a positively accelerated charged body—react back upon the motion which produced them in such a way as to oppose it. To oppose it actually or elastically, not passively or sluggishly as by friction. The reaction ceases the instant the motion becomes steady; it is not analogous to friction therefore, but to inertia; it is the coefficient of an acceleration term. The magnetic lines generated by a falling current—that is, by a negatively accelerated or retarded charged body—react oppositely and tend to continue the motion; thus here also we have a term corresponding to inertia. And the charged body may be said to have momentum by reason of its charge while it is moving. The value of the momentum is proportional to the velocity so long as the velocity is not excessively great, and accordingly the inertia term is constant, and independent of speed, under the same restriction. It may therefore be considered to be in existence even when the charge is stationary, and thus it simulates exactly the familiar mechanical inertia of a lump of ordinary matter.

In an appendix will be given the simplest form of the quantitative relations here indicated, and the inertia due to an electric charge will be calculated. It is to be understood that whatever inertia a material sphere may possess, considered as matter, it will possess more when it is charged with electricity, and this no matter whether the charge be positive or negative. The amount of extra or electrical inertia is proportional to the electrostatic energy of the charge—that is to say, it is proportional to the charge and its potential conjointly. Call the charge e, and the radius of the sphere a, the potential will be $e/\kappa\,a$ and the appropriate inertia is $m = \frac{2}{3\,v^2}\,e\,.\,e/\kappa\,a$, where v is the velocity of light.

Another way of putting it is to say that if a mass of this amount were moving with the speed of light, its kinetic energy would be half as great again as the potential energy of the electric charge when standing still for $\frac{3}{4}\,m\,v^2 = \frac{1}{2}\,e\,.\,\frac{e}{\kappa\,a} = \frac{1}{2}\,Q\,V$ = potential energy. Now, any appreciable quantity of matter, even a milligramme, moving with the speed of light has a prodigious amount of energy—namely, for the mass of 1 milligramme, 15,000,000 foot-tons Or, as Sir William Crookes has expressed it, a gramme or 15 grains of matter moving with the speed of light would have energy enough to lift the British navy to the top of Ben Nevis. Consequently the inertia of any ordinary quantity of electric charge must be exceedingly minute. Nothwithstanding this, it is quite doubtful whether or not there really exists any other kind of inertia. The question whether there does or not is at present, strictly speaking, an open one, though to my mind it is practically closed. The only way of conferring upon a given electric charge any appreciable mass is to

* Paper read before the Institution of Electrical Engineers.

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make its potential exceedingly high—that is, to concentrate it on a very small sphere. A coulomb at the potential of a volt has an electrostatic energy of half a joule—that is, $\frac{1}{2} \times 10^7$ ergs. The mass equivalent to this would be

$$\frac{2}{3}\frac{10^7}{9 \times 10^{20}} = \frac{2}{27} \times 10^{-13} \text{ gramme} = 10^{-8} \text{ milligramme.}$$

Raise the potential to a million volts, and the mass equivalent to a coulomb at that potential would be the hundredth part of a milligramme; still barely appreciable therefore. The charge on an atom as observed in electrolysis is known to be 10^{-10} electrostatic units. If this were distributed uniformly on a sphere the nominal size of an atom—viz, one 10^{-8}cm. in radius—its potential would be one-hundredth of an electrostatic unit, or about three volts. The energy of such a charge would be 10^{-12} erg, and the inertia of a body which would possess this energy if moving at the speed of light would be 10^{-33} grm. But this is incomparably smaller than the mass of a hydrogen atom, which is approximately 10^{-25} grm. Consequently, the ionic charge distributed uniformly over an atom would add no appreciable fraction to its apparent mass. If, however, the atomic charge were concentrated into a sphere of dimension 10^{-13}cm., its potential would be 1,000 electrostatic units or 300,000 volts, its energy would be 10^{-7} erg, and its inertia 10^{-28} grm., or about $\frac{1}{1000}$ of the mass of a hydrogen atom.

All this is a preliminary statement of undeniable fact—that is to say, of fact which follows from the received and established theory of electricity, whether such things as electrons had ever been found to exist or not. All that we have stated is true of an ordinary charge on any ordinary sphere which can be made to move by mechanical force applied to it. It gives us the phenomena of electrostatics when at rest, of magnetism when in motion, of radiation when started and stopped, and it incidentally, by reason of the known laws of electromagnetic induction, exhibits a kind of imitation inertia, and in that way simulates the possession of the most fundamental property of matter. I will add a few more closely connected assertions. Apply a sufficiently violent E.M.F. to a charged sphere, and the charge may be wrenched off it. Insert an obstacle in the path of a violently moving charged sphere so as to stop it mechanically with *sufficient* suddenness, and again it is possible for the charge, or something like it, to be jerked off it and passed on. But to do this the speed of the sphere, as well as the suddenness of stoppage, must be excessive. Usually the charge is merely thrown into an oscillation, when the sphere is suddenly stopped; and it then emits a solitary wave or spherical shell of thickness equal to the diameter of the sphere: or greater than that diameter by the amount the sphere has moved during its retardation. When the acceleration is moderate, however, the radiation is less energetic and also less intense: less energetic because its power depends on the square of the acceleration, less intense because it is spread over a thicker ethereal shell. Röntgen rays are perceptible only when the speed was great and the stoppage so sudden that the wave or pulse shell is strong and thin.

The doctrine of the behaviour of a charged sphere in motion, and the calculation of the value of the quasi-inertia of an electric charge, was begun by Prof. J. J. Thomson in an epoch-making paper published in the *Philosophical Magazine* for April, 1881—one of the most remarkable physical memoirs of our time. The stimulus to this investigation was supplied by those brilliant experiments of Crookes, published in the *Philosophical Transactions* for 1879, which were preceded by observations of Plucker and Hittorf, and followed by other observations by Goldstein and Puluj and others in 1880. In 1891 Sir William Crookes was your president, and in his inaugural address expounded further some of these brilliant experimental investigations, to which Schuster and many others had contributed. It is not too much to say that up to the time of Crookes the phenomena of the vacuum tube were shrouded in darkness, notwithstanding much laborious and painstaking work done both in this country and on the Continent in connection with them; but that since the researches of Crookes in the seventies the theoretical luminosity of the vacuum tube has steadily increased, until now, as Maxwell predicted, it is shedding light upon the whole domain of electrical science, and even upon the constitution of matter itself.

Appendix A.

Calculation of the Inertia of an Electric Charge.—Let a spherical conductor of radius a carrying a charge of electricity e move forward with moderate speed u, meaning by moderate speed anything distinctly less than the speed of light; it constitutes a current element of magnitude $e\,u$, and its circuit is closed by displacement currents in the surrounding dielectric; for its lines of force arise in the medium in front and subside in the medium behind, and so a displacement of electricity takes place from fore to aft to compensate the motion forward, and the lines of displacement are identical with the magnetic lines due to a short magnet. A charge may be said to travel carrying its electrostatic lines with it, or it may be said to be constantly generating a radial electrostatic field in front and destroying one behind. When an electric field thus moves partly laterally it generates a magnetic field—in the present instance in circular lines round the line of motion—for the moving charge is an element of a linear current. The generation of these magnetic lines act so as to oppose the current which produced them, but so long as they continue steady they exert no effect on it. When they subside, however, they tend to prolong the current which maintained them. Consequently, if the moving charge (or current) tries to stop, its retardation meets with obstruction; it is constrained to persist by the subsidence of the magnetic field which its motion excited and maintains. Its velocity is not resisted, there is nothing equivalent to friction, but its acceleration + or − is obstructed, an effect precisely analogous to inertia. If it is at rest it will need force to start it, and if it is in motion, its motion will persist. The charge acts, therefore, as if it had inertia, and we can proceed to calculate its amount. While moving it is a current, and will be surrounded by rings of magnetic force, whose intensity at any point with polar co-ordinates $r\ \theta$ referred to in the line of motion as axis and the moving charge as origin will be the quite ordinary expression (with $e\ u$ for the current element instead of $C\ d\ s$)—

$$H = \frac{e\ u \sin \theta}{r^2}.$$

The ordinary expression for the electrostatic force at the same point is

$$E = \frac{e}{K\ r^2};$$

and if the motion is slow this value will be preserved, but if it is rapid the electric field gets weaker along the axis and stronger equatorially, having been shown by Mr. Heaviside (*Philosophical Magazine*, April, 1889) to be given by the following expression:

$$E = \frac{e}{K\ r^2} \cdot \frac{1 - (u/v)^2}{\{1 - (u \sin \theta/v)^2\}^{\frac{3}{2}}},$$

where v is the velocity of light. The strength of the magnetic field will be similarly modified in this case; but the simplest mode of stating it is to express it in terms of E, and to say that *always*

$$H = K\ E\ u \sin \theta.$$

The rate of transmission of energy will be the vector product of E and H; and the whole magnetic energy—that is, the whole energy due to the current—*i.e.*, due to the motion—will be obtained by integrating the ordinary expression $\mu\ H^2/8\ \pi$ all over space outside the charged sphere—viz., from a to ∞ all round. In the general case this expression is a little long, but in the most important case, when the speed of motion, u, is decidedly less than the speed of light, v, it is quite simple, and the working may as well be given:

$$\text{Kinetic energy} = \int_a^\infty \frac{\mu\ H^2}{8\ \pi}\ d\ (\text{vol.})$$

$$= \frac{\mu\ e^2\ u^2}{8\ \pi} \int_0^\pi \int_0^{2\pi} \int_a^\infty \frac{\sin^2 \theta}{r^4}\ dr \cdot r\ d\theta \cdot r \sin \theta\ d\phi$$

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$$= \frac{\mu e^2 u^2}{8} \int_0^{2\pi} \int_a^{\infty} \frac{\cos^2\theta - 1}{r^2} dr \,.\, d\cos\theta = \frac{\mu e^2 u^2}{3a}.$$

Comparing this with mechanical kinetic energy, $\frac{1}{2} m u^2$, we see that the charge on the sphere confers upon it additional kinetic energy, as if its mass were increased on account of the charge by the amount

$$m = \frac{2\mu e^2}{3a},$$

which may also be written—

$$m = \frac{2\mu K \,.\, e^2}{3 K a} = \frac{2}{3v^2} \,.\, e \,.\, \frac{e}{K a} = \frac{2}{3v^2} \times \text{charge} \times \text{potential}.$$

or $\frac{2}{3} m v^2$ = the electrostatic energy of the charge.

In other words, the mass equivalent to the charge is such that if it were a piece of matter with constant inertia travelling with the speed of light, its kinetic energy would be half as great again as the potential energy of the electric charge when standing still.

Appendix B

The Electric Field Due to a Moving Magnet.—If a short bar magnet or uniformly magnetised sphere (its moment, M, being the intensity of magnetisation × the volume of the sphere) moves along axially—that is, in the direction of its magnetisation—with velocity u, it generates circular lines of electric force all centred upon its axis, much as a moving charge generates circular lines of magnetic force. If there is a conducting path around any such circle, then the motion of a magnet along its axis will generate a current in it, but if there be no conductor the motion will only result in an electric displacement, which subsides when the magnet stops. The intensity of the magnetic field at any point along the axis is well known to be $2\,M/r^3$; at any point on its equatorial plane it is $-\,M/r^3$; and in any intermediate direction it is, as regards magnitude alone,

$$H = \frac{M}{r^3}\sqrt{\left(1 + 3\cos^2\theta\right)}$$

All this holds for the moving as for the stationary magnet, provided its speed does not approach that of light. The electric force at the same point is

$$E = \frac{3\,M\,u}{2\,r^3} \sin 2\theta$$

$$= 3\,H\,u\,\frac{\sin\theta}{\sqrt{(4 + \tan^2\theta}}.$$

The electrostatic energy resulting will be the integral of $K E^2/8\pi$ everywhere outside the moving magnetised sphere of radius a—viz.,

$$\text{Energy} = \frac{K}{8\pi}\iiint\left(\frac{3\,M\,u}{r^3}\right)^2 \sin^2\theta\cos^2\theta\, d\,r.r\,d\,\theta.r\sin\theta\, d\,\phi$$

$$= \frac{K\,M^2\,u^2}{5\,a^3} = \frac{M^2}{5\,\mu\,a^3}\left(\frac{u}{v}\right)^2.$$

The displacement acts like an elastic strain set up in the dielectric, storing the above energy statically; and so long as the magnet continues moving steadily the electric displacement exerts no force upon it; but acceleration will be resisted. If the magnet begins to go faster it sets up more displacement, and the act of setting this up constitutes a transient current which opposes the motion as long as the acceleration continues, but it dies out the instant the motion becomes steady again. Conversely, if the motion of the magnet began to slacken, the electric strain would begin to subside, and its subsidence would constitute an inverse transient current which would assist the motion—*i.e.*, oppose the slackening. In other words, the variations of the circular electric strain in the surrounding medium confer upon a moving magnet a spurious or apparent momentum, in addition to its real mechanical momentum; and thus the elastic strain itself may be said to represent a spurious or apparent inertia due to magnetisation, in addition to any real mechanical inertia which the body holding the magnetism may itself possess. And the amount of this extra inertia is

$$m = \frac{2\,K\,M^2}{5\,a^3} = \frac{2\,M^2}{5\,\mu\,a^3\,v^2} = \frac{8}{15}\cdot\frac{\pi\,I\,M}{\mu\,v^2}$$

$$= \frac{2}{5}\cdot\frac{H_0\,M}{v^2},$$

where I is the intensity of magnetisation and H_0 the intensity of the field inside the substance of a uniformly magnetised sphere of radius, a, and magnetic moment, M. The equivalent mass moving with the velocity of light would, therefore, have an energy equal to one-fifth of the potential energy of the magnetised sphere if it were held at right angles to a field of its own internal intensity. This result may be applied, *mutatis mutandis*, to a moving molecule consisting of a pair of equal opposite electrons not in absolute coincidence.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

Answers.

Question No. 538.—In a certain town in which the voltage of supply is 460 across outers, 230 being the declared voltage at consumer's terminals, a complaint has been made by a consumer, who states that on switching on his shop incandescent lamps they glow *very* brilliantly for three seconds or so, and then burst, showing that voltage must be considerably more than the declared standard—viz., 230 volts. At the supply station the volts on the night in question were normal, as recorder's cards proved. What is the cause of this? And although consumer was connected between neutral and an outer, is it possible he could have been getting voltage across outers, and, if so, what should be done to make a similar occurrence impossible?

Answer to No. 538 (*awarded* 10s.).—The burning out of the lamps may be due to several causes.

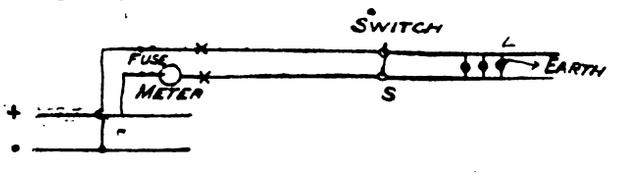

Fig. 1.—Earth on Lamp Fitting on Neutral Side.

1. Fig. 1 represents a consumer's installation, connected across + and neutral, the lights being switched on by double-pole switch, S. Suppose there is a bad earth sag at L, on neutral side of lamps. If there is no other earth anywhere, nothing will happen on switching on. Now, if the insulation of the outer mains is perfect, the positive and negative outer mains will be 230 volts above and 230 volts below earth potential. The neutral being about earth potential, if the neutral is properly earthed at the works, it cannot be much above or below earth potential. Suppose that the neutral is either not earthed, or else earthed (as it is at some stations) through an automatic switch which puts in circuit a resistance of, say, 23 ohms when earth current exceeds 10 amperes. Suppose, now, that on the night in question a bad earth came on negative side. The earth switch would come out and put in resistance (see Fig. 2). The negative outer will now be at about earth potential; the neutral will go up to 230 volts above earth, whilst the positive outer will rise to full pressure—460 volts above earth. If now our consumer puts on his double-pole switch to light up, his lamps will promptly burst, as they will get full pressure across them, as one pole is connected to + (460 volts above earth) whilst the other pole is earthed. If the neutral is permanently

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earthed at the station with a good connection, the neutral will be always at about earth potential, the positive about 230 volts above and the negative about 230 volts below

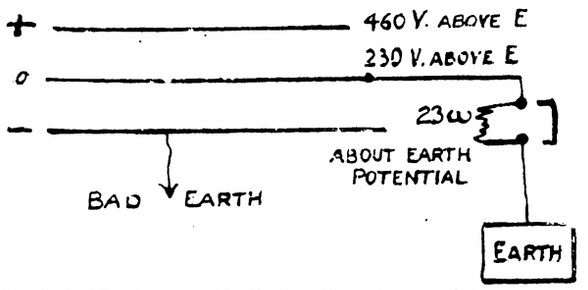

FIG. 2.—Bad Earth on (−) Side, Earth Switch out, or Neutral not earthed.

the earth. In this case, if a bad earth comes on either outer, it will act as a short and blow the fuse. A consumer cannot in this case get full pressure due to an earth on his own lamps. Fig. 3 shows how the same thing may

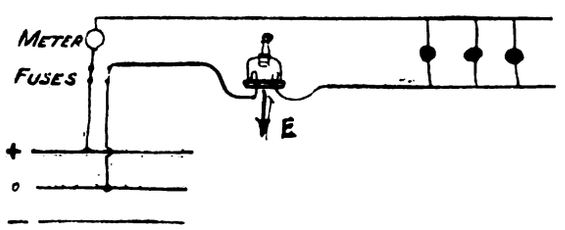

FIG. 3.—Switch Case makes Good Earth, and Switch Blade is not properly insulated from case.

happen in a slightly different manner. Consumer's switch is put on neutral side. Suppose that it is a bad tumbler, with the case alive when switch is on; also the case makes good connection with earth. On ordinary occasions

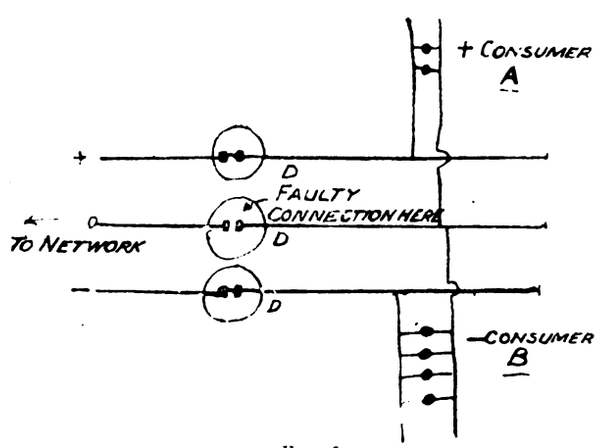

FIG. 4.

nothing unusual will happen on switching on, but if the state of things is as shown on Fig. 2, on switching on his lamps will get full pressure across them, and they will probably burst.

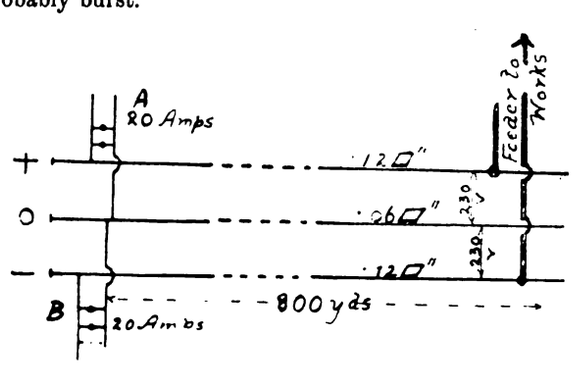

FIG. 5

2. A consumer may get too much pressure across his lamps if the neutral is disconnected. Fig. 4 shows a distributor fed by disconnecting boxes, D, D, D. Consumers A and B have their services (+ and − respectively) taken off this distributor. Suppose by accident the connection is left out of neutral box, D, or does not make proper connection. Services A and B are now in series across the two outers. When B turns on all his lamps they will not light; if, then, A turns his lamps on his lamps will glow too brightly, while B's lamps will only glow dull red.

3. A *short* on one side may cause excessive pressure on the other side (see Fig. 5). A length (800 yards) of ·12, ·06, ·12 square inch distributor is shown, fed at one end by feeding point, F P; at the other end, 800 yards away, are consumers, A and B, on + and − sides respectively. Each consumer takes 20 amperes. Pressure at feeding point, F P, is kept at 230 volts a side. According to the books, a cable working at 1,000 amperes per square inch drops five volts for every 100 yards of cable (lead and return). The drop in this case is:

$$\frac{5}{2} \times 8 \times \frac{20}{120} = 3{\cdot}3 \text{ volts on positive.}$$

$$\frac{5}{2} \times 8 \times \frac{20}{120} = 3{\cdot}3 \text{ volts on negative.}$$

0 0 neutral.

So that pressure at each consumer would be 226·7 volts. Suppose that, now, consumer B got a *short* somewhere, taking, say, 200 amperes for a short time, the pressure at feeding point, F P, being still kept at 230 volts a side:

$$\text{Drop on positive} = \frac{5}{2} \times 8 \times \frac{20}{120} = 3{\cdot}3 \text{ volts.}$$

$$\text{Drop on negative} = \frac{5}{2} \times 8 \times \frac{220}{120} = 36{\cdot}6 \text{ volts.}$$

$$\text{Drop on neutral} = \frac{5}{2} \times 8 \times \frac{200}{60} = 66{\cdot}6 \text{ volts.}$$

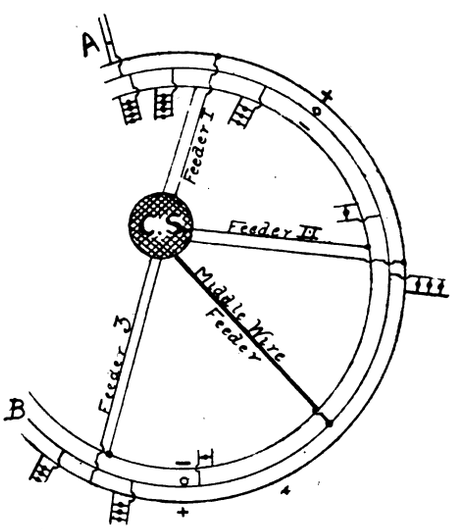

FIG. 6.

B's pressure has now dropped to

$$230 - (66{\cdot}6 + 36{\cdot}6) = 126{\cdot}8 \text{ volts,}$$

whilst A's pressure has gone up to

$$230 + 66{\cdot}6 - 3{\cdot}3 = 293{\cdot}3 \text{ volts.}$$

4. Bad balancing may cause excessive pressure on some parts of the supply system. Fig. 6 shows a central station, C S, supplying by three feeders a long distributor. The distributors connected to the various feeders are very unequally loaded. On Feeders 2 and 3 the positive distributors have the greatest load, whilst on Feeder 1 the negative distributors have the greatest load. The middle-wire ammeter at the station may, however, show perfect balance. The feeders are all run on one 'bus bar at the station, the pressure being regulated by Feeder 3, say. Owing to the greater loading on + side of Feeder 3, the pressure on + 'bus bar would have to be much higher than the pressure on negative bar. At feeding point on Feeder 1 the positive pressure is above normal and the negative pressure below. As the load on the distributors here is greatest on the negative side, the negative pressure will drop still lower, whilst the positive pressure will rise higher still. A consumer, say at A, on + side will have an excess

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of pressure on his lamps. By being more careful over the balancing of each consumer, and by interconnecting the distributors as much as possible, so that the distributors will help each other, a much more uniform pressure may be kept over the supply system. Thus, if A and B are joined together by a length of distributor, each would help the other, and the pressure be immensely improved.—H. B. D.

Answer to No. 538 (*awarded* 7*s.* 6*d.*).—In view of the present practice, rules, and regulations relating to electricity supply on three-wire direct-current systems, it is possible for a consumer connected to one of the outers and balancing wire to get other than the declared voltage of supply. It is not an infrequent occurrence for even the full voltage across the outers to be thrown on the installa-

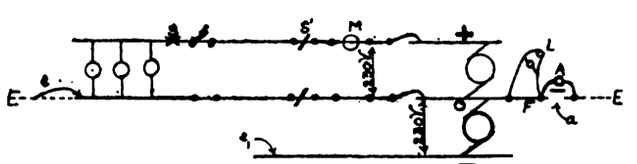

DIAGRAM I.

tion, resulting in burst lamps if the circuits have not been very carefully *fused on the outer*. On many three-wire systems the rule is to earth the neutral conductor at the station end only, and also to insist upon fuses being inserted in both poles of a supply taken off the neutral and one of the outers. The supply company similarly insert fuses in the neutral throughout their system of feeders, distributors, and at consumers' terminals.

Diagram I. illustrates the most usual method adopted of connecting the neutral conductor to earth at the station end, and shows the system in its normal condition with a consumer tapped on to the neutral and positive lead. If a fault develops on the negative outer, the connection thus created between the earthed negative and earthed neutral causes a current to pass

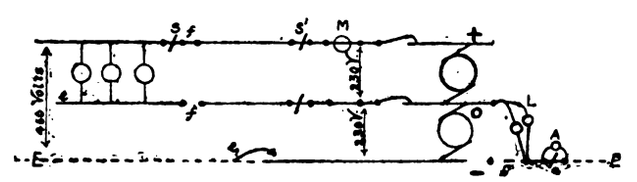

DIAGRAM II.

between neutral and earth through fuse, F, and ammeter, A. The strength of this current will depend upon the resistance of the fault, e_1, and the resistance of the paths between E and *e*, which latter is negligible. When this current attains a predetermined value, say 20 amperes, the switch, *a*, falls, shunting ammeter, A. Fuse, F, is set to blow at a current which varies according to the idea of the engineer or the size of the system. We will assume that it is calculated to fuse with a current of 40 amperes. In Diagram I. is indicated an earth or fault on consumer's negative or neutral wire in one of the lamp circuits. Under these conditions immediately an earth occurs upon the negative *outer*, the small branch fuse, *f*, will break, and later the 40-ampere station fuse, F, if the fault is a bad one,

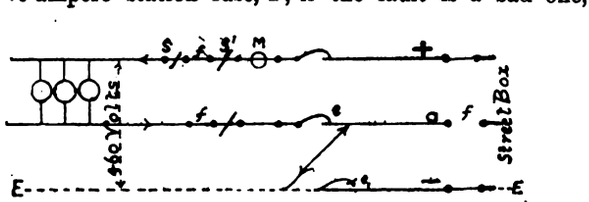

DIAGRAM III.

thus disconnecting the neutral from earth and allowing the earthed negative to take its place. The bank of lamps, L, will now light up. The voltage across the terminals is the same as the potential difference between the balancing wire and earth. E E in diagrams stands for earth or zero potential and the full potential of the system, 460 volts, is now to the + side of this zero line. Diagram II. shows this displacement of the system in its relation to earth, explaining one possible cause of consumer's lamps bursting when switch, *s*, was made. In a case of this nature the voltage across lamp terminals will depend upon the resistance of the faults at *e* and e_1. I have again in Diagram III. sketched the same faults, but this time, instead of being partly on consumer's installation and partly on the supply company's mains, they are both shown on the supply network, and the company are responsible for the damage to lamps and trade.

There is another disorder which sometimes occurs of upsetting the standard voltage of supply without showing on station recorder cards—viz., local out of balance, that cannot be dealt with from the station or even observed from the voltmeters connected to feeding points. By

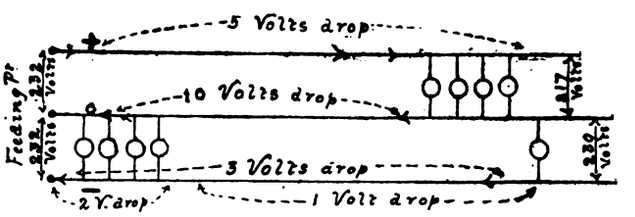

DIAGRAM IV.

proper manipulation and subdivision of the system, balancing can be worked in nearly every instance to give a termiual voltage that conforms to the Board of Trade regulations. Occasionally, however, through the cutting out or disablement of feeders and sections of the network, and sometimes through want of discrimination on the part of the mains engineer, a section of the distributors becomes unbalanced in a way that causes the volts on one side to rise above normal, and on the other side a corresponding drop. Diagram IV. describes how this may occur, and is a practical example with the exception of the voltage values.

To prevent a recurrence of this trouble, the consumer should see that his circuit fuses in the outer are very carefully set to protect their circuits against excessive load, and also have the insulation of his installation periodically tested. The supply company should abolish *all* fuses in the neutral conductor, and have the pleasure of finding and rectifying the faults upon outers without delay. Result: experts required in every department; no duffers need apply.—J. C. S.

Answer to No. 538 (*awarded* 5*s.*).—If the installation in the shop in question is a new one, and the complaint refers to the first time of switching on, the occurrence may be due to the use of lamps of a lower voltage than 230, or possibly even a mistake has been made in connecting the premises to the street mains, the lamps being placed between the outers instead of between an outer and the neutral. If, however, the installation is not a new one and has worked satisfactorily previously, the occurrence is probably connected with the arrangement of the fuses. Suppose, for instance, a single neutral connection is carried through two houses, the lamps in one of which are connected between the neutral and the negative outer and the lamps in the other between the neutral

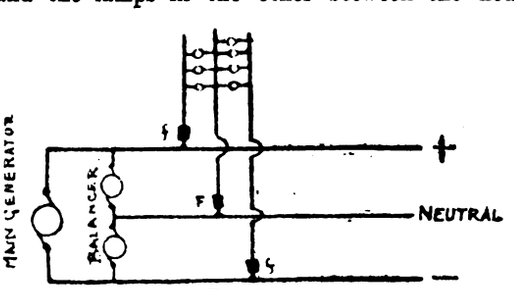

FIG. 1.

and the positive outer. Then should the fuse, F, in the neutral blow, the lamps in one of the two houses are likely to be damaged, for there being only the positive and the negative mains leading back to the station, the whole current passing through the lamps in the one house must pass through those in the other; and if the two numbers of lamps in use do not happen to be alike, the voltage on one side will rise and that on the other will fall until the voltages across the two sets of lamps are

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approximately inversely as the numbers of lamps on the two sides. A slight discrepancy in these numbers would, therefore, be quite sufficient to burst the lamps on the side which had fewest, whilst the lamps on the other side would burn dim and then go out, and remain out until the fuse at F was replaced. If this is the cause of the trouble, its recurrence can be prevented either by putting fuses in the outers only (as at *f*, Fig. 1) and none in the neutral, or by using a given neutral connection for lamps connected to only one side of the system, and a separate neutral connection for the other side (Fig. 2). This last remedy, is, however,

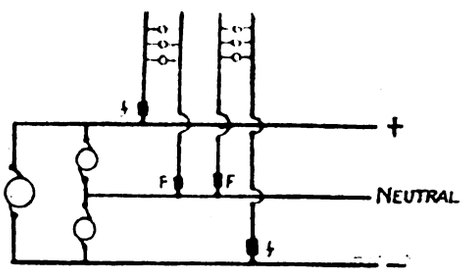

FIG. 2.

not a complete safeguard in itself, for, suppose the neutral at the shop to be earthed, either intentionally or by accident (Fig. 3), then, should an earth occur on the negative outer anywhere near the shop (the lamps in question being connected between the neutral and the positive outer), a large current would flow from the station through the neutral, the fault, and the negative outer back to the station, and might be sufficient to blow the fuse, F, on the neutral connection of the shop. Once this had taken place, a very decided rise in voltage on the lamps would occur, this voltage being anything between 230 and 460 volts, according to the nature of the fault on the negative outer and the earth on the neutral connection

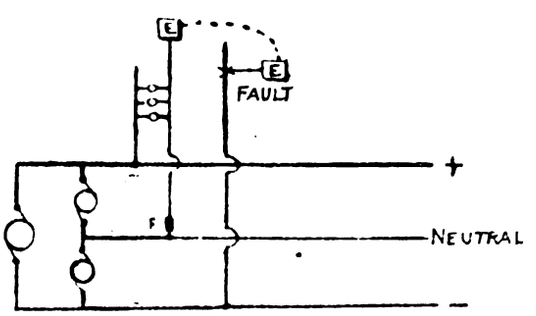

FIG. 3.

in the shop. The cure for this would again be to put all fuses in the outers, for so long as the neutral wire is maintained continuous from the station to the whole of the supply and is well earthed, no large rise in voltage across one side of the system can occur.—*Q.*

Answer to No. 538 (*awarded* 5*s.*).—It is evident the trouble set forth in the above question is due to a fault in the wiring of the consumer's premises. This alone, however, could not bring about the disastrous effects. On three-wire systems of supply having 460 volts between the outer conductors, as is the case in the system under consideration, the Board of Trade require the supply authority to earth the middle wire, so that the potential to earth from either of the outer wires cannot be more than 230 volts. It is usual to connect the middle wire to earth through a switch and fuse, or automatic cut-out at the supply station. As to the advisability of this or any other method of earthing the middle wire, the writer cannot pass an opinion. The subject requires more space devoted to it than can here be afforded. What has happened in the case in question is probably that a fault has developed on the outer wire of the system (either on the mains or on some consumer's wiring), on the opposite side of the system to that on which the consumer who has been unfortunate enough to have his lamps burnt out has been connected. In the sketch this consumer's wiring is shown at A, another consumer at B, and the generating station, G. The station earth connection is E, and the first fault has occurred on B's wiring at E_1. Now, if the resulting earth current has been big, it is probable that the cut-out or fuse connecting the middle wire to earth at E has broken connection, and so the system has now one outer (the negative in sketch) earthed. A's wiring has doubtless developed a fault on the middle-wire side of his lamps, as shown at E_2. Therefore, E_2 is to all intents and purposes now connected to the negative of the system through the earth, as shown by the dotted line. When, then, the lamps at

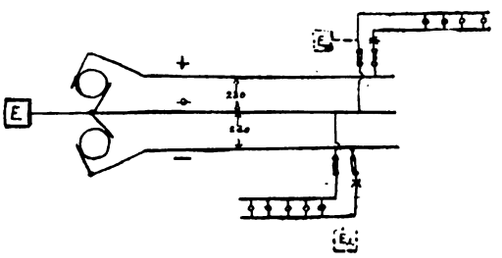

FIG. 1.

A are switched on they will get 460 volts, and so produce the brilliant effect mentioned in question, and the *middle-wire* fuse at all events will blow unless it be stronger than that on the negative of B's wiring.

The remedy for this state of things is to have the wiring at A tested, and the fault located and made good. Of course, this may not have been the exact state of the case, but it is evident that A's lamps have been getting more than 230 volts, and this cannot have occurred without a fault exists on the middle-wire side of his lamps. It may be, however, that the other fault has not been on another consumer's wiring, and that the station earth connection has been good all the time. This state of things has occurred where armoured cable or sheathed cable is used

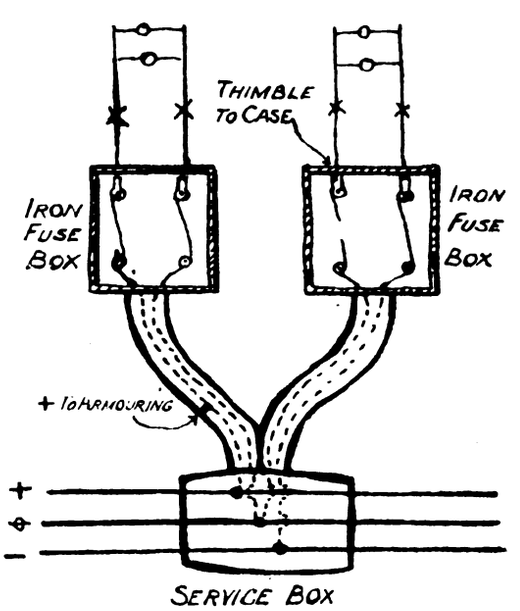

FIG. 2.

for services, and two services run out of one box, but not efficiently earthed, the cables being run in troughs filled with pitch. A fault has occurred on the outer (positive), making the armouring of both service cables "alive" from the positive. Then, at a later date, the thimble on the middle wire of the fuse box on the negative service came into contact with the side of the box, which in all cases was making metallic contact with the armouring of the cable, thus making the middle wire of the consumer's wiring positive, at the same time, of course, blowing the middle-wire fuse in the box. Thus, as soon as the lamps on the negative service were switched on, they got the full voltage across the outers. A diagrammatic sketch will, perhaps, show more clearly this rather curious example.—S. A. C.

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Answer to No. 538 (*awarded* 5*s.*).—There are several possible causes of this lamentable occurrence, and they are as follows, in order of probability: neutral disconnected; misconnection on service; leak; bad local balance.

Neutral Disconnected.—The fact that the querist does not appear to have fathomed the cause leads one to suspect that human ingenuity has covered the traces of a human cause, and that whoever left the neutral link out of the feeder pillar or disconnecting box, whichever controlled the circuit, managed to replace it without those in authority being any the wiser. This disconnection would tend to raise the volts considerably upon the side of the three-wire distributor that had least lamps upon it, and it is likely that if enquiries were made it would be found that this unfortunate consumer was either the only one on his side of the branch circuit, or that he switched on his lamps first, as there appear to have been no complaints made by other consumers, who stood an equal chance of being affected also. It is hardly likely that the rise of volts at a distance from the power station would affect the recorder there.

Misconnection on Service.—Daylight testing may also have had something to do with this, and the service joint or the main branch joint may have been wrongly reconnected so as to give the full outer voltage to this consumer. The same could have been secretly rectified by the person responsible on the trouble appearing. This would not produce any effect on the recording voltmeter tapes.

Leak.—If the free outer of the distributor from which this consumer is fed had gone to earth or been shorted with the neutral (either by leaving fittings disarranged in disconnecting box or from a fault on the cable), there would be a difference of potential of anything up to 340 volts on the other side of the circuit; but this would also depend upon the distance from the recorder whether or not it would show. Other consumers should have been affected also.

Bad Local Balance.—This would want to be really very bad to break lamps in a few seconds, but if caused by a leak on one side, the preceding paragraph refers to it. The balancer at the power station should have something to say in the matter unless disconnected by the opening of the neutral, which has been considered, or by opening the outers between the balancer and the smitten installation.

To make a similar recurrence "impossible," the first thing to do is to be certain of the cause, and the querist should now be able to do this. It should be remembered, however, that in electrical work there is no such word as "impossible"—call it reasonably improbable, perhaps. If a misconnection is the cause, read the culprit the Riot Act and exercise more supervision. If a leak is the reason, get the main tested and overhauled till it is like unto Cæsar's wife for reliability.—B. C. H. J.

PHYSICAL SOCIETY.

At the meeting of this society on Dec. 12, Mr. S. Lupton, vice-president, in the chair,

Mr. S. W. J. Smith exhibited and described **"A Portable Capillary Electrometer."** This instrument is a modification of the form of capillary electrometer which consists of two wide tubes joined by a cylindrical capillary tube which may be horizontal or inclined. The apparatus contains mercury and sulphuric acid of about maximum conductivity suitably distributed in the tubes. A spring key is commonly employed with such an instrument, and keeps the two platinum terminals at the same potential unless the spring is depressed. When the spring is depressed, the terminals are put in contact with the two points the potentials of which are to be tested for equality. In the instrument shown by the author the two wide tubes are sealed at the top to prevent evaporation of the sulphuric acid. The wide tubes are also joined near the top by another tube which allows free motion of the liquids within the apparatus. With this arrangement the instrument is made airtight, and can, if desired, be made air-free by exhaustion of the apparatus before sealing. The distribution of the mercury can be altered most easily by means of a third cross-piece provided with a tap. To prevent the platinum wires forming the electrodes being wetted by the acid, if the apparatus should accidentally, or during transit, be laid on its side or turned upside down, the lower ends of the tubes may be slightly constricted above the ends of the platinum terminals. If the terminals consist of amalgamated platinum foil the constriction is unnecessary. If a spring key is made of brass the contacts frequently become unsatisfactory through surface tarnishing, and if to avoid this the bearing surfaces are made of platinum, the key may be subject to thermo-electric effects. Such a key cannot conveniently be fastened on the same stand as the rest of the instrument, for, unless the stand and the support on which it rests are very rigid, the pressure necessary to depress the spring produces sufficient movement of the meniscus during the act of depression to render the detection of minute changes of surface tension impossible. These difficulties are overcome by using a key consisting of a U-tube closed at one end, communicating at the other with a pneumatic pressure ball, and containing mercury in the bend. Three platinum wires are fused into the tube, so that by squeezing the ball the same change of contacts is produced as by pressing the lever of an ordinary spring key. This form of key can be extended so that a slight pressure applied to the ball makes it work as an ordinary electrometer key, and greater pressure reverses the contacts between the terminals and the points under investigation. With such an arrangement the sensitiveness of the instrument is doubled, and by using a microscope magnifying 50 diameters a potential difference of $\frac{1}{10000}$th volt can be detected without difficulty. The instrument, used as a surface-tension galvanometer, is more convenient than an ordinary galvanometer with a magnetic system because there is no suspension, no lamp and scale, and practically no levelling.

Dr. R. T. Glazebrook congratulated the author, and said that workers with the capillary electrometer would appreciate the improvements introduced. He said that the author had given the minimum E.M.F. which the instrument could detect, and asked what was the maximum E.M.F. which could be safely applied. He referred to the advantages of the mercury keys exhibited, and remarked that, by their use, many difficulties were obviated.

Dr. Lehfeldt said the mercury keys were improvements on those used by Prof. Onnes. In these keys the contacts were changed by the motion of mercury brought about by tilting. The tubes containing the mercury were exhausted to prevent oxidation.

Mr. Smith, in reply to Dr. Glazebrook, said that the maximum E.M.F. should not exceed half a volt.

The society adjourned until Jan. 23.

FORTHCOMING EVENTS.

SATURDAY, DEC. 27.

Royal Institution.—At 3 p.m., Christmas lecture. Prof. H. S. Hele-Shaw on "Locomotion."

TUESDAY, DEC. 30.

Royal Institution. — At 3 p.m. Prof. Hele-Shaw on "Locomotion—the Road Motor."

THURSDAY, JAN. 1.

Royal Institution. — At 3 p.m. Prof. Hele-Shaw on "Locomotion—the Motor on the Rail: No. 1, Steam."

Rontgen Society. — At 8.30 p.m., ordinary meeting. Paper: "X-Ray Work in Private Practice," by Dr. G. M. Lowe.

FRIDAY, JAN. 2.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "Marine Boilers," by Mr. H. M. Roathwaite.

SATURDAY, JAN. 3.

Royal Institution. — At 3 p.m. Prof. Hele-Shaw on "Locomotion—the Motor on the Rail: No. 2, Electricity."

APPOINTMENTS VACANT.

City Electrical Engineer, Dundee Town Council. £400 per annum, Dec. 27. See advertisement in last issue.

Assistant Electrical Engineer, London County Council Tramway Department, £500 per annum, Jan. 5, 1903. See advertisement in last issue.

Electrical Engineer, Morley Town Council, Dec. 27. See advertisement in last issue.

Senior Electrical Engineer, Sanitary Commissioners of Gibraltar, £300 per annum, Jan. 20, 1903.

Mechanical Electrical Engineer, Croydon Mental Hospital, 35s. per week, Dec. 30. See advertisement in last issue.

Skilled Mechanic, as instructor, Dec. 29. See advertisement in last issue.

Foreman Fitter, Ipswich Corporation, £2. 10s. per week, Jan. 10. Full particulars may be obtained from Mr. Will. Bantoft, town clerk, Town Hall, Ipswich.

Kirkintilloch.—Mr. A. W. Stewart, Glasgow, in a report submitted to the Town Council states that to light the town and provide a two-cell refuse destructor (the heat from which would generate the steam for a 112-h.p. engine) would cost £10,900. At 6d. per unit there would be a slight loss in the first two years, but after that there would be a profit, which would go to reduce the price. The refuse destructor would deal with the burgh's refuse at a cost of 2s. 2d. a ton, excluding cartage. The Council have resolved to apply to Parliament for a provisional order for the production and supply of electricity within the burgh.

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CONTENTS.

Notes	901	Legal Intelligence	919
An Electric Steering Gear	905	Companies' Meetings and Reports	919
Heating of Transformers	906	New Companies Registered	921
On Electrons	907	Contracts for Electrical Supplies	921
Questions and Answers	909	Traction Notes	922
Physical Society	913	Lighting Notes	924
Forthcoming Events	913	York Electricity Works	927
Appointments Vacant	913	Provisional Patents, 1902	927
Marconi's Transatlantic Telegraph	914	Complete Specifications	927
Correspondence	915	Companies' Stock and Share List	927
Some Limits in Heavy Electrical Engineering	915	Traffic Returns	928
Toddie's Electrocution	917		

TO CORRESPONDENTS.

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MARCONI'S TRANSATLANTIC TELEGRAPH.

The end of the year 1902 will be notable to electrical engineers for all time, due to the fact that in the last weeks of the year the first Transatlantic message has been transmitted by means of etheric waves. It has been known to all that experiments in this direction have been conducted between Cape Breton, in Canada, and Poldhu, in Cornwall, during the past few weeks, and there have been numerous rumours as to the successful or unsuccessful issue of these experiments. It is now assured that Signor Marconi has overcome the technical difficulties of transmitting signals between these two places, situated some three thousand five hundred miles apart. The congratulatory messages commenced to pass between the two stations on Sunday, when Signor Marconi sent a message to our King and to the King of Italy. In acknowledging the first of these, King Edward congratulates the inventor on the successful issue of his endeavours, and remembers that the first experiments with the system were conducted from the Royal yacht "Osborne" in 1899. The whole of the scientific world will join with the King in these congratulations on results secured after comparatively few years of investigation. The question now arises as to the commercial value of the system as a means of communicating between continents, and of its capabilities of dealing with the vast amount of work which will be found for it, if it reduces the cost of telegraphic communication. On the technical side the difficulties are great when such large powers are used at the transmitting stations as have been found necessary in the present case. It must be remembered, however, that criticisms on technical grounds have to be made by experts who are not fully informed as to the actual results obtained by Signor Marconi and as to his methods. Obviously, the difficulties of syntonising for the sake of secrecy, and in order to increase the number of messages which can be sent simultaneously from the one transmitting station, are great. The past success, however, of the inventor in overcoming many difficulties, argues well for his chances of solving these other problems. The hardest fight before any company using wireless telegraphy, is that of overcoming the opposition due to vested interests. Leaving the cable companies on one side for the present, there is ample evidence in the papers of the last week or so that our own Government and the Government of France are by no means helping forward the new system of telegraphy. In France the police have recently seized and sealed the signalling station at Cape Hogue, near Cherbourg, which was being erected by Messrs. Popp and Branly. The company for which this was being constructed are really engaged in experimental work, and it seems somewhat early days for the French Post Office to be prosecuting them for infringing the State monopoly over telegraphic communications. In this country the Post Office refuse to receive for transmission over their land wires any messages to be afterwards transmitted through stations of the Marconi Company. We are pleased, however, to find that our Government has not gone to the great length of preventing experiments. As a marked contrast to the above comes the action of the Canadian Government in concluding an agreement with the Marconi Company on terms which, if they can be carried out, will be favourable to both parties. The agreement reduces by one-half the cost of transmitting messages from England to Canada, and allows messages received at the Glace Bay station free transmission over the land lines in the Dominion. Without, however, there being some similar arrangement in this country the commercial development can hardly proceed, as to send the messages to and from

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Cornwall by post would cause undue delay. The situation reminds us very much of what has happened in the case of the telephone industry, and we trust that when our Government decides the great question of its policy respecting etheric telegraphy, the blunders made over telephony will not be repeated. The question really becomes an international one, and there is an opening for some interesting legal cases to decide whether the man who first makes use of the ether for transmitting signals between any two distant points can claim the sole right to continue to do so. We would conclude by again congratulating Signor Marconi on his scientific success, and by wishing him equal success in the commercial working of his Transatlantic system.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ARC LIGHTERS.

SIR,—I feel that I must reply to two of the contributors of answers to Question 537. In the first place, "A. J. J. G. W." has got the field shunt idea from a Brush arc lighter, which is very different from a Thomson-Houston. Secondly, "M." has not had anything to do with Thomson-Houston machines when he speaks about the coils being cut out by the brushes, which I agree that the book he mentions would lead one to suppose, whereas that only occurs when the machine is working at its maximum, a condition at which they are only rarely run. I am well aware that a four-volt machine will either have a different field, speed, or number of inductors than a 400-volt machine, so that I cannot see any analogy. If the coils are cut out of circuit, how is it that these machines get very hot when run on light loads? It is certainly not with the coils being cut out, as this would have an opposite effect. "Q.'s" reply would be much nearer the mark.—Yours, etc.,

A. W.

SOME LIMITS IN HEAVY ELECTRICAL ENGINEERING.*

BY JAMES SWINBURNE, PRESIDENT.

(Continued from page 843.)

Steam-Engines.—The primary question in all heat motors is: What temperature range is available? In the case of a steam-engine there is enormous waste of mutivity†—to use a variation of Lord Kelvin's convenient term—in boiler flues. We burn carbon and hydrogen, capable even with air of giving a temperature of some 1,500deg. C, and the heat is degraded down to some 200deg. C.—that is to say, instead of getting the heat with a mutivity of about 0·825, we degrade it down to, say, 0·35, a clear loss of 0 45 out of 0·8, or 56 per cent. This degradation is apart from the efficiency; the efficiency is concerned with the loss of heat up the chimney. The higher limit in large modern reciprocating engines may be taken roughly at 600deg. A. (327deg. C., or 620deg. F.). Above this there is difficulty in lubrication, and to some extent weakening of the material. The pressure corresponding to this temperature for saturated steam is out of the question, and the pressure may be taken at, say, 12·5 magadynes per square centimetre or 12½ atmospheres,* or 200lb. per square inch, and steam leaving the boiler superheated to 600deg. A. does not get at the cylinder lubrication at that temperature. Our limits in the steam-engine are thus pretty clearly defined. The pressure is the essential factor. Superheating is not much good in the way of getting higher mutivity in the boiler, nor is it very important in getting much more energy into the steam This is shown diagrammatically in Fig. 1. The vertical ordinates are absolute temperature, but in Centigrade degrees, and the horizontal distance represents the quantity factor corresponding with mutivity corresponding to various temperatures. Thus if one wants to find the value of some heat at, say, 600deg. absolute with a lower limit of 200, the line starting from 200 is followed till it cuts the horizontal 600deg. line. The other ordinate gives the mutivity 0·66.

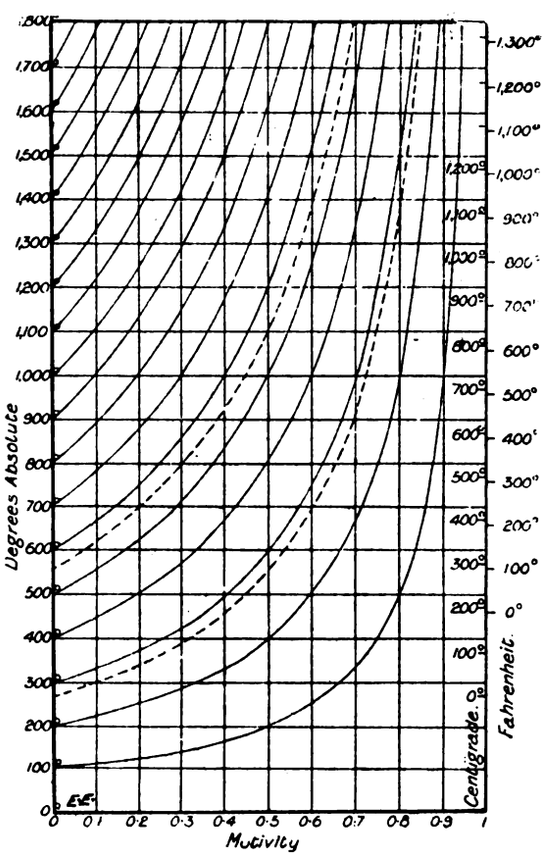

FIG. 5.

* Inaugural address delivered before the Institution of Electrical Engineers.

† MUTIVITY.—The term motivity was introduced by Kelvin (*Phil. Mag.* 1879, Math. and Phys. Papers, I.), but is not used much now. The expression "available energy" is well known and clear, though through an obvious slip in the first edition of Maxwell's "Heat" it was called, but not confused with, "entropy." The term motivity suggests, according to the modern fashion in nomenclature, a specific quantity, but I have no right to use it in a new sense. I therefore suggest "mutivity," which is a contraction for "mutativity," to denote the changeability or convertibility of the heat into other forms of energy. The mutivity is thus a number equal to $(\theta_1 - \theta_0)/\theta_1$, which is less than unity, so that the mutivity is the available energy per joule. The energy integral of the mutivity is thus the available energy. The curves (Fig. 5) give roughly the

* COMMON-SENSE SCIENTIFIC UNITS.—To talk of boiler pressure in magadynes per square centimetre may seem strange. We, the electrical engineers, have an almost perfect scientific system of units so that the quantities hang together in a sensible way. No one who once understands the C.G.S. system ever wants to work any other. If a man never wants to apply thermo-dynamics to anything but British steam-engines, and never wants any foreigner to read his work, and never wants to know what is done outside this small island, the English system may suit him if his time is of so little value that he does not mind a tangle of useless coefficients. If, however, anyone wants to do quantitative work—and all such work should be quantitative—the ordinary units and tables in thermo-dynamics are terrible. In England we measure heat in thermal units with no name, and energy in foot-pounds, and power in horse-power. Our thermometer is graduated without any apparent relation to anything. It has been said that its zero is the temperature of ice-cream, and its 100 that of the fevered patient who consumed it. Mr. Ram has pointed out that each degree really corresponds to the expansion of mercury by a ten-thousandth part. Our pressures are in pounds per square inch less the magic number 14·6967, but we take condenser pressures as the difference between the number of inches of mercury read and 29·92. These measurements involve a huge amount of unnecessary arithmetic every time they are used. This means waste of time and chance of inaccuracy. The French are by no means beyond reproach. Their pressures are either in atmospheres, atmospheres less one, or in millimetres of mercury. The Centigrade scale is just as absurd as the Fahrenheit. Even with 273 added, it has no numerical relation with anything. Some day we will perhaps have an absolute scale. But practically all thermodynamical workers fail to realise that heat is really energy, and have a special unit of heat depending on the specific heat of water which has nothing to do with anything else. We, as the most scientific of the engineers, ought to use our own scientific and rational units, so that the horse-power, foot-pound, pound per square inch, poundal, calorie, British thermal unit, inch of vacuum, and all the thousand and one silly weights and measures may be be helped into the limbo of disuse.

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temperature, so that the area is the energy of a gramme of steam—that is to say, the energy in the gramme of steam at any point in the cycle is the part of the whole area included in a horizontal line from that point to the left, and a vertical line to the zero line at the bottom of the diagram. The figure A B C D E is thus the energy taken by the steam, of which A B C F G is used and the rest wasted. The motivity scale for a lower temperature of 338deg. A. shows the small value of the energy taken in. This curve is for temperature 473deg. A. and 338deg. A., 200deg. C. and 68deg. C., and the exhaust is opened at 382 A, causing the wedge-shaped loss on the lower right-hand corner. The expansion is taken as adiabatic without

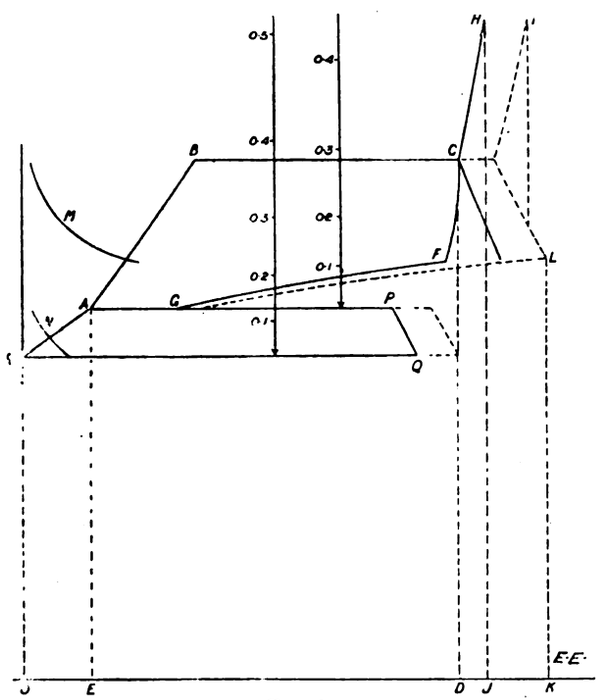

FIG. 1.

cylinder cooling. To the right is shown dotted to the same scale the ordinary temperature entropy diagram.*

The mutivity scale shows that superheating up to H on the energy or I on the entropy curve gives little advantage from the mutivity point of view, while the extra energy C H J D is small. Superheated steam thus carries but little extra energy, and carries that little without much extra mutivity. But superheating steam is very important for ordinary engines, as it reduces the expansion condensation, and, what is much more important, the cylinder condensation. It has been proposed to reduce cylinder condensation by coating the piston and cylinder cover. Perhaps enamelling them would help. The walls even in a short fat cylinder give most trouble. Hadfield has proposed alloying the surface. The alloy would have to be mechanically suitable, and ought to have low specific heat and low conductivity. Jacketing is also used to reduce condensation. As long as the cylinder is hotter than the steam there can be little communication of heat; the trouble is, that if the surface is wet evaporation cools the metal. The jacket should, therefore, keep up such a flow of heat through the cylinder walls that there is no deposit from expansion condensation, so that the walls never get wet. Pouring heat through a cylinder wall into colder steam is itself an uneconomical process, meaning increase of entropy. Superheating proves to be the easiest and most economical way of dealing with a source of waste that is inherent in a reciprocating engine. But the weight of steam should not alone be used in comparing the performance of an engine with superheated steam with another. Throughout the pressures in common use a kilogramme of standard steam takes sensibly the same heat to evaporate it, and there

* ENTROPY.—There is an unfortunate misconception as to the nature of the function entropy in most treatises on the steam and gas engine, and in the use of the θ,ϕ diagram. Clausius defined entropy so that

$$\int \frac{d\,H}{\theta} < \phi.$$

The whole idea of entropy is that in every change in nature it must increase, otherwise the change cannot occur. In the hypothetical but impossible case of reversibility

$$(\int) \frac{d\,H}{\theta} = 0,$$

where the brackets mean that the integration is round a closed cycle, and

$$\int \frac{d\,H}{\theta} = \phi.$$

The study of reversible changes occupies most of the space in books on thermodynamics, just as the study of frictionless mechanisms throws light on engineering problems; but, though it is numerically correct in the limiting and purely hypothetical case of reversibility, the equation

$$\int \frac{d\,H}{\theta} = \phi$$

as a definition of entropy is fundamentally wrong. It gives a wholly wrong notion of entropy. The temperature entropy diagram was, I believe, first brought forward by Gibbs (*Trans.* Connecticut Acad. II., 1873, p. 309). This paper is difficult to get in English, but a translation is accessible in "Thermodynamische Studien," Gibbs, published by Engelmann. Here the author is definitely dealing mainly with hypothetical reversible processes and the properties of fluids, and such things as perfect gases, and anyone reading the paper alone would get a wrong idea of entropy; but it was rather meant to clear the ideas of students, and did not affect engineers. We really owe the practical use of the entropy diagram, and the insight we have gained through it in spite of the confusion as to entropy, to Macfarlane Gray. In his papers, "The Ether-Pressure Theory of Thermodynamics" and "Rationalisation of Regnault's Experiments" (*Proc.* Inst. Mech. Engin., 1889, p. 379), the definition of entropy is as faulty as Gibbs's; but he again is discussing the properties of steam and dealing with reversible processes, so again there is no numerical error. In discussing the θ,ϕ diagram of an engine, however, it is usual to define the entropy by the equation $d\,\phi = d\,H/\theta$, which is wrong, and to lay down that the area of the θ,ϕ is equal to that of the p,v diagram (divided by the mechanical equivalent of heat). This incorrect definition has no doubt given rise to the notion that entropy is the factor of heat corresponding to temperature. I think Zeuner first called entropy "heat weight," a confusion of thought which is constantly cropping up. The whole object of engine analysis is to trace irreversible changes. If the diagrams were of the same area, after multiplying by the wholly unnecessary coefficient, the engine would be reversible and perfect, and there would be no use in investigating it. The badness of an engine in its way of using its working fluid should come out in terms of the excess of the θ,ϕ over the p,v diagram. In thermo-dynamics there is a constant tendency to confusion between the working substance and the reservoirs. Entropy is a function that essentially concerns the reservoirs. Thus a perfect engine would allow no increase of entropy. If an engine and a boiler were perfect, the entropy taken in by the water from the hot gases would be equal to that given to the condenser water. There are various increases of entropy in practice. The most important are increases of entropy due to adding feed water below the boiler temperature, wire-drawing steam, heating the air by convection and radiation of steam-pipes and engine, conduction between cylinder walls and steam, conduction through cylinder walls from jacket, sudden expansion into condenser, and mechanical friction throughout the mechanism. The importance of each growth of entropy depends on the temperature. The temperature integral of the irreversible increase of entropy would be an area on a real θ,ϕ diagram. The total area of the θ,ϕ diagram would then exceed that of the work of the engine (or of the p,v diagram if the mechanical friction is excluded) by this area, which would represent the badness of the engine. To give a clear idea of the value of this loss the mutivity should come in as a coefficient right through. This is done graphically by cutting off the bottom of the area. We should, therefore, localise all increases of entropy in an engine, and then try to prevent them.

It may be urged that the definition of entropy with which I find fault is given not only in engineering text-books, but that it occurs in nine out of ten treatises on mathematical physics. That is so; most writers define entropy incorrectly. As the mathematical treatment of reversible processes naturally occupies most of their attention, an incorrect definition gives no quantitative error until irreversible processes are considered. The mathematical physicist then generally, perhaps consciously, rises to accuracy, but sometimes he does not. Adiabatic and isentropic are thus also defined as synonymous. The isentropic or curve of constant entropy does not coincide with the adiabatic or curve of no passage of heat except in hypothetical reversible changes. On a p,v diagram the adiabatic curve may be anywhere between the isentropic and the isothermal coinciding with either in a limiting case. Unfortunately also entropy fell among pedagogues. The pedagogue takes $d\,\phi$ as a leading illustration of an exact differential. It is extraordinary that out of the whole domain of physics he should select the one differential whose conspicuous characteristic is that in nature it never is exact. Perhaps he has a fellow feeling for it. It is sometimes stated that if the quantity is a single valued function of the co-ordinates, its differential is exact, and that is what exactness means, which is also inaccurate. This not only shows that it is infinitely easier to work with mathematical symbols than to get a clear grasp of their physical meaning, but it emphasises the extreme difficulty and slipperiness of thermodynamical work in particular.

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is such a great fall of mutivity in the flues that a boiler can evaporate at one temperature nearly as economically as at another, so the weight of steam used is a measure of the badness of the engine. But superheated steam takes more heat to produce it, so that a boiler with a given coal consumption and chimney temperature gives less.

Our upper limit in the engine is thus somewhere about 473deg. A. for saturated steam with a mutivity of, say, 0·285, with a little addition up to 600deg. A., with an average mutivity of, say, 0·37. An extra temperature or "superheat," as it is somewhat barbarously called, of 127deg. thus would give very little advantage if it were not for the inherent badness of the engine. I am here dealing with large high-class engines. Superheating is of very much greater advantage with the ordinary small and middle-sized engine in common use. The lower limit is, however, of great importance. If we could work down to the temperature of the air we would gain greatly. We cannot do so because the engine would have to be enormous. The $\theta\ v$ curve is shown at M to a small scale. It shows the volume becoming unmanageable. A great deal of condenser water would also be needed. A two-fluid engine is theoretically possible. We want a second fluid which gives a higher pressure at, say, the temperature of a condenser, or, better, at the temperature at which it is inconvenient to expand steam any further. I have taken sulphur dioxide as an example, because most of the data are available, and because it is being tried in Germany, though I have not seen any accounts of results. If a higher temperature than the one I have taken were used, the lower right-hand corner of the steam diagram would be saved. The lower closed area, A P Q R, is the energy curve of the corresponding weight of SO_2. I have only considered the internal energy, or U, of the fluids for simplicity. It is accurate enough for the purpose of explanation. The curves are not minutely accurate either. The additional area, A P Q R, is thus, theoretically, clear saving due to the use of SO_2, which enables a second engine of reasonable size, as it were, to continue the useful expansion down to a temperature little above that of the air. The θ,v curve N, which takes the place of the continuation of M, shows graphically the convenience of going to a second working fluid. How far such saving will pay will be proved to us in Germany. There appears to be room for economy.

The turbine is under the same limit as regards pressure—in fact, high pressures are perhaps even more difficult to use—and superheating does not, as already explained, seriously increase the mutivity of the heat taken in by the boiler. The turbine is almost perfect thermodynamically. There is practically no variation of temperature of any part of it, so there is no growth of entropy by conduction. Wire-drawing produces kinetic energy which is wholly convertible into work. There must be increase of entropy, however, through eddies and steam friction. In fact, one aim in design is to avoid the turbine being a large "porous plug." There is no admission condensation, and the increase of entropy of the steam passing through should prevent any expansion condensation. If superheating is necessary to prevent expansion condensation, it is the highest compliment to the designer, for it shows the wire-drawing due to irreversible expansion and that due to the leakage and the axial conduction of heat taken together are not enough to prevent expansion condensation, and the accompanying friction and entropy production near the exhaust end. Comparatively little superheating decreases not only the water, but the heat consumption of a Parsons turbine.

One of the chief disadvantages of steam-engines for stations with small load factors is the difficulty of storing energy so as to get uniform boiler load. Batteries are no longer used for this, and the difficulty reduces the value of steam in comparison with the gas engine. Mr. Druitt Halpin has proposed and used "thermal storage." Lagged vessels are filled with water raised to the temperature of the working steam. This arrangement, however, is not isothermic—that is to say, to get out the energy the temperature must fall. What is wanted is a reservoir containing something which undergoes a physical or chemical isothermal change—for instance, a substance that fuses at the right temperature, and has a high latent heat of fusion, or a substance which, like sulphur, changes allotropically with considerable change of internal energy, at a suitable temperature. Unfortunately, there is no substance within the range of practical engineering. Moreover, the storage is on the wrong side of the engine. To store heat with a mutivity of only some 0·35 is not so promising as to store some higher form of energy. The secondary battery thus begins with an apparent advantage. The difficulty of storage is another drawback to the steam-engine, and gives the gas-engine a further advantage.

Before leaving the steam-engine, it may be in place if I bring before the Institution a recommendation of the Institution of Civil Engineers that in future the British thermal unit be written B.Th.U. instead of B.T.U., as B.T.U. is used for "Board of Trade unit."

(To be continued.)

TODDIE'S ELECTROCUTION.

BY B. C. H. J.

It is now well known why it happened, and the reasons for the happening were these.

Toddie had successfully held the position of youngest son to his parents for a long, long time—ever since he could remember, in fact—and he had always been led to believe that he was quite the most important and perfect personage in the world. This usually becomes part of the religion of children who are much petted, and very few things can happen to disabuse their minds early of this belief.

One of these very few things, however, happened to Toddie, and the initial and most primary beginning of it was the Event which took place one day; which Event had been looked forward to by the adults among Toddie's worshippers with a certain mixture of anxiety, pleasure, and curiosity. And when that Event had become a thing of the immediate past, the Idol Toddie was overthrown and replaced by another Idol without a name, and with no nose to speak of, but fitted throughout with lungs of an unnecessarily strident composition.

Toddie could not understand his new position at first. Why did not his papa make much of him and bring unto him tribute, in the shape of sweets, as was his wont but a few days ago! And why might not Toddie see his mamma?

When at last he was allowed to visit her, he was shocked to find that a little pink baby, that howled and bubbled alternately, was the only person considered to be of interest in the room. He, even he himself, was supposed to assume the *rôle* of worshipper. He who had hitherto been the only and original household god!

Small wonder, then, when Toddie retired to the Capital of his tottering Kingdom—the nursery—that his eyes were full of tears and his lips were quivering, not only for the loss of his devotees, but for the rank blasphemy contained in the words, "Sulky little beast!" which had caught his ears as he disconsolately left the room. He would never forgive brother Bert for that—Never!

The nursery was very dull that afternoon. The rocking-horse looked kindly at him, it is true, but only when he got in the direct line of vision of its sole remaining eye. No loving voices shouted for "Toddie, you pirate!" or "Toddie, darling, where are you?" only the howls of the thrice-times ridiculous baby rang through the house. Toddie hoped that it would die, and in his agony of mind appended a requisition to that effect to his bedtime prayers.

Before that time, however, a ray of sunshine illumined his gloom. Toddie knew the ray in private life as Unken Henwy, and was very glad to see him, even though his uncle's fealty towards himself seemed to have been lessened after an audience with the rival Idol.

"Well, Toddie!" said the faithless one, "you don't look such a healthy little vagabond as usual. I hope you haven't tumbled across the key of the pantry again?"

"I'm vewy well, thank 'oo, and I don't 'teal jam now,

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Unken Henwy," and Toddie clambered on to his knee. "Temme a tale, pease."

So Toddie's Uncle told him of his recent visit to America, of the wonders to be seen there, of the real niggers and genuine Chinamen that could be seen every day in the streets for nothing, and of what the policemen did to naughty little boys in that country who stole their mothers' jam. This interested Toddie immensely, and he persuaded his uncle to repeat in detail the course of punishment, which was really an account of how criminals were executed at Sing Sing jail by means of electricity, the narrator substituting "naughty little boys" for "murderers" for educational reasons.

"Put him in a chair," repeated Toddie, "shave his head and put a 'ponge on it. Tick his feet in water wiv salt in it, and tie ve wires to ve 'ponge and ve water-basin. What are ve wires like, Unken Henwy?"

"Oh, like—er—just like that piece of window cord."

"Unken Henwy, I fink I should like to be a 'lectwic hangman when I gwow up," said Toddie, as his uncle was called downstairs.

When Toddie went to bed that night he lay for a long time thinking. His downfall still weighed upon his mind, and being of an eminently practical nature he debated within himself the best way of regaining that which he had lost. With the newly-acquired knowledge in his mind, he fervently wished he had the baby in the fatal chair at Sing Sing jail, and he finally went to sleep and dreamed a happy dream of being the "'lectwic hangman" at that place, with the baby condemned to death for howling without asking permission.

The next day was but a continuation of Toddie's trials. The visitors who called only cared to see the new baby—that is, all but one, and he was the man who came periodically to do certain mysterious things to a big box that lay in the coal cellar. Usually Toddie was too disdainful to notice him, but to-day his spirit sought companionship, and as the man had not seen the superior attraction upstairs, who knew but that he might become a worshipper at his own private shrine.

Toddie sought the coal cellar, and asked the man his name and how old he would be next birthday, which according to Toddie's experience of men and manners was the only true and correct way of opening conversation with a total stranger.

"I'm Mr. Lord-knows-who," answered the man genially, "and I shall be eleventy-twelve next year but one."

"Oh, indeed!" said Toddie, who could only count up to twenty, "and what are 'oo doing wiv ve box?"

"That's the electric battery that rings the bells, and I'm feeding it," as he put some salammoniac into the cells.

Toddie gasped with emotion. "A real 'lectwic one. Are'nt 'oo af'aid of getting killed?"

"No," said the man; "I've had the measles, you know."

"I've had ve measles, too, so it wouldn't kill me either. Would it kill anybody who hadn't ve measles?"

"Yes," replied the man as he finished mixing the electrolyte; "kill 'em dead. See that cockroach," he continued, as he attached a couple of pieces of wire to the terminals of the battery, and touched a promenading insect with them; "watch him die!" And, sure enough, the cockroach seemed to have yielded up the ghost after the contact, which, perhaps, was not too gentle.

"Why didn't 'oo 'tick his feet in salt water and put a 'ponge on his head?" enquired Toddie. But the man had finished his work, and knowing naught of electrocutional etiquette as practised at Sing Sing, said something about salting its tail instead, and went away.

Here, then, was a Sing Sing to hand; and Toddie stood like a little statue in thought for five minutes, trying to make his mind up about something. This was a very difficult matter, inasmuch as Toddie loved his mother, and had a strong suspicion that if he acted according to the dictates of his inmost soul she might not like it. This was the only thing that kept him from an instantaneous decision upon the subject, for he had jealousy enough in his little nature to condone the killing of anything; and, according to his point of view, a squalling baby and a cockroach were much upon the same social level. But he would not decide upon the instant, so returned to his nursery, and was having a hilarious time with a Christmas-tree trumpet and a real kettledrum six inches in diameter, when a woman whom he had never in his life seen before rushed in, took his instruments of music away, smacked him on the side of the head, and then explained that he was waking the baby, and better not. After which she returned to her lair.

Toddie wept with the pain and ignominy of what had taken place, and, weeping, made up his mind. This last straw had broken the camel's back for good; and Toddie arose with deep and vengeful purpose, and went to the scullery for a wash-hand basin, to the larder for some salt, to the odds-and-ends box for some "wire," while his little nursery basket-chair and milk jug full of water completed the apparatus. These were all taken down to the coal cellar at judicious intervals; as Toddie judged that Mahomet, being the lighter of the twain, had better come to the mountain. The servants were busy about the house, and his father and brothers were out, so his nefarious designs were not subject to unkind interruptions.

All alone in the coal cellar, with only the light from the street grid to work by, Toddie felt as he had never done before, even in the darkest hours of nocturnal jam-pot raids; but the sting had not departed from his ears, nor the jealousy from his heart, and he fixed the window cords to the terminals of the battery, even as the man had done the wires that same morning. To the end of one piece he tied the sponge, and the other cord was tied to the handle of the basin in which he had put salt and water—all in accordance with his uncle's version of Sing Sing practice.

Nothing now was wanted but the sacrifice, and Toddie went up to where it lay in state. The hateful nurse who had boxed his ears was in the room, he could hear her talking to his mother. He would wait until she came out, though he was rather afraid of his mother seeing him, and he was not sure if the baby would be light enough for him to carry.

The nurse came out at last, and went downstairs. Toddie crept to the door and peeped into the room; his mother seemed to be asleep, and the baby was quietly watching the ceiling. The moment seemed an opportune one; so Toddie went in on tiptoe, hauled the victim out of its cot and dragged it to the corridor, where, by judiciously stripping it of wraps and superfluous clothing, he was enabled to pick it up and carry it downstairs to the fatal coal cellar. Baby took things very aimably, and coo'd in a manner that would have melted a heart less implacable than was the heart of Toddie at that time. No one heard the faltering footsteps as they neared the sacrificial spot, and they became very faltering, indeed, towards the end of the journey—according to the well-known formula that after fatigue point has been reached the weight of a baby increases in proportion to the square root of the distance with the power factor of unity.

Toddie put his burden in the chair by the side of the water-basin, and took its remaining shawl off. There seemed to be no need to shave its head, as it had from all appearances only just been shaved, and was as bald as any electrocutioner could have desired. Just then he heard a loud knock at the house door, and fearing that it might be another worshipper to the hateful shrine made haste with his preparations. He placed the baby's feet in the water and put the sponge to its head, which proceedings made the victim squeal vigorously, but it seemed to be no nearer death than before. Toddie could not understand this, and squeezed the sponge well down with no better result. Baby only howled the louder; and while Toddie wondered at the length of time it took to die, he was startled by a shriek just behind him, and the nurse appeared with his uncle closely following. The nurse did not waste words, but picked the baby up, and ran upstairs shouting for hot towels, and Toddie and his uncle were left alone.

"Toddie," said the latter, trying to look serious, "you young rascal, what were you trying to do to baby?"

"Pwactising 'lectwic hangman," explained Toddie dolefully, acting on the time-honoured principle of "tell the truth and scorn the devil when found out."

Uncle Henry took him upstairs, and by means of sympathy judiciously administered laid bare the canker

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which had fed on Toddie's heart since the unfortunate advent of the baby; and notwithstanding the blood-thirsty intentions of the would-be executioner, he did his best to prevent the paternal wrath from falling too heavily upon Toddie's head—and spine.

It was a lesson to Toddie's parents, though; and it will be readily understood to what extent his power has been regained when it is known that he now shares the household throne with his baby brother, the like of whose friendship for one another causes the reciprocated feelings of Messieurs Damon and Pythias to become by comparison even as viprous hatred.

LEGAL INTELLIGENCE.

ALLEGED BREACH OF CONTRACT.

The case of Smith *v.* the City of London Electric Lighting Company came before Mr. Justice Grantham and a special jury in the King's Bench Division of the High Court last week. It was an action brought to recover for non-delivery of certain lamps by the defendants under a verbal contract.

Mr. McCall, K.C., in opening the case, said that the plaintiff was a dealer in electric fittings and electric lamps, carrying on business in East Ham. In November, 1901, the defendants issued an advertisement in the *Electrical Engineer*, to the effect that they had a large quantity of plant, material, and stock for sale. Included in that was a large quantity of 100-volt incandescent lamps and fittings. The plaintiff requiring lamps of this kind for the purposes of his business, applied in pursuance of the advertisement in the form of tender mentioned in the advertisement. On Dec. 9, having made personal enquiries of the defendants, the plaintiff offered £300 for the lot, comprising 28,000 lamps. On Dec. 17, nothing having been done on the tender, the plaintiff called at the defendants' place of business, and he was then informed that the old list and the old tenders were off, and that there was a new list dated Dec. 9. That day being the day after the date fixed for sending in the tenders, the plaintiff saw a Mr. Jackson, the defendants' chief engineer, on the matter. Mr. Jackson told him that the lamps which were in question in the case had been withdrawn — viz., new Ediswan lamps—but he asked plaintiff to make a verbal offer for the other lamps. Plaintiff had been told that there were 10,000 new lamps in addition to the Ediswan, and then the plaintiff offered £2 per 1,000 for them, and 2d. a piece for the Ediswan lamps. Terms were afterwards agreed on for all lamps. The plaintiff asked defendants to confirm this verbal sale in writing, and accordingly on Dec. 19 the defendants wrote a confirmatory letter to the plaintiff. The learned counsel submitted that it was clear that the contract was that defendants were selling to plaintiff 20,129 Ediswan lamps. What the plaintiff actually got delivery of was only 1,509 lamps. He accordingly claimed from the defendants for the breach of contract £620. 13s. 4d., that sum representing the profit the plaintiff estimated he would have made if the lamps had been delivered by the defendants.

The plaintiff was called, and gave evidence in support of his case.

After a lengthy hearing,

Mr. Lawson Walton, K.C., said he was glad to say they had settled the case. The City of London Electric Lighting Company had always been anxious to adjust the claim on what they considered a fair basis. There was no doubt that, owing to the quantity in the warehouse, there was a mistake in the stock lists; but at the same time they never guaranteed the quantities, because the lamps had never been counted. The plaintiff had consented to accept a sum which had been agreed upon.

His **Lordship** said it was very right that the parties should settle the matter.

Judgment was then given for plaintiff for the amount agreed upon.

ALLEGED DAMAGE TO MAINS.

Mr. Justice Wright, sitting without a jury in the King's Bench Division on the 11th inst., concluded the hearing of the case of the Westminster Electric Supply Company *v.* the Improved Wood Pavement Company. In this case the plaintiffs had parliamentary powers for the supply of electric energy in the city of Westminster, such energy being distributed to the plaintiffs' customers by means of, *inter alia*, insulated copper mains laid beneath the roadway. These mains were composed of copper core surrounded by alternate layers of jute and lead, the whole being covered in lead cases to protect the mains from the action of water. In October, 1900, the defendants were engaged in laying wood pavement on a portion of the roadway in Berkeley-square under which the plaintiffs' mains were laid, and the plaintiffs' case was that through the negligence of the defendants in laying the pavement one of their mains was damaged by a pick or wedge being driven through its outside covering. Owing to this, the main became exposed to the moisture of the surrounding earth, and then became rotten, and lost its insulating qualities. The electric current being allowed to escape, the lead covering and jute insulation of the adjacent mains was destroyed, and the mains rendered useless, thus stopping the supply of current to the plaintiffs' customers. The plaintiffs claimed as damages from the defendants the expense they had been put to in putting down a considerable length of new main, and also the expense of taking up and relaying the wood pavement to the satisfaction of the local authority. The defendants denied the alleged negligence and also the alleged damage to the main.

Mr. H. Avory, K.C., and Mr. Kennedy appeared for the plaintiffs, and Mr. Bray, K.C., and Mr. Spencer Bower for the defendants.

A considerable amount of conflicting evidence was called on both sides.

His **Lordship**, in giving judgment, pointed out that there had been no cross-examination by the plaintiffs' counsel of the defendants' witnesses, as to the specific dates on which damage was alleged to have been caused. It appeared to him that there was no case made out by the plaintiffs against the defendants, and therefore there must be judgment for the defendants with costs.

A LIVERPOOL BANKRUPTCY CASE.

At the Liverpool Bankruptcy Court on Thursday last week, before Mr. Registrar Bellringer, the first public examination took place of Alfred Percy Archibald Hunt, electrical engineer, of Southport and Liverpool. The gross liabilities, it appeared, amount to £409. 12s. 11d., of which £354. 8s. 2d. is expected to rank for dividend. The assets are estimated at £415. 7s. 9d., less creditors for distrainable rent, etc., £60. 19s. 7d.; balance, £354. 8s. 2d. The debtor's alleged causes of failure are slackness of last summer season, and insufficient capital to enable him to wait till his money came in.

In reply to the Official Receiver, debtor stated that he was by profession an electrical engineer. He estimated his assets at £415. 7s. 9d. gross—the sum of £50 was for the stock-in-trade, £280 for trade fixtures, and £79. 1s 9d. for book debts.

Further evidence showed that the debtor's premises were fitted up most elaborately, the electrical fittings alone costing about £450. He thought that the amount of his indebtedness would be realised by the sale of the business as a going concern.

At the conclusion of the debtor's examination the enquiry was adjourned till Jan. 15 next.

ELECTRIC LIGHTING BOARDS.

In the High Court on Friday last, Mr. Justice Kekewich, in a debenture-holder's action of Brounger *v.* the Electric Lighting Boards, Limited, appointed a receiver and manager of the company's business, the gentleman nominated by the plaintiff to act as receiver not beyond Jan. 16, till when the motion was adjourned.

BRITISH POWER, TRACTION, AND LIGHTING COMPANY.

On the 16th inst. Mr. Justice Byrne made the usual winding-up order on the petition of L. Hannen in the case of this company. A receiver and manager was appointed in a debenture holder's action. Mr. Bramwell Davis, K.C., for the company, said winding-up would produce no good result, as the whole thing would not sell for more than £15,000.

COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER.

The fifth ordinary general meeting of the shareholders in this Company was held at Winchester House on the 18th inst., Mr. H. Hirst presiding.

The **Chairman**, in moving the adoption of the report, which showed a net loss on the year's trading of £6,032, said it was to be regretted that on this, the first occasion on which he was privileged to address them, he had to lay before them what must be considered as an unfavourable report. The difficulties that befell the Company had not reached their crisis at the end of last year as the directors had hoped, but they continued throughout the year under review. Considering the matter from the technical point of view, he said that their experience in London at the beginning of this year was disheartening. Enquiries were, however, made through a disinterested party of all the principal stations on the Continent which used the Aron meter. He had a list before him of such stations, such as the municipal electricity works of Charlottenburg, of Munich, of Hanover, of Konigsberg, of Breslau, of Dortmund, of Blankenburg, of Bremen, etc., representing some 20,000 or 30,000 meters, that without exception expressed themselves favourable about the instrument, and had no serious complaint at all. But meters manufactured in that country, which apparently worked well in the works, developed certain defects after some time on the consumers' premises. The Company accordingly incurred the heavy expense of travelling representatives to visit the stations to put right the defects, either on the spot or in their works. These expenses formed one of the principal items of the loss incurred by the branch in London. Dr. Aron was specially called over here, and spent in the aggregate several months in England to thoroughly investigate the cause of the defects. As a result of these investigations, the directors changed the entire technical management and the methods of manufacture in London, and they had ample proofs that under the new management better results had already been obtained. In Berlin the profit of the factory had been less, principally on account of the smaller business done last year in consequence of the slackness of trade. The building at Schweidnitz having been finished, the heavy expenses of manufacturing incurred in Berlin would cease, and Schweidnitz, established with more modern and better machinery, ought without difficulty to bring down the cost of manufacturing, and

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enable the branches to make an increased profit. Mr. Doerr, who had been associated with Prof. Aron for many years, had been placed in charge of the Schweidnitz establishment. Dealing with the commercial side of the question, the industrial depression on the Continent continued to some extent to be the principal cause of the reduction of profits. The Paris branch had really done much better than in the previous year, though it did not affect the balance-sheet. The day and night load meter, as well as the time switches, which were simply other types of their meter, were beginning to do well, and promised to add to the revenue. The electric clocks of which Dr. Aron thought so well, and which it was thought were cheap and reliable, had so far proved a disappointment. Referring to the small meter, owing to the change over of electrical supply stations from low to high pressures, the number of these meters required had become a very considerable proportion of the whole meter business. On a recent trip to Berlin Prof. Aron showed to Mr. Blumlein and Mr. Hirst his latest "Baby" meter, and if his hopes and anticipations were borne out it would mark an epoch in the history of this Company. Coming now to the financial aspect, in spite of the under balance this year, he ventured to say their financial position was at least as good as it had been at any time since the Company's existence. They had over £28,000 cash in hand, and a stock of £45,000, which last year stood at £58,000. They had liquidated, therefore, £13,000. The chairman concluded by reading a letter he had received from Dr. Aron, stating that he was busily engaged with his new meter for small currents. He had strong hopes of the result, which would, he trusted, solve satisfactorily the great difficulty to produce a reliable instrument for smaller currents, and enable the Company to successfully compete in the market.

Sir James Pender, Bart., seconded the motion.

A **Shareholder** urged upon the directors the advisability of dividing the item of £198,454 given in the balance sheet in respect of goodwill, patents, stocks, and shares, etc., in order that the shareholders might see what their property was really worth.

The **Chairman** said that the item appeared in the balance sheet exactly as it was originally given in the prospectus. He, however, promised to meet the views of the shareholders on this point. On the question of the value of the patents it was an absolutely impossible amount to calculate; but in his opinion the patents were to-day of more value than at any other time. A number of new patents which Dr. Aron had taken out were quite as good and as valuable as the old ones.

The motion was ultimately adopted.

BASTIAN METER.

The fifth ordinary general meeting of the above Company was held on the 18th inst. at the works, Kentish Town, under the presidency of Mr. C. Orme Bastian.

In moving the adoption of the report, the **Chairman** said that the profit made during the last six months had been nearly 5 per cent. upon the whole of the capital of the Company, but that was really no criterion of what they would do in the future. So far they had doubled their output of meters. He held the opinion that in about five years time the price of electricity for public lighting would be practically the same as gas was to-day, and then would commence the period when large fortunes were to be made in the electrical industry. They had been successfully developing the business in the British Colonies and also on the Continent of Europe, and the Spanish market had opened up so well that the directors, being of opinion that a large trade could only be safely conducted by manufacturing in the country, were in negotiation for the sale of Spanish patents.

The report was adopted, the election of Mr. Thomas Johnson to a seat on the Board was confirmed, and Mr. D. J. Cowles was re-elected a director.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

The ordinary general meeting of this Company was held on the 19th inst. at Winchester House, Mr. E. B. Ellice-Clark presiding.

The **Chairman**, in moving the adoption of the report and accounts, explained that the delay which had arisen in presenting the report was due to the searching examination of the accounts which the present Board had been occupied in making. The directors now submitted the accounts with the conviction that everything possible had been done to present a correct statement of the Company's position. The figures of the total sales for the past five years were as follows: in 1898, £226,877; in 1899, £268,881; in 1900, £320,444; in 1901, £270,524; and this year, £246,487. While the further decrease this year was to be regretted, it was proportionately much less than in the preceding 12 months, and it might be hoped that, in spite of the greater competition, the downward rate of the sales had been arrested. The lamp sales had advanced by £4,511, notwithstanding that the selling price was lowered last autumn to meet the growing competition, but the sales in fittings continued to decline in about the same ratio as in 1901. From the exhaustive stocktaking which had been made, it turned out that last year the stocks were overvalued to the extent of £40,774. This depreciation was large, but the fittings stock alone amounted to £76,734, and this rapidly deteriorated, not only from changes of fashion, but also from improvements in design. It was confidently believed, with the additional depreciation shown under the head of special charges, that these stocks and stores would be brought into next year's accounts at such figures that in future they would only require the necessary annual depreciation, and would not be again subject to a special writing down. Last year a considerable amount—about £60,000—was written off for special losses not incidental to the year's working. Owing to the causes to which he had referred, there was an adverse balance of £2,067 on the year's working, after providing a fair and sufficient sum for depreciation and payment of debenture interest. This, added to the special charges, brought the total adverse balance to £59,792, which would have to be dealt with in future accounts. Competition had been exceedingly severe; foreign-made lamps were offered at prices which were neither profitable to the producer nor beneficial to the consumer, and with these low-priced and inferior articles no company with a name to lose could pretend to compete, although they were the cause of the general lowering of prices. Even some of the municipalities, where they were in competition with the local gas companies, were willing to sink their patriotism and their unfavourable experience of these inferior goods by the purchase of cheap foreign-made lamps and the resale of them at a fractional profit—a profit which could not support a trader, who was unable to obtain his capital at such a low rate of interest as a corporation. The outlook, though it forecasted a long and arduous struggle, was hopeful, and the Board believed that the business would, in the end, emerge successfully from its present position.

Mr. Henry Wolfenden seconded the motion.

After a somewhat protracted discussion the report was unanimously adopted.

COVENTRY ELECTRICAL ENGINEERING AND LIGHTING.

A meeting of shareholders in this Company was held at Coventry on Monday to consider the subject of winding-up.

Mr. W. H. Robinson presided, and in proposing a resolution to wind up the Company said the causes of failure were want of working capital, unsaleable nature of the stock-in-trade, heavy interest and establishment charges, and insufficient turnover.

Mr. W. Lee seconded the motion, which was carried.

Mr. J. Cudworth, of Birmingham, was appointed liquidator.

BRITISH ELECTRIC TRACTION.

The directors have issued an interim report for December, 1902, in which they take up the question of municipal trading from the point of view of the Company. The affairs of the Company are stated at great length, but on the municipal question the principal claim made is that whilst the company has been engaged in establishing a large number of undertakings in districts where municipalisation would have been quite impossible, it has indirectly stimulated municipalities to adopt electric traction. Further on the directors rebut a misrepresentation which has been put forward to the effect that the British Electric Traction Company is an American organisation. Turning to the financial question, it appears that since the date of the last balance-sheet, March 31, 1902, the Company has issued further share and debenture capital to the amount of £1,020,168, the net premiums on which amount to about £80,000, making a total of £1,100,168. Of this sum £321,400 has still to be paid up, and £310,030 was issued in fully paid-up shares in exchange for shares in the Brush and the Electrical Power Distribution Companies. During this period the following approximate amounts of capital have been expended upon associated undertakings: £32,130 in exchange for ordinary shares in the Brush Electrical Engineering Company, Limited, and £114,470 in exchange for preference shares in that company; £163,825 in exchange for, or purchase of, shares in the Electrical Power Distribution Company, Limited, and £21,500 has been advanced for the development of that company's various undertakings; £241,186 in shares of the Auckland Electric Tramways Company; £26,807 advanced to the Barnsley and District Electric Traction Company, Limited; £101,372 in purchase of shares in the City of Birmingham Tramways Company, Limited; £9,349 in purchase of the Airdrie and Coatbridge Tramway undertaking; £21,844 advanced to the Gravesend and Northfleet Electric Tramways, Limited; £83,810 invested in shares and debentures of the Middleton Electric Traction Company, Limited; £15,000 advanced to the Peterborough Electric Traction Company, Limited; £3,000 to the Rothesay Tramways Company, Limited; £36,063 to the Southport Tramways Company, Limited; £82,124 to the Wolverhampton District Electric Tramways, Limited; £18,803 to the Wrexham and District Electric Tramways, Limited; and £81,071 advanced to the Yorkshire (Woollen District) Electric Tramways, Limited. The Company is now also largely concerned in the Metropolitan Electric Tramways, Limited, and various sums of capital are being provided for that company, which has made arrangements with the Middlesex and Hertfordshire County Councils by which the light railways to be constructed in those counties (45 miles) are to be leased to the company for 30 and 42 years respectively. Altogether the total mileage of tramways and light railways controlled by the Company and its associated companies is 570 miles, and, in addition, there are about 58 miles of omnibus routes. A large proportion of these lines is in operation by electricity, steam, or horses, and the associated companies are carrying over 100,000,000 passengers per annum, with gross receipts of over £700,000 per annum. An analysis of the profits for the period ended March 31, 1902, shows amount received from dividends, interest fees, and commissions, £156,266; profits on working of lines, on sales of investments and materials, rents, and sundry profits, £14,131; profits on sales of undertakings and of parliamentary powers and underwriting profits, £77,838—total, £248,235; less expenses and sundry losses chargeable against above profits, £44,965; balance as per published profit and loss accounts, £203,269. Dealing with the question of depreciation, the report states that for the year 1901 the various associated companies wrote off, reserved, or carried forward out of the profits of the year £108,500, which is equal to about 2½ per cent. of their aggregate subscribed capital. Considering that many of the undertakings had only recently been started, the provision thus made is, in the opinion of the directors, ample. This Company has, moreover, placed to reserve all the premiums received on new capital, amounting to

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£519,705, and has also applied out of profits to writing down or reserve and carried forward up to March last £93,881, and that the valuable goodwill of the Company has been written down to the nominal figure of £1,000. In conclusion, the directors state that the fact that capital has been raised from time to time as the business required, has enabled larger dividends to be paid than would have been possible if any other course had been pursued.

JOHNSON-LUNDELL ELECTRIC TRACTION.

A meeting of this Company was held at the Holborn Restaurant on Monday, from which representatives of the Press were excluded. It is believed that a movement for an investigation of the position of the Company is on foot.

NEW COMPANIES REGISTERED.

N.S. Electric Storage Company, Limited.—Capital, £21,100. Object: chiefly indicated by the title.

Hasley Electric Generator Company, Limited. — Capital, £2,000. Object: to carry on the business of manufacturers of and dealers in electric plant.

"K. C." Motors, Limited. — Capital, £20,000. Objects: to carry on business as cycle and motor manufacturers, whether driven by electricity, oil, or other motive power, etc.

Albany Motor Company, Limited.—Capital, £10,000. Objects: to adopt an agreement with the Albany Manufacturing Company, Limited, and to carry on the business of a motor company generally.

Amies and Sons, Limited.—Capital, £65,000. Objects: to acquire and continue the business of Amies and Sons, to construct and superintend and maintain any rail or tram roads, electric works, etc.

Colonial Railway Construction Company, Limited.—Capital, £10,000. Objects: to acquire any concessions, and to construct and maintain railroads, whether driven by electricity or other motive power, etc.

North-West London Electric Supply Company, Limited.—Capital, £75,000. Objects: primarily to carry on business as producers and suppliers of electricity for the purposes of light, heat, or traction, etc.

Fife Electric Power Company, Limited.—Capital, £30,000. Objects: to carry on the business of bankers, contractors for public and other works, makers and suppliers of gas, electric, hydraulic, and other motive power, etc.

Metropolitan Electric Tubes Syndicate, Limited.—Capital, £15,000. Objects: to adopt an agreement with Thomas Hunter, and to carry on the general business of an electric light works, tube makers, and as engineers generally.

Milnes-Daimler, Limited.—Capital, £20,000. Objects: to enter into an agreement made Nov. 10 with J. F. Milnes and Co., Limited, for the acquisition of the property of the Daimler Motoren Gesellschaft, and to carry on business as electricians, etc.

Nottingham and Derbyshire Tramways Development Company, Limited.—Capital, £30,000. Objects: to construct and maintain any electric tram and light rail roads in Notts and Derby; as producers and suppliers of gas and electricity, etc.

Stephens and Johnson, Limited.—Capital, £11,000. Objects: to carry on business as manufacturers and builders, ironmongers, makers of and dealers in ammunition, etc., carried on by Stephens and Johnson at Aldershot, as electricians and electrical engineers, etc.

Electrical Mining Company, Limited.—Capital, £5,000. Objects: to acquire as a going concern the business and undertaking of the Electrical Mining Company, of Derby, to develop and carry on the same, to carry on the business of general, mechanical, and electrical engineers, etc.

Birkenhead and Chester Tramways Company, Limited.—Capital, £5,000. Objects: to lay down trams and light railways; as manufacturers of and dealers in rails and all necessary appliances, rolling-stock, vans, cabs, and other vehicles and carriages, whether propelled by compressed air, gas, electricity, steam, or otherwise, etc.

Bridgwater and District Electric Supply and Traction Company, Limited.—Capital, £15,000. Objects: to carry on in all its branches the business of a light, heat, and power company; for the purposes of the company to lay any cables, wires, lines, as manufacturers of accumulators; to lay down in Bridgwater and elsewhere rail and tram roads, to build and run electric omnibuses and vans, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Swindon.—The Corporation invite tenders for the wiring of the town hall for the electric light. Tenders by Dec. 29. See advertisement.

Smyrna.—The Municipality are ready to receive tenders for the construction of a tramway between the two railway stations; the distance is about 1½ miles.

Wigan.—The Corporation invite tenders for a supply of cable. Tenders by Dec. 29. See advertisement.

Bucharest.—The Postal Telegraph Department require tenders for 50,000 kilos of galvanised iron wire. Tenders by Dec. 29.

Wigan.—The Corporation invite tenders for an extension to the switchboard at their central electric supply station. Tenders by Dec. 29. See advertisement.

Oldham.—The Electricity Committee invite tenders for the supply and delivery of feeder cable, pilot cable, joint-boxes, etc. Tenders by Dec. 30. See advertisement.

Glasgow.—The Corporation invite tenders for the supply of 100 electric motor equipments and spare parts for same. Tenders by 11 a.m. on Jan. 5, 1903. See advertisement.

Lowestoft.—The Corporation invite tenders for motorcars, trucks, motors, and equipments, and track sweeping and watering car. Tenders by Jan. 7, 1903. See advertisement.

Stepney.—The Electrical Committee invite tenders for a 500-kw. combined steam-engine and multipolar direct-current dynamo. Tenders by Jan. 16, 1903. See advertisement.

Bristol.—The Electrical Committee invite tenders for surface condensers, etc., for the second instalment of their Avonbank electricity works. Tenders by Jan. 6, 1903. See advertisement.

Rome.—Tenders are invited for Messine harbour lighting, including 12 arc lamps, etc., estimated at £4,232. Particulars may be obtained from the Public Works Department, Rome. Tenders by Jan. 3.

Sunderland.—The Corporation invite tenders for the supply of a Lancashire boiler, 28ft. by 8ft. 6in. diameter, with fittings, etc., complete. Tenders by 12 noon on Jan. 2, 1903. See advertisement.

Wallasey.—The Urban District Council invite tenders for engine and dynamo for traction purposes, Lancashire boiler, condensing plant, and water-cooling tower. Tenders by Jan. 15, 1903. See advertisement.

Tamworth.—The Guardians invite tenders for providing and fixing ventilators in the Board-room and dining hall at the workhouse. Specifications, etc., can be obtained from the architect, Mr. J. W. Godderidge, Bolebridge-street. Tenders by Jan. 2.

Walsall.—The Corporation invite tenders for the supply of 28 double-deck tramcars with electrical equipment. Specification, etc., may be obtained from Mr. Alexr. Wyllie, borough electrical engineer, Wolverhampton-street, Walsall. Tenders by 29th inst.

Blackpool.—The Cleansing Committee invite tenders for the supply and erection of high-speed engine, 240-b.h.p., two 20, two 10, and one 5-b.h.p. motors, main switchboard, wiring, and lamps, and overhead traveller in connection with the refuse destructor extensions. See advertisement.

Canterbury.—The Asylums Committee invite tenders for a system of electric tell-tales, clocks, and bells at the borough asylum, Canterbury. Specification, etc., can be obtained on application to the Borough Electrical Engineer, Electricity Works, Canterbury. Tenders by 10 a.m. on Jan. 1.

Partick.—The Town Council invite tenders for the supply of 200 arc lamp columns, arc lamps, fittings, etc., supply, laying, and jointing of necessary, cables, feeders, joint-boxes, etc. Specifications, etc., can be obtained from Mr. H. B. Maxwell, burgh electrical engineer, Partick. Tenders by Jan. 6.

Stoke-upon-Trent.—The Corporation invite tenders for the supply and erection of boiler-house plant, steam dynamos (single-acting engines), balancer, reversible boosters (hand-regulated), switchboard, battery, street mains and accessories, travelling crane, and workshop machinery. Tenders by Jan. 14. See advertisement.

Hackney.—At the last meeting of the Borough Council the Electric Lighting Committee reported that they consider the present time very opportune for obtaining fresh quotations for cables, as both lead and copper are now abnormally low, and recommended that they be authorised to issue an advertisement inviting tenders for cables at schedule rates.

La Valette.—The Municipality invite tenders for the establishment and working for 99 years of a tramway between La Valette and Senglea Cospiena, Vettoriosa and Casal Zebbug. Deposit £300. Tenders by Nov. 25 to Wm. Casolani, receiver-general and director of contracts, La Valette. Plans and particulars will be ready by March 1, 1903.

Barrow-in-Furness.—The Corporation invite tenders for the supply and erection of two 250-kw. engines and generators, generator and traction feeder switchboards and Board of Trade panel, and steam and exhaust pipes. Specifications, etc., can be obtained from Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness. Tenders by Jan. 5.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply, delivery, laying, erection, and connecting-up, etc., of high-tension cables, low-tension cables, telephone, and test wires, etc., extra high-tension switchboards for main generating station and four sub-stations, and low-tension switchboards. Tenders by Jan. 5. See advertisement.

Cromer.—The Urban District Council invite tenders for erection of an electric light station, comprising boiler-house, engine and accumulator rooms, stores, and offices at Cromer. Specifications, etc., can be obtained at the offices of Messrs. O'Gorman and Cozens-Hardy, 82, Victoria-street, Westminster, consulting engineers to the Council, and at the office of the Council, Town Hall, Cromer, on and after 29th inst. Tenders by 12 noon on Jan. 12.

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Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection complete of elevators and conveyors for coal and ashes comprised in specification No. 8. Copies of the specification and drawings can be obtained from Mr. Arthur Andrew, Gas and Water Offices, Oldham, on payment of £1. 1s., to be returned on receipt by the Corporation of a bona fide tender. Specification can be seen at, but not obtained from, the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders by Jan. 13.

Devonport.—The Corporation invite tenders for the supply of materials in connection with and the execution complete of the overhead equipment of about 2 miles 4 furlongs 3 chains of double trolley line, together with incidental works. Specification, etc., may be obtained on application to Mr. C. Chadwell, 20, Victoria-street, Westminster. Copies of the drawings may be inspected daily between 11 a.m. and 5 p.m. on application being made to the Resident Engineer, 40, St. Aubyn-street, Devonport. Tenders by 9 a.m. on 29th inst.

Bulawayo (Rhodesia).—Tenders are invited by the Municipal Council for the establishment and working of an electric tramway system for that municipality. A limited number of copies of a draft agreement upon which the Council is prepared to grant the right, together with plan of township, suggested route, and other details, can be obtained upon application to Messrs. Davis and Soper, 54, St. Mary's-axe, London, E.C., London agents of the municipality, by whom sealed tenders, endorsed "Tramways," will be received up to noon on Feb. 26.

London, S.E.—The Camberwell Borough Council invite tenders for the maintenance of electric bells and private telephones, and maintenance of electric light storage batteries at Church-street baths from April 1, 1903, to March 31, 1904. Particulars may be obtained from Mr. W. Oxtoby, borough engineer, Town Hall, Camberwell, S.E. Samples may be inspected at the Grove Vale Depôt, opposite East Dulwich Station. The committee will not consider any tender except on the authorised form of tender, which must be delivered at the Town Hall by 5.30 p.m. on Jan. 12 and 7 p.m. on Jan. 6 respectively.

Wellington (New Zealand).—The City Council invite tenders for the complete supply and installation of electrical tramways, other than buildings; the supply, delivery, and erection of certain tramcars and electrical equipment; plant and materials for the power station: supplies and the erection of plant for the power station; materials for the permanent way; supplies and the construction of the permanent way; material and fittings for the overhead equipment and feeders; and erection and maintenance of all materials, etc., for the overhead equipment and feeders. Tenders by Jan. 21. See advertisement.

Sydney (N.S.W.).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on Wednesday, Feb. 4, 1903, from persons desirous of contracting for the supply and delivery of an additional subscriber's section of the present metallic circuit branching system multiple telephone switchboard at the Central Exchange, General Post Office, Sydney, New South Wales. Sealed samples, specification, and general conditions may be seen at the office of the Chief Electrician, General Post Office, Sydney. Specification and general conditions may also be seen at the General Post Office, Melbourne, Brisbane, Adelaide, Perth, and Hobart. The tenderers must state the shortest time within which the switchboard can be delivered at the Central Exchange, General Post Office, Sydney.

RESULTS OF TENDERS.

Luton.—The Town Council have accepted the tender of the St. Helens Cable Company for the supply and delivery of distributing mains, feeders, etc., at £695.

Mansfield.—The Town Council have accepted the tender of the Mansfield Engineering Company for wiring the electricity works, at £303. Twelve tenders were received.

Croydon.—The Town Council have accepted the following tenders: Dick, Kerr, and Co., engine and generator, £5,630; Mirrlees, Watson, and Co., condensing plant, £2,305.

Chester.—The Town Council have accepted the following tenders: H. Vernon, erection of a switchboard platform, £62; Oliver and Co., Woolwich, supply of 40 arc lamps and fittings, £340.

Blackpool.—The Corporation have accepted the following tenders for the supply and erection of coal elevator, bunker, and automatic weigher in connection with their electricity works, West Caroline-street, Blackpool: Graham, Morton, and Co., Black Bull-street, Leeds, coal bunker and conveyor; W. and T. Avery, Limited, Birmingham, weighing machine.

Newport (Mon.).—Messrs. G. F. Lovell and Co. have received the following tenders for extension of the electric light installation at their Monmouth confectionery works, Crindau, Newport:

C. E. Bedford and Co., 23A, Mount Stuart-square, Cardiff	£160	0	0
Alger and Sons, Dock-street, Newport	150	0	0
Arnold and Son, High-street, Newport	148	10	0
W. A. Baker and Co., 7 and 8, Commercial-street, Newport (accepted)	135	16	0
E. Perman, 50, Dock-street, Newport	132	9	9

Surbiton.—The District Council have received the following tenders for the erection of the electric light station:

Hockley and Son, Grantham	£4,455	15	1
Gaze and Son, Kingston (accepted)	4,539	17	3
F. Hawkey, Surbiton	4,578	7	11
Kavanagh and Co., Tolworth	4,665	12	9
Oldridge, Kingston	4,777	3	9
Messom and Son, Twickenham	5,359	0	0
MacDonald Bros., Surbiton	5,768	4	4

Bradford.—The School Board have accepted the following tenders for the electric lighting required at the Feversham-street New Baths and the Green-lane School and Baths: G. A. Steinthel, Bradford, Green-lane School; Smith and Croft, Providence-street, Bradford, Feversham-street School.

London, S.W.—The Wandsworth and Clapham Guardians have received the following tenders for providing and fixing up an electric wiring installation, and the fittings thereto, to the new buildings at the infirmary, St. John's-hill, Wandsworth:

Fryer and Co., Harrow-road, W. (accepted)	£299	0	0
M. Wiedhofft, 42, Upper-street, Islington	321	0	0
F. J. Coleby and Co., 7, Thayer-street, W.	325	0	0
J Bakewell and Co., 130, Queen Victoria-street, E.C.	348	3	0
H. Sutton and Co., 2, Upper James-street, Golden-square, W.	389	5	10
Ward Bros., Bevois House, 28A, Basinghall-street, E.C.	410	10	0
Spearing and Stark, 107, Merton-road, Wimbledon	417	0	0
Southern Electrical Installation and Wiring Company, Limited, 9, Claremont, Hastings	424	14	0
W. H. Tilley, 53, Kingsland-road, E.	429	5	0
Wenham and Waters, Limited, Croydon	433	0	0
London Electrical Engineers, Limited, Union-buildings, Clerkenwell-road, E.C.	437	0	0
W. Simmons, Martin Works, Frederick-street, Stratford, E.	439	8	0
J. A. Henderson, 30, Oklands-road, Clapham	465	10	0
R. Dawson and Co., Stalybridge	480	0	0
Warrington and District Electric Light and Power Company, Limited, Warrington	483	17	0
W. Mossop and Co., 52, Queen Victoria-street, E.C	494	16	0
Tamplin and Makovski, Limited, James-street, Haymarket	563	13	8
Graham and Biddle, 463, Oxford-street, W.	580	0	0
P. S. Tasker, 53, Victoria-street, S.W.	583	9	0
F. Hodgson and Co., 24, Queen Victoria-street, E.C.	590	0	0
J. Wilson, Ferrier Works, North-street, Wandsworth	592	10	0
Jackson Bros., Broadway, Plaistow, E.	670	10	3
Benham and Sons, Limited, 66, Wigmore-street, W.	716	0	0
W. G. Murrin, 111, Aslett-street, Wandsworth	723	15	0

BUSINESS NOTES.

TRACTION.

Duntocher.—The inhabitants of this place are asking for an extension of the Glasgow tramways to Duntocher.

Portsmouth.—The Tramway Committee have resolved that 2d. cheap return tickets be issued for all routes and by all cars before 8.45 each morning.

Luton.—It was agreed at the last meeting of the Town Council to oppose the electrical tramway scheme which is being promoted in the district by a syndicate.

Cardiff.—The Tramways Committee recommend the appointment of Councillor Courtis and Councillor Fox as chairman and deputy-chairman respectively for the ensuing year.

Dundalk.—The Dundalk Electric Tramway Company have obtained an extension of time for the construction of the proposed tramways in and near Dundalk, in the county of Louth.

Heaton Norris.—An arrangement has been made with the Urban District Council whereby the Manchester Corporation will advance the sum of £7,000 required for tramway purposes.

Morriston Light Railway.—The Board of Trade will not hold another enquiry into the Morriston-to-Pontardawe light railway scheme, but will confirm the order with certain clauses.

East Preston.—The Rural District Council have decided not to consent to the British Electric Traction Company's scheme for an electric tramway between Worthing and Littlehampton.

Morecambe.—Negotiations with the British Electric Traction Company with respect to the acquisition of the Morecambe tramways, with a view to working them by electricity, have been reopened.

Wigan.—At the last meeting of the Corporation it was resolved to promote in the next session of Parliament a Bill to empower the Corporation to construct and work additional tramways in the borough.

Bournemouth.—Last week a trial trip was made by the Corporation officials and others over the section of the tramways which has been equipped on the side-slot conduit system. The trial is reported to have proved satisfactory.

Musselburgh.—The Town Council have given assent to the application by the promoters of the Musselburgh electric tramway scheme to the Board of Trade for an extension of time to August, 1904, wherein to construct the undertaking.

Brighton.—A meeting of owners and ratepayers has approved the promotion by the Town Council in the ensuing session of Parliament of a Bill containing provisions for tramway extension and the enlargement of the area for the supply of electricity.

Davyhulme.—The Parochial Committee had before them on Friday the amended plans for the construction of electrical tramways from Barton Bridge to Gatley. A sub-committee was appointed to watch the Bill which has been deposited by the promoters.

Dudley.—Two electric cars collided at the bottom of the steep gradient at Snow-hill last week. The passengers were badly shaken, and the motorman was severely injured. Both cars were knocked off the rails, and the traffic was blocked for several hours.

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Bath.—It was stated at the last meeting of the Town Council that once the question of the power station was settled the promoters of the tramway scheme would push on with the work, and they still hoped to open the first section of the system by August next.

Reading.—The work of constructing the new tramways along London-street, Castle-street, Castle-hill, and Bath-road is proceeding rapidly. Several of the electric cars have been ordered and the generating station in Mill-lane is fast approaching completion.

Haydock.—The District Council are recommended to dissent from the application of the South Lancashire Tramways Company to Parliament in the ensuing session for powers to extend the time for taking lands and for the construction of certain authorised tramways and works in the district.

Macclesfield.—The capital of the company who are promoting the tramway scheme in this district is to be £240,000. Powers are also sought in the Bill to take over by agreement with the Corporation the provisional order granted to them for electric lighting, on such terms as may be agreed upon.

North London.—A letter has been addressed by the town clerk of St. Pancras on behalf of the Borough Council to the London County Council, pointing out the necessity of substituting electrical for horse traction on the tramways in North London "before any new tramway schemes are carried out."

West Cumberland.—The West Cumberland Electric Tramway Company are applying to Parliament in the ensuing session for an Act to extend the time limited by the West Cumberland Electric Tramways Act, 1901, for the construction and completion of tramways and tramroads in the district.

Stoke-on-Trent.—The Potteries Electric Traction Company hope shortly to proceed with the construction of the light railway from Stoke to Newcastle. The question of the extensions from Newcastle to Trent Vale and from Trent Vale to Hanford will be considered at the next meeting of the directors.

Chatham.—In consequence of the recent fatal tramcar accident at Chatham the whole of the cars have been refitted with the newest pattern Westinghouse brake, and during the past week severe tests were carried out in the presence of Major Pringle of the Board of Trade. The result is said to have been satisfactory.

Tewkesbury.—At the next meeting of the Town Council in committee a resolution will be brought up: "That this Council memorialise the County Council of Gloucestershire to take such steps as they may deem necessary to provide an electric light railway between the city of Gloucester and the borough of Tewkesbury."

Newcastle.—The 16th inst. was the first anniversary of the running of electric cars in Newcastle. The number of passengers who have travelled during the year on the cars is 28,251,018. The receipts have amounted to £127,117, and the miles run have been 2,750,965. The average receipts per car mile were 11·5d.

Darlington.—The Tramways Committee are pushing forward as rapidly as possible with the scheme of electric tramways for the borough. As a preliminary step the borough surveyor has prepared plans, which have been adopted by the committee, for raising a considerable stretch of the roadway on the Harrowgate-hill route.

Presentation.—Mr. C. J. Spencer, the general manager of the Bradford City Tramways, presented to Mr. H. V. Pratt, on behalf of his colleagues, a handsome pair of silver candle lamps, the occasion being his recent marriage. Mr. Spencer, in making the presentation, spoke of the good feeling which existed throughout the department.

High Peak Light Railway.—The promoters of this electric railway are amending the draft order so as to provide for a passenger traffic only throughout the whole line, except on that portion which lies between the depôt near Ladmanlow and Macclesfield, where they will endeavour to meet the agricultural requirements of the district.

Ipswich.—The Corporation have empowered the Tramways Committee to invite tenders for the supply of cars according to specification, and to deal with such tenders when received. A proposal that if the committee in their opinion find that it is desirable to accept any tender by a foreign manufacturer, such a proposal shall be submitted to the Council, was rejected.

Aberdeen.—The receipts for the 28 weeks of the financial year have amounted to £28,869, compared with £21,817 for the corresponding period of 1901, an increase of £7,052. The expenditure for the same period this year has amounted to £9,425, as against £10,358, a decrease of £933, which, added to the increase in the receipts, £7,052, gives a total advantage of £7,985.

Fawley.—A meeting of the Parish Council was held last week to consider a notice received from the London and South-Western Railway Company, with reference to the electric light railway proposed to be made from Totton to Hythe and Fawley. After considerable discussion it was agreed to assent to the scheme, but at the same time a hope was expressed that there would be a station at Fawley.

King's Norton.—The King's Norton and Northfield District Council have decided by an almost unanimous vote to support the Birmingham District Tramways Bill, and have sealed an agreement with the City of Birmingham Tramway Company and the British Electric Traction Company providing for running powers in connection with the authorised section of tramways from Selly Oak to Northfield.

Exeter.—As a result of the recent conference between the Electric Traction Committee and a committee of the Heavitree Urban District Council in regard to the proposal to construct electric tramways in a part of the Heavitree district, the Urban District Council are disposed to offer no opposition to the project, especially having regard to the belief that the general body of ratepayers are in favour of the trams.

Bradford.—The Tramways Committee are considering the advisability of proceeding with the Barkerend-road section of the tramways before the Church Bank scheme is undertaken, this matter having been brought before them by a deputation of ratepayers from the South, East, and Bradford Moor Wards. It is expected that the operations will provide work for a considerable number of the unemployed.

Lizard Light Railway.—The amending order of the Lizard Light Railway Order, 1898, enables the company to construct level crossings over certain roads in the parishes of Wendron, Mawgan-in-Meneage, and Mullion, but gates may be required to be erected. Another alteration gives the Great Western Company power to object to the use by the company of electric motive power on any lands of the Great Western Company, except on terms to be agreed upon.

Blackburn.—The Corporation have extended their facilities for carrying parcels on the tramway system, and have established an express parcels delivery system. The system covers the collection, carriage, and delivery of parcels. The rates charged are: parcels weighing up to 7lb., with ticket affixed, 2d.; parcels weighing over 7lb., and not exceeding 14lb., with ticket affixed, 3d.; parcels weighing over 14lb., and not exceeding 28lb., with ticket affixed, 5d.

Greenock.—It was reported to the last meeting of the Corporation that a letter had been received from the Greenock and Port-Glasgow Tramways Company asking them to fix the price for units of electricity used beyond the amount stipulated in the tramway agreement—viz., 500,000—and asking a reduced rate. It was stated that, after having considered a report from their engineer, they had resolved that they could not make any reduction in the price of electricity.

Hamilton.—In the provisional order they are applying for the Hamilton, Motherwell, and Wishaw Tramways Company ask powers to make certain tramways and tramroads (13 in all) in the parishes of Cambuslang, Blantyre, Hamilton, and Motherwell. Power is also asked to use electrical energy supplied from any generating station belonging to the company for the working of the tramways and tramroads. The company proposes to raise a capital not exceeding £240,000.

Middleton.—Arrangements were made for the tramway between Middleton and Manchester to be opened on Wednesday. The Manchester Corporation have constructed the permanent way, and are providing the cars and the whole of the management of the service, but the Middleton Corporation are supplying the current up to the boundary. It is expected that the fare from Manchester to Middleton will be 3d. through. The fare on the railway at present is 8d. third-class return.

Heckmondwike.—At last Monday's meeting of the District Council it was reported that under the agreement come to with the British Electric Traction Company the latter have undertaken to pay the Council £1,250 per year for a supply of 160,000 units of electricity for the working of their tramway system in the township, which works out at a shade over 1¾d. per unit, the rate to become less for larger quantities The agreement is for 28 years, subject to revision at the end of 14 years.

Salford.—The statutory meeting of owners and ratepayers was held last week to consider the expediency of consenting to the promotion in the ensuing session of Parliament of a Bill dealing with tramway matters, the principal items being the making of a tramway in and from Middleton-road in the city of Manchester, to Great Cheetham-street East, and a tramway to connect the existing tramways in Bury Old-road with the former tramway. A resolution approving the Bill was carried with but few dissentients.

Hastings.—At their last meeting the Town Council had under consideration Mr. Murphy's Front-Line Tramways Bill to which the consultative committee recommended that assent be given on certain conditions. It was explained that the effect would be that the system to the outbounds would be constructed and trams actually running before the front-line was touched, and when the front-line was commenced the trams would run concurrently with the circular route. The Council decided by 26 votes to 8 to assent to the Bill.

Devon.—The County Council have agreed to the following Councils making tramways within the county—viz: Devonport—from the borough boundary near the intersection of Tavistock-road with Tor Grove-lane, along the Tavistock-road to Crownhill near the intersection of the Tavistock-road with the road to Tamerton Foliott. Exeter—from Polsloe-road to South View-terrace, Heavitree; from Blackboy-road along Pinhoe-road to Cemetery-road. Plymouth—from the borough boundary at Compton-lane end to near the same point of termination as Devonport.

Additional Traffic Returns.—Anglo-Argentine, £583 increase; Barcelona Ensanche y Gracia, £52 increase; Barcelona, £104 increase; Brisbane, £155 increase (month of November, £10,291, increase £552); Buenos Ayres and Belgrano Electric, £243 increase (month of November, £13,698, increase £925); Calcutta, £645 increase; Cape Town (month of October), receipts £16,507, expenditure £8,727; Isle of Thanet Electric, £9 decrease; Mexico Electric (month of November), receipts £42,800, expenditure £24,800; Perth Electric, £131 increase; Port Elizabeth (month of October), receipts £3,832, expenditure £2,095.

Middlesex.—The county engineer reported on the Watford and Edgware Railway Bill at the last meeting of the County Council. Power is sought by the Bill to construct a line of railway from Watford in Hertfordshire cross country to Edgware in Middlesex, where it is proposed to obtain a connection with and running powers over the Edgware and Hampstead, and the Charing Cross, Euston, and Hampstead authorised railways, thus forming a continuous line of railway from Watford to Charing Cross. The Council will take steps to obtain the usual clause for the protection of the roads affected by the scheme.

Nelson.—The work of laying the tramlines in Leeds-road is practically completed, the metals only having to be placed in position at

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two passing points. The car-shed is being constructed opposite the electricity works, and lines branching out of Scotland-road into Charles-street leading to the shed are now being laid. The shed is expected to be completed in about three weeks. The completion of the lines in the centre of the borough will only occupy about a couple of days, and the work is to be shortly taken in hand. The Electricity and Tramways Committee of the Corporation are advertising for drivers and conductors for the electric trams.

Perth.—By the Perth and District Tramways Order, 1892, the Perth and District Tramway Company were authorised to construct certain tramways within and beyond the burgh, but by the same order the Corporation were entitled, after the opening for public traffic of the tramways within the burgh, to exercise the powers of purchase given by the Tramways Act of 1870 of so much of the undertaking as is within the Corporation's district. The Corporation have resolved to acquire so much of the undertaking as is within the burgh, and ask power in a provisional order to work the tramways by animal or mechanical power. Power is asked to borrow a sum not exceeding £60,000.

Light Railways in Essex.—The proposal which was made three or four years ago to construct a light railway through North Essex is likely to be carried out. Mr. J. A. Pease, M.P. for the Saffron Walden Division, has lately been interesting himself in the matter, and the amount of money required by the Great Eastern Railway Company to undertake the work is said to be forthcoming. The scheme provides for a line, of the ordinary gauge of 4ft. 8½in., to start from Elsenham Station, on the Great Eastern main line to Cambridge, and proceed through Henham and Thaxted, thus opening up a very large area of rural Essex, which at present is badly in need of better railway facilities.

Walsall.—A special meeting of the Council was held last week for the purpose of transacting the necessary business connected with the question of the construction of tramways in Sutton and district. The draft of the Birmingham and District Tramways Bill was afterwards considered in committee at considerable length, when it was resolved to approve the draft, subject to such alterations as might be made during the progress of the Bill, and which might be approved by the General Purposes Committee. The draft agreement between the various local authorities and companies promoting the Bill was approved, subject to such alterations therein as the town clerk might think necessary.

Paris Metropolitan Railway.—The shareholders of the Paris Metropolitan Railway Company have sanctioned an increase in the capital from £2,000,000 to £3,000,000, the money being mainly required to meet the growing traffics on the line. During the first 10 months of the present year the ratio of working expenses to gross receipts amounted to 42 per cent., as compared with 47 per cent., whilst the proportion further declined to 38 per cent. in November. The dividend paid a year ago was at the rate of 15fr. per share, and it is thought the distribution for the current period will be at least at the same rate. It is calculated that the profits for 1903 will reach a total of £200,000.

Glasgow.—The Corporation of Glasgow are promoting a provisional order authorising them to construct new tramways and to acquire others. The principal tramway line referred to in the order is that which was authorised by the Clydebank Tramways Order, 1901, and which the Corporation of Glasgow seek power, under an agreement with the burgh of Clydebank, to construct and work in connection with the city lines. Powers are also sought to construct seven short lengths of line to connect the routes already existing in various parts of the city of Glasgow, and to give readier access to the docks on the north side of the river. An extension of the Corporation's borrowing powers for tramway purposes is asked from £2,400,000 to £2,600,000.

Leeds.—An inquest was held last week concerning the death of Joseph Whitear, 32 years of age, who was killed on Wednesday by a tramway derrick falling upon him. Mr. Whitear was the tramway assistant engineer, and at the time of the accident he was, with others, on a wagon which bore the derrick, on the way to effect some repairs in Armley-road. When near to Parliament street one of the wheels of the vehicle became detached, causing the derrick to topple over, and throwing Whitear and the other men on to the road. Whitear unfortunately was caught by the platform of the derrick and received a fracture of the skull, from the effects of which he died on the way to the General Infirmary. The jury found a verdict of accidental death.

Cheshire Lines.—The railway companies forming the Cheshire Lines Committee have deposited their Bill for introduction into Parliament next session. The committee propose to construct nearly a mile of new lines for the purpose of connecting their Liverpool and Manchester Railway with the Liverpool Overhead Railway. The new line will run from the Herculaneum Dock Station of the Overhead Railway to a point near the St. Michael's Station of the Cheshire Lines Committee. This connecting link is to be deemed to be part of the undertaking of the committee, who also ask for running powers over the whole of the Liverpool Overhead Railway, together with the right to use all stations, electric current appliances, and all conveniences connected with that railway.

West Bromwich.—The opening for the use of the travelling public of the first section of the new system of tramways which have been taken over, reconstructed, and electrically equipped by the Corporation took place last Friday. The section in question runs between Carter's Green and the borough boundary on the Handsworth side. The work of reconstruction and electrical equipment of the other portions of the route to Hill Top, Great Bridge, Oldbury, and Spon-lane is proceeding. The total cost of the whole of the work which has to be borne by the West Bromwich Corporation, including £37,500 purchase money, will be nearly £140,000, but the Corporation expect to be fully recouped for this by the British Electric Traction Company under the 21 years' agreement for the working of the lines by that company. The electricity for the trams is being supplied from the Corporation works.

St. Petersburg.—The St. Petersburg correspondent of one of the daily papers says that the committee appointed by the Municipality of St. Petersburg to enquire into the various projects for electric tramways in the capital has issued a report which is hostile to foreign tenders in general. Of the three foreign syndicates tendering, the Verner-Balinsky is by far the most ambitious. It involves the making of an underground railway, the drying up of the Catherine Canal, the building of 16 bridges, and the conversion of a hospital into a power house. According to the information, the syndicate is to deposit the capital sum for the whole work of construction with the Minister of Finance, without interest. As the sum is estimated at £12,000,000, this is equivalent to giving the Russian Government a short loan of several millions on the easiest possible terms. St. Petersburg is at present entirely served with horse traction in the streets.

Automobiles on Railways.—The *Times* Paris correspondent furnishes some interesting particulars with respect to a new system of automobile railway communication which he says is beyond the stage of experiment. It consists of the substitution on railways for the existing locomotives and carriages of trains of automobiles, each of which will be of the dimensions of the corridor carriages at present in use, will accommodate 40 passengers with luggage, will include a lavatory and refreshment bar, and will be capable of a normal speed of 100 km. (61½ miles) an hour. The first automobile train is to start from the Lyons Station, Paris, on June 18 next, and is expected to reach Dijon in 3 hours and 10 minutes, while, according to the correspondent, the same rate of speed may be maintained for the whole distance between Paris and Nice. M. Noblomaire, a leading French railway authority, has declared the new system to be an absolute revolution.

Goods Traffic on Tramways.—A meeting of gentlemen from various parts of Lancashire, convened by the special committee of the Liverpool Corporation Tramways Committee appointed to consider the question of the carriage of merchandise on the electric tramway systems of Lancashire, has been held at Liverpool. It was unanimously resolved: "That this meeting of gentlemen connected with various towns of South Lancashire and the County Council of Lancashire approves of the principle of the scheme for the transport of merchandise from the Liverpool Docks to the towns of South Lancashire by means of the Liverpool Corporation and other tramways, and recommends that a committee be appointed to consider the details of the scheme, and with authority to take such action in the matter as they in their opinion may think desirable in the interests of the scheme." The appointment of a committee consisting of 23 members was also agreed to.

Scarborough.—The Scarborough Corporation, who have leased their streets to a syndicate for the purpose of tramways, have now under consideration the question as to whether they shall pave their streets with wood or not. The middle of the tramway and a certain distance at either side are to be laid with wood by the company, and a sub-committee of the Corporation recommended that this style of paving should be carried to the full width of the road by the town authority. The Town Council in committee have, however, declined to adopt the suggestion, and if this decision be upheld at the monthly meeting macadam will be used on the Corporation part of the roads. Financial considerations, it is stated, are mainly responsible for the decision. The sub-committee have now received the report of the deputation which has visited several towns where electric tramways are in operation with a view of studying the different modes of paving employed in the streets.

Birmingham.—The Tramways Committee have issued a long report which is to be considered at the meeting of the City Council on Jan. 6. They state, in short, that they have received from Mr. Emile Garcke, as representing the City of Birmingham Tramways Company and the Birmingham and Midland Tramways Company, overtures for an arrangement between the companies and the Corporation for the immediate improvement and future working of those tramways; but, inasmuch as the Council determined that on the expiration of the existing leases they would themselves work the tramways within the city, the committee are prevented from considering or reporting upon any such proposals. As they consider that under present circumstances any proposals made by the companies should receive the careful consideration of the Council, they recommend that, notwithstanding anything contained in any minute of the Council, they be authorised to consider the proposals, to confer with the companies, and to report their recommendations.

LIGHTING AND GENERAL.

St. Marylebone.—The Guardians have sealed a contract with the telephone exchange.

Ainsdale.—The National Telephone Company are making enquiries as to a suitable exchange for Ainsdale.

Batley.—The electric generating station is now practically completed, and a good local support appears assured.

Hungerford.—A movement is started whereby it is hoped to secure telephonic communication for Hungerford.

Southwell.—The Parish Council have arranged to meet the Derbyshire and Notts Electric Power Company's representatives.

Hackney.—The plant mentioned in our last issue includes a 1,500-kw. set, and we learn that tenders will shortly be advertised.

Change of Address.—The office of the electrical engineer of the Bradford Corporation has been removed to Whitaker-buildings Victoria-square.

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Ramsgate.—Mr. Ritson's report on the supply of electricity for lighting purposes is to be submitted in the early part of January.

Kingston (Surrey).—We understand that Mr. Henry R. J. Burstall has been asked to report upon the Corporation's electricity undertaking.

Glasgow.—Mr. W. A. Chamen, city electrical engineer, delivered a lecture in the Berkeley Hall on Friday on the electricity supply of the Corporation.

Swiss Plant.—Escher, Wyss, and Co. have, we understand, been the successful tenderers for the three 10,000-h.p. turbines for the Niagara power plant.

Kirkdale.—Messrs. W. M. Herd and Co., electrical engineers, Cheapside, have completed an installation in the Mersey Assembly Rooms, Great Mersey-street.

Llandudno.—Mr. Daniel Hughes, acting switchboard attendant, has been appointed second assistant engineer, to take alternate duty with the first assistant engineer.

Croydon.—A cooling tower is to be erected in substitution for the present cooling pond in the yard at the rear of the station. The cost of this tower is estimated at £640.

Chester.—The Lighting Committee propose to purchase from Messrs. Mather and Platt, of Salford, an engine and dynamo, erected at the electric light station, for £2,570.

Morecambe.—A cable is to be laid to Green-street Wesleyan Chapel. An application from Mr. Toft for his son to be apprenticed for two years to the electrical engineer has been agreed to.

Wall Calendar.—We have received from the United States Metallic Packing Company, Limited, Soho Works, Bradford, Messrs. Beck and Inchbold's date pad (printed in very conspicuous type).

"The World's Work."—No. 2 of "The World's Work," edited by Henry Norman, M.P., fully bears out the promises implied by the excellency of get-up and literary matter contained in the initial issue.

Chalfont.—The Uxbridge Electric Supply Company has been granted permission to extend their area into the Amersham rural district with the object of supplying Chalfont St. Peters and Chalfont St. Giles.

Crystal Palace School of Practical Engineering.—Mr. W. H. Maw, president of the Institution of Mechanical Engineers, presided on Thursday last week at the distribution of certificates to the students of this school.

Stock Exchange.—The Stock Exchange Committee have ordered the Electrolytic Alkali Company's 29,233 vendors' ordinary shares of £1 each, fully paid, Nos. 35,000 to 58,146 and 68,914 to 75,000, to be quoted in the official list.

Johannesburg.—A report is before the Town Council recommending the laying down of 23 miles of double-track electric tramway and new lighting plant. The total capital required for the combined undertaking is £1,240,000.

London Gazette.—The partnership existing between L. Marston and Reginald Jones (trading as Marston and Jones), electrical and mechanical engineers, 68, Birmingham-road, West Bromwich, has been dissolved by mutual consent.

Kirkcaldy.—The Tramways and Electric Lighting Committee have resolved to recommend the Council to oppose the Bill proposed to be promoted in next session of Parliament to constitute a company with powers to supply electric energy in Fife.

Norwich.—The Town Council are purchasing for £1,500 the five cottages and blacksmith's shop and the land adjoining the electricity works, and will also complete the purchase of the Norwich Electricity Company's undertaking by Jan. 31, 1903.

Cupar.—The Town Council have decided with regard to the Fife Electric Power Company's proposed provisional order that the other burghs in Fife should be communicated with, and that the opinion of the town's parliamentary agents be obtained.

Dewsbury.—Messrs. D. Firth and Sons, Manchester, have just completed an installation of electric light at the infirmary. Mr. Campion, borough electrician, has undertaken to make all connections in time for the light to be used on Christmas Day.

Camborne.—Up to the present only a few of the leading business houses have been lit electrically, although a large number of orders have been taken by the company. Now 170-c.p. Nernst lamps will be erected at the Redruth Brewery Company's stores.

Institution of Civil Engineers.—The next paper will be "Electric Automobiles," by Mr. H. F. Joel, A.M.I.C.E. At a students' meeting on Dec. 19 a paper was read on "Electricity Supply from Double-Current Generators," by Mr. P. R. Wray, Stud.Inst.C.E.

Carmarthen.—The Carmarthen electric lighting scheme, for which a Bill is now being promoted in Parliament, has been referred to the following committee: The Mayor, Mr. H. B. White, Mr. W. V. H. Thomas, Mr. E. Colby Evans, Mr. D. E. Stephens, and Mr. Soppitt.

Alsager.—The Urban District Council will take no action at present with regard to the Electric and Gas Power Supply Syndicate's application for a provisional order for power to supply the whole of Cheshire and neighbouring counties, including the greater part of North Staffordshire.

Newport (Mon.).—Steady progress is being made with the new electric power station in Corporation-road, and the first double set of furnaces has been lighted up. The furnaces will supply the steam power for driving the great engines by which the electricity will by-and-by be generated.

Wandsworth.—At a recent meeting of the Borough Council, the question of adopting electric lighting was under consideration. The County of London and Brush Provincial Electric Lighting Company had offered to supply current for all-night arc street-lighting at 2d. per unit. The offer was declined.

Luton.—The electrical engineer in his last report stated that since Oct. 10 last 22,000 units had been generated; an equivalent of 490 8-c.p. lamps connected, making a total of 84 consumers with 6,133 lamps and seven motors of 25 h.p.; and that at present there were 280 additional lamps being wired.

Hull.—A sub-committee of the Corporation Telephone Committee has visited Tunbridge Wells and Portsmouth for the purpose of obtaining further information with reference to the establishment of a municipal exchange in Hull. Mr. Bennett is preparing a report for presentation to the full committee.

Galloways, Limited.—The directors of Galloways, Limited, Manchester, have declared a final dividend at the rate of 5 per cent. per annum on the preference shares. Warrants in respect of this dividend and for half-year's interest on the 4 per cent. first mortgage debenture stock of the company will be posted on Dec. 30.

Hove.—Mr. Williams has held an enquiry on behalf of the Board of Trade into an application of the Hove Electric Lighting Company, Limited, for permission to charge the standard of electrical pressure for lighting purposes within the company's area of supply from 110 volts to a uniform pressure of 220 volts to all consumers.

Electric Fire Pump.—An electric fire pump is in use in Rouen. The idea is to obtain current for operating the motors from adjacent electric tram cables. The whole machine can be placed on a hand-cart, or on a little two-wheeled wagon drawn by one horse. Its total weight, with accessories, and two men on the seat, is about a ton.

New Cruiser.—The London and Glasgow Engineering and Shipbuilding Company last week launched from their yard at Glasgow the first-class cruiser "Cumberland," of the County type, for the British navy. A special feature of the new cruiser is the ventilation of the machinery spaces, the old arrangement being displaced by electric fans.

Nottingham.—At the last meeting of the Nottingham and District Guild of Engineers, Mechanics, and Electricians, a lecture on coal mining was given by Mr. Herbert Perkin, M.I.M.E., lecturer in mining and mine surveying at the Huddersfield Technical College, and assistant lecturer in the mining department at the Yorkshire College, Leeds.

Aberdeen.—At a smoking concert last week the employés of the Corporation electricity works presented Mr. Charles M. Henderson, assistant engineer, who is leaving to fill an appointment in the British Westinghouse Company, Limited, with a lithographed address, a photograph of the staff, and an album containing views of Dee Village works from the commencement.

Hawick.—At the half-yearly meeting of the council of the South of Scotland Chamber of Commerce last week, the Chairman intimated that he had had an interview with Mr. Austen Chamberlain, Postmaster-General, anent underground telegraphs, who had assured him that the underground system would be carried to Edinburgh and Glasgow whenever sufficient funds could be devoted to that desirable object.

Bo'ness.—The Town Council at a recent special meeting received a deputation from the ratepayers in the east ward, some misunderstanding having arisen in reference to the provisions of the proposed scheme for the lighting of the burgh by electricity. This having been satisfactorily explained, the Town Council decided that application be made to the Board of Trade under the Electric Lighting Act by way of a provisional order.

German Cartels.—The *Morning Post's* Berlin correspondent telegraphs that the Allgemeine Electricitäts-Gesellschaft, which has a capital of about 88,500,000 marks, and the Union Gesellschaft, with a capital of 34,000,000 marks, have been amalgamated. The last German advices discredit a similar statement made a week ago, stating that no amalgamation took place, but hinting at a kind of pool as far as orders are concerned between the five big German companies.

Chesterton.—The Rural District Council have consented to the grant by the Board of Trade to the Cambridge Electric Supply Company, Limited, of a provisional order under the Electric Lighting Acts 1882 and 1888, and the Electric Lighting (Clauses) Act, 1899, for the supply of the parishes of Cherryhinton, Coton, Fen Ditton, Girton, Grantchester, Great Shelford, Histon, Impington, and Trumpington, all within the Chesterton rural district and in the county of Cambridge.

Huddersfield.—The Mayor (Alderman F. Calvert) has been appointed chairman and Councillor Longbottom deputy-chairman of the Electricity Committee. The total number of consumers is 1,695, and the number of lamps connected 112,767, increase on the month of 22 and 1,995 respectively. The units metered during November represented an increase on the year of 10 per cent. Sanction has been obtained to the borrowing of £5,000 for the purchase of motors and appliances.

Bradford.—The Electricity Committee are trying to arrive at the cost of electricity, and there is a difference of opinion as to what should be written off by way of depreciation, etc. It is estimated by Mr. Chattock, the engineer, that the cost to the committee is 1¼d. per unit, and at present current is being supplied to the Tramways Committee at 1d. per unit, which is below cost. There is, therefore, a feeling in favour of increasing the charge to the Tramways Committee.

Uxbridge.—At the last meeting of the Rural District Council a letter was read from the resident engineer of the General Post Office stating that no undertaking could be given to put up ornamental poles throughout the district, but in such places as Hallowell-road, Northwood, ornamental poles would be erected. As to the application of the Council for a rent of 1s. per pole per annum, the letter pointed out that the Postmaster-General had a statutory right of the use of the public roads.

Fire Laws.—The Society of Arts have awarded the prize of £50, together with a silver medal, offered for an essay on "Existing Laws

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By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions," to Mr. T. Brice Phillips, sanitary inspector to the Uckfield Rural District Council; a prize of £10, with a bronze medal, to Mr. George H. Paul; and a similar prize to Mr. W. Craig Henderson. They have accorded honourable mention to the essay of Captain Arthur W. C. Shean.

Coventry.—A decided financial improvement was shown in the half-yearly report of the Coventry electric light undertaking, which has just been presented to the committee. The trading for the half-year ended Sept. 30, as compared with the same period of 1901, shows a saving of £941. In other words, the demand on the rate is £1,082, instead of £2,023, and considerable economies have been effected. The cost of manufacture has been reduced from £2,151 to £1,572, and some 36 per cent. more current has been sold.

Glamorgan.—The Postmaster-General having informed the County Council that he had granted a license to the Swansea Corporation to erect telephones within an area surrounding the borough, subject to the consent of the County Council, the County Council have decided that the Corporation be informed that in considering any application they may make for such license it will be a condition that where there are already two lines of poles on any road, the Corporation's wires must be carried by arrangement on one or other of such lines of poles.

Bolton.—At the last meeting of the Electricity Committee a letter was read from Messrs. Greenhalgh and Shaw enquiring whether the committee would be willing to supply alternating current for the purpose of driving their works, and it was resolved that the representatives of the firm be interviewed on the matter. The committee also considered an application from the Bolton Iron and Steel Company for the supply of electricity for night lighting at their works, and the company was informed that the committee would be prepared to supply electricity on terms stated.

Wellingborough.—The electric light cables were tested about a fortnight ago with satisfactory results, and last week the current was turned on for practical use by all who are at present connected with the mains. The supply lasted between the hours of dusk and midnight, and this course is being resorted to until the completion of the storage batteries, when the supply will be available throughout the 24 hours. The street-lighting scheme is to be commenced almost immediately, and will probably be finished by the time the arrangements at the generating station for giving a permanent supply to the town are complete.

St. George's (Hanover-square).—The special committee of the Board of Guardians *re* installation of electric light at the Fulham-road Workhouse reported at the last meeting of the Guardians that in accordance with the authority given to them by the Guardians they had engaged Mr. Thomas J. Digby, electrical engineer, of 32, Shaftesbury-avenue, to report as to the installation of electric light. The committee had also agreed with Mr. Digby that, in the event of the Guardians appointing him to superintend the installation of electric light at the workhouse, the fee should be merged in his commission on the total expenditure incurred.

Wimbledon.—Mr. H. A. Nott, of Motherwell, N.B., has been appointed mains superintendent at a salary of £120 per annum, rising by annual increments of £10 to a maximum of £150 per annum, it being understood that he devotes the whole of his time to the duties of the office. The Council will supply the London and South-Western Railway Company for the purposes of lighting Wimbledon Station with electrical energy in bulk for the purposes named at a flat rate of 3d. per Board of Trade for a minimum consumption of 50,000 units per annum. Tradesmen who desired to have "shows" at Christmas time will be supplied at the rate of 2d. per unit.

The "Smart Set."—There are 50 items in the table of contents of the January number, and the sum total of merit in these, in stories, verses, and humour, both explains and justifies the magnificent success of the magazine. "The Lieutenant-Governor," by Guy Wetmore Carryl, is a well-drawn picture of what the tyranny of unions may lead to in the U.S.A.—or elsewhere. The speed of the automobile per hour is given by H. Jansenale as follows: chaffeur's private opinion, 12 miles; chauffeur's opinion for his friends, 20; policeman's private opinion, 14; policeman's opinion for the judge, 28; lady's opinion who was knocked down, 50; actual speed, 8.

Hereford.—All Saints' Church is now entirely lighted by electricity. The supply is from the Hereford Corporation works, and there are altogether 77 lamps. The specifications were prepared by Mr. F. G. Poulton, A.M.I.E.E., the city electrical engineer, and the work undertaken by Messrs. Edwards and Armstrong, Hereford. The fittings, which were handsomely designed in wrought iron and hammered copper, were manufactured by Messrs. Edwards and Marsden, Birmingham. The work was carried out under the supervision of Mr. G. H. Watson, the Hereford manager for Messrs. Edwards and Armstrong. The cost of the undertaking has amounted to about £160.

Greenock.—Mr. James Robertson, who has been appointed to succeed Mr. Nelson as Corporation electrical engineer, enters on his duties at the close of the New Year holidays. Mr Robertson served his apprenticeship as a mechanical engineer with Messrs. J. and H. Wilson, Liverpool. His electrical experience includes service in the Liverpool electrical supply stations and as chief assistant to the electrical engineer of Stirling. He was also in the service of Messrs. Mavor and Coulson, Glasgow, and was for 4½ years in charge of the whole of the electrical plant of Messrs. Kelvin and James White, Limited, Glasgow, and is at present chief electrical engineer to Messrs. Denny and Co., Dumbarton.

Ashton-under-Lyme.—Since Mr. Appelbee became electrical engineer at the Ashton Corporation electricity station the Corporation have, says the *Herald*, had the opportunity of admiring in him, by practical results, the qualities of a valuable public servant. He has done Trojan work in "licking into shape" the state of the works as an economically running establishment, and has saved the department large sums of money. This fact is showing itself in the improving finances of the Electricity Committee. With the object of securing to themselves Mr. Appelbee's assistance for some time to come, the committee propose presenting to him a "New Year gift" of an advance of his salary by £100 per annum, on the condition that he will remain in the service of the committee for at least two years. The committee are unanimous on the point that the £200 is a splendid investment.

Tiverton.—Ratepayers, says the *Western Mercury*, are up in arms against the Town Council for their objection to the offer made by Messrs. Christy Bros. to instal the electric light in the town upon most advantageous terms. The Council have instead, by a bare majority of one, adopted the scheme of their borough accountant, and the ratepayers, now paying 6s. in the £, are strongly adverse to the increase which the Council's decision threatens. The two schemes are almost identical in their details, but Messrs. Christy undertake the management for 21 years, guarantee the town from any loss, including the payment of interest and sinking fund, and when the undertaking pays a profit they promise to share the profit with the Council. A requisition, signed by a numerous and influential body of townspeople, has been presented to the Mayor, and he has called a public meeting for the 29th inst., when the Council's action will be discussed and probably condemned.

Brighton.—The Telephones Committee have presented a report in which they recommend that Brighton should start without delay to establish a municipal telephone system in Brighton, Portslade, Southwick, Shoreham, and Burgess Hill, ignoring Hove, Hassocks, Steyning, and Rottingdean for the present. The proposed switchroom was to be on the site at the Pavilion granted by the Council. The total amount of the tenders for the several works included in the scheme was £15,333. 5s. 11d., which, added to the estimated cost of erecting overhead work and fixing subscribers' instruments—to be done by Corporation employés instead of by tender—makes the actual cost of the work in the smaller areas £19,989. 16s. 8d. The committee recommended that the work be put in hand forthwith. It was anticipated that when Hove saw the advantages of the Brighton municipal system, it would show more disposition to give facilities for extension to that town.

Fleetwood.—The Finance Committee of the Urban District Council have received the following letter from the National Telephone Company, Limited, with reference to the recent correspondence as to delays on trunk telephone calls to and from Fleetwood, Blackpool, etc.: "London, E.C., Nov. 28, 1902.—With reference to your letter of the 13th inst., I have now made enquiry into the statement of the Post Office with reference to the inadequate number of the company's junction circuits between Fleetwood and Blackpool, and I find that on the representations of the Post Office instructions were given for an additional junction circuit between these places to be erected, and, in the opinion of the company's officers, the junction accommodation is now quite sufficient for present requirements. The company's officers are, however, keeping the matter before them, and if it is found that further lines are required, they will, of course, be erected.—Yours truly, (signed) W. E. GAINE." The committee recommended that a copy of the letter be sent to the Postmaster-General for his information.

Cardiff.—Mr. Ellis reported that last month 168,882 units were generated for private consumers, as compared with 123,951 units in the same month last year, an increase of 36 per cent. The revenue from this source last month was £1,596. 14s., as against £1,148 in November, 1902. Slot meters are to be offered consumers at the rate of 6d. per unit, meter rent included. The Cardiff Railway Company have declined the rates offered by the Corporation for supplying electricity to the Bute Docks. On the other hand, it is stated that so many applications for the installation of electricity are being received by the Corporation from private consumers that the electrical department is finding it difficult to cope with the demand. Respecting the negotiations with the Guardians for an installation at the workhouse, a charge of 3d. per unit for an annual consumption of 25,000 units is proposed, with an additional charge of ½d. per unit for every 1,000 units below that figure, all units for the first, second, and third quarters to be charged at 3d. per unit, and at the end of the year, should the consumption not reach the minimum, the account to be adjusted according to the scale. At a meeting of the Cardiff Property Committee on Wednesday it was agreed to let the unoccupied portion of the basement of the Cardiff Fish Market to the Electric Lighting Committee for the purpose of an electric storage battery at £143 a year.

Electricity in the Dockyards.—A very comprehensive scheme for improving the Government dockyards at home and abroad is referred to in the *Glasgow Herald*. It includes equipment with electric power plant, so that all the machinery, which is to be considerably augmented, will be driven by electric power. Sir William Preece and Major Cardew have elaborated the whole scheme, which is now under the consideration of the Admiralty, and will be put in hand probably during the next year. At present consideration is being given to the question of meeting the outlay, and it is not improbable that this will be arranged by a special vote rather than by the inclusion of this extraordinary expenditure in the navy estimates. In conjunction with this electrification of the dockyards, it is the intention to organise a separate electrical department for the Admiralty, with electrical engineers for each of the dockyards. This had become imperative owing to the very extensive amount of electrical work now carried out in connection with new ships and with the refitting of old vessels, for although the constructive department may have several members who are more or less in touch with modern electrical progress, it is recognised as impossible for anyone but an expert to realise the very best conditions now obtainable in electrical practice. Moreover, the arrangement of a new department will result in work being very considerably expedited, and this is an important point, conducive not only to ultimate efficiency but also to economy.

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YORK ELECTRICITY WORKS.

Appended we give an analysis of the accounts of the York Corporation undertaking for the year ended March 31 last: The capital expenditure on that date last year stood at £31,362, as compared with £55,832 on March 31 this year. Total revenue in 1900-1 amounted to £3,802; in 1901-2, £6,110; total costs, £2,276—£3,518; gross profit before for providing for interest and sinking fund, £1,526—£2,591; percentage of gross profit to capital (being outlay during the year averaged), 5½ per cent.—6¼ per cent.; interest on loans, £850—£1,281; sinking fund, £266—£960; percentage of sinking fund to capital (outlay during the year being averaged), 1 per cent.—2·7 per cent.; financial result after payment of all charges, including interest and sinking fund—income, £409—£349; capacity of dynamos (March 31), 400 kw.—720 kw.; maximum load reached, 271—410; load factor, 10·02 per cent.—11·8 per cent.; number of 8 c.p. lamps connected (March 31), arcs, incandescents, and motors (equivalent in 8-c.p.), 16,476—32,766; number of units sold, 222,369—423,000; units sold per 8-c.p. lamp (connections during year being averaged), 19·7—19·9; price charged—private lighting 7d. and 3d.—7d. and 1½d., public lighting £20 per arc per annum—£20 per arc per annum, power and heat 3d.—1½d.; average price obtained—private supply 4·47d.—3·60d., public supply 1·9d.—2·7d. Nothing was charged to consumers for meter rents.

Analysis of Costs.

Generation, etc.	1900-1.	Per unit.	1901-2.	Per unit.	Difference.
Coal and other fuel ...	992 3 9	1·07	1,257 18 5	·71	– ·36
Oil, etc., and stores ...	121 13 11	·13	283 7 9	·16	+ ·03
Wages of workmen ...	353 9 1	·38	449 1 9	·28	– ·10
Repairs, etc., of buildings and plant	251 0 7	·28	461 6 10	·26	– ·02
Works costs	1,728 7 4	1·86	2,501 14 9	1·41	– ·45
General costs.					
Rents, rates, and taxes	51 16 10	·05	238 13 1	·130	+ ·08
Management expenses.	496 5 5	·54	778 1 0	·44	– ·10
Total costs.....	£2,276 9 7	2·45	3,518 8 10	1·98	– ·47

Financial Result for 1900-1901.

Gross profit on year's working	£1,526	5	10
Less interest, £850. 4s. 6d.; sinking fund, £266. 6s. 1d.	1,116	10	7
Income for year.....	£409	15	3

Financial Result for 1901-1902.

Gross profit on year's working	£2,591	15	10
Less interest, £1,281. 19s. 6d.; sinking fund, £960. 0s. 8d.	2,242	0	2
Income for year.....	£349	15	8

PROVISIONAL PATENTS, 1902

DEC. 10.

27184. Improvements in devices for operating electrically the points on electric tramways and railways. Joseph Patrick Tierney and John Malone, 44, Booterstown-avenue, Booterstown, co. Dublin.

27232. Improvements in and relating to rotary electric contacts for high-tension circuits. Francis Claude Blake, 60, Queen Victoria-street, London.

27237. An improved electrical connection fitting for use in conduit boxes and the like. Gustav Byng and Henry Alfred Casperd, 71, Queen Victoria-street, London.

27239. A new or improved combined electric incandescent lamp holder and switch. Frederick John Riddall, 77, Chancery-lane, London.

27247. Improvements in or relating to dock standards used in electric traction. Edwin John Smallcombe, 99, Cannon-street, London.

27253. Improvements in apparatus for selective electric signalling. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (John Stone Stone, United States.)

27265. Improvements in or relating to electric storage batteries. Walter Charles Head, 173, Fleet-street, London.

27272. Improvements in the method of selective electric signalling. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (John Stone Stone, United States.)

27274. Improvements in apparatus for indicating at a distance the position of a magnetic needle principally for use with "tell-tale" compasses. Adolf Pieper, 18, Buckingham-street, Strand, London.

DEC. 11.

27284. A new method of retarding the back running of electric tramcars. Charles Henry Spencer, Sunbridge-chambers, Bradford.

27295. Improvements in apparatus for amplifying electromagnetic signal waves. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (John Stone Stone, United States.)

27301. Improvements in the method of amplifying electromagnetic signal waves. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (John Stone Stone, United States.)

27303. Improvements in apparatus for cleaning the grooves of electrical tramway rails and for facilitating the passage of the electric current. Alfred Thomas Meldrum Mather, 41, Reform-street, Dundee.

27322. Improvements in electric switches. Henri Pieper, 24, Temple-row, Birmingham.

27369. An improvement in synchronism indicators for use in connecting alternate-current or polyphase dynamo-electric machines in parallel. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany). (Complete specification.)

27373. A new or improved galvanic cell. George Pearson and Lothar Fiedler, 70, Chancery-lane, London.

27374. A new or improved electrode for galvanic cells and a method or process for producing same. George Pearson and Lothar Fiedler, 70, Chancery-lane, London.

DEC. 12.

27397. Improvements connected with trolley poles of electric cars or locomotives. John Samuel Rigby and Edmund Gormly, 15, Water-street, Liverpool.

27443. Improved switchboard for effecting telephonic intercommunication. John Young, 21, Gloucester-walk, Campden-hill, Kensington, London.

27472. An improvement in cooling devices for continuous-current dynamo-electric machines. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany). (Complete specification.)

27476. Improvements in or relating to electric railway or tramway traction. Wilfrid Swanwick Boult and Cedric Randal Boult, 111, Hatton-garden, London.

27486. Improved means for controlling or regulating the supply of electricity in installations subjected to considerable fluctuation in the demands thereon. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Elektrizitäts Actien-Gesellschaft vormals W. Lahmeyer und Co., Germany.)

DEC. 13.

27497. Improvements in watertight cases for electric bells and telephones. Lancelot Walter de Grave, 9, Iron-gate, Derby.

27540. Improvements in or relating to arc lamps. Tito Livio Carbone, 322, High Holborn, London.

27557. Improvements in and relating to electrical resistances. Robert Martin and Porzellanfabrik Kahla Filiale Hermsdorf-Klosterlausnitz, 27, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 1, 1903.

1902.

239. Electrical transformers for polyphase currents. Berry and British Electric Transformer Manufacturing Company, Limited.

1104. Dynamo-electric machinery. Soar

1688. Electrolytic separation deposit and refining of zinc. Paweck.

21732. Telephone signalling systems. Ekström.

22532. Incandescent electric lamps. Rooney.

22615. Insulated connectors for electric cables. De Grave.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	1/16-3/16
British Insulated and Helsby Cables, Ord., 1-70,000	5 ..	7½-8
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	103-106
—— (1902 Issue)	100 ..	100-103
British Westinghouse Elec. and Manuf., 6 per cent. Pref...	5 ..	6-6¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	102-104
Brush Electrical Engineering, Ordinary, Nos. 1-105,731....	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	100-103
—— 4½ per cent. 2nd Debenture Stock	100 ..	93-98
Callender's Cable, Debentures	100 ..	109-113
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	2¼-3
—— 5 per cent. Debentures	100 ..	101-106 p.c
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	74-78
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1½
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102

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Name.	Amount paid.	Last price.
	£	£
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10½
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16½-17½
—— 4½ per cent. Preference	5	5½-5¾
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	14½-15½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105

Electric Lighting and Supply.—

Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	110-113
Bournemouth and Poole, Ordinary	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	10-11
—— Debenture Stock, Red.	100	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	101-104
Brompton and Kensington, Ordinary	5	10-10½
—— 7 per cent. Preference	5	10-10½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	6½-7½
—— Nos. 20,001-30,000	5	6½-7½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½
—— " " " £10 Ord.	6	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	105-108
Charing Cross and Strand	5	9½-9¾
—— Nos. 50,001-70,000	5	8-9
—— 4½ per cent. Cum. Pref.	5	5½-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4¾-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	103-106
Chelsea Electricity Supply	5	5½-6
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	9½-10½
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	124-129
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104-107
County of London and Brush Provincial, Ordinary	10	3⅝-9½
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6½-6¾
—— 6 per cent. Cum. Pref.	5	6-6½
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	3½-4½
—— 5 per cent. Debenture Stock, Red.	100	99-102
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	6-6½
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	3	1¾-2¼
—— 6 per cent. Pref.	5	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	95-98 xd
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	109-114
—— 5½ per cent. Mortgage Debenture, Red.	100	99-102
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6½
Notting Hill Electric Lighting	10	14½-15½
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	101-104
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	3-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8½-9½
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	3	3¼-4¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	3	3¼-4¼
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	5	6-6½

Name.	Amount paid.	Last price.
Electric Railways.—	£	£
Central London, Ordinary	100	106-109
—— 4 per cent. Pref.	100	105-108
—— " " deferred	100	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-119
City and South London, Consolidated Ordinary	100	75-76
—— 4 per cent. Debenture Stock	100	115-116
—— 5 per cent. Pref. Stock '91	100	128-131
—— " " " '96	100	127-130
—— " " " '01	100	123-127
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	93-96
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	4¼-4½
—— Permanent 5 per cent. Debenture Stock, 1888	100	127-132
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3¼-3⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,500	10	9½-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12⅜-13¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12-12½
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅜-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-400,000	1	2½-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	4¾-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14⅛-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	95-98
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4¼-4⅜
—— 4 per cent. Debenture Stock	100	95-98
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10	11⅛-12
—— " " " " "	10	11⅛-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	105-107
—— " " Prov. Crts.	100	105-107
New General Traction, Ordinary	5	2-3
—— 6 per cent. Cum. Pref.	10	2½-3½
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	93-98
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11½-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 26,667-40,000	10	8¼-9⅜
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	18s.	14/16-15/16
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	90 p.c.	90 p.c.
Telephones.—		
National Telephone, Preferred	100	92-94
—— Deferred Stock	100	62-64
—— 6 per cent. Cum. First Pref.	10	12½-13½
—— 6 per cent. Cum. Second Pref.	10	11½-12¾
—— 5 per cent. Non. Cum. Third Pref.	5	5-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	95-98
—— 4 per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	⅞-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1902.	1901.	Week.	Current year.	1901.	1900.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 29	839	628	+ 211	+ 6,630	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Birmingham Tramways	Dec 13	4,649	4,201	+ 448	+17,572	6¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	23½	—	Mar. 31	31,593	6,456,361	—	1·17	—	1,342	—
Blackburn Corporation	,, 19	648	587	+ 61	+ 3,974	24	—	—	26,064	—	738,557	—	11·86	1,085	—
Blackpool Corporation	,, 18	260	202	+ 58	+ 434	16½	—	Mar. 31	41,818	5,809,190	758,563	1·73	13·2	2,538	—
Blackpool-Fleetwood Tramways	,, 20	145	140	+ 5	+ 160	16½	—	Dec. 31	31,391	1,902,692	569,827	3·96	13·20	1,900	7·25
Bolton Corporation	,, 14	1,459	1,305	+ 152	+ 4,611	32	—	—	77,274	15,828,933	1,705,580	1·17	10·86	2,420	—
Bradford Corporation	—	—	—	—	—	61	—	Mar. 31	70,213	—	1,530,531	—	11·00	1,150	7·57*
Bristol Tramways Company	,, 19	4,343	3,854	+ 489	—	51½	49	Dec. 31	210,112	36,714,906	5,462,039	1·37	9·25	4,080	6·31
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	8,675	2,010,873	323,044h	1·03	6·46	—	4·65
Central London Railway	,, 13	7,329	6,858	+ 471	+12,225h	12	12	,, 31	335,086	41,188,389	1,243,730a	1·88	64·29a	27,923	34·89a
City and South London Railway	,, 21	3,399	3,242	+ 157	+22,283	12½	9½	,, 31	62,601a	7,008,842a	1,234,730	2·15	—	5,010	—
Cork E. T. and L. Company	,, 18	391	343	+ 47	+ 5,971	15	13·69	—	23,921	5,714,325	855,332	1·00	6·71	1,590	—
Darwen Corporation	—	—	—	—	—	7½	5½	Mar. 31	10,470	2,114,983	217,891	1·19	11·53	1,398	12·56
Darwen-Hoddlesden	—	—	—	—	—										
Dover Corporation	,, 13	149	167	− 18	+ 17	4½	—	,, 31	11,864	2,905,823	270,533	0·979	10·53	2,630	9·65
Dublin & Lucan Electric Railway	,, 14	75	70	+ 5	+ 93h	6¾	6¾	Dec. 31	5,553	362,484	101,464	3·68	13·20	823	8·08
Dublin U. T., electric cars	,, 12	3,227	3,285	− 58	+2,857	46	46	,, 31	246,255	45,813,734	6,670,000	1·29	8·89	5,350	5·71
Dublin S. District, Electric	,, 12	684	690	− 6											
Dundee City Tramways	,, 3	814	667	+ 147	—	22	—	May 15	26,058	6,393,412	446,350	0·98	14·0	1,180	—
Glasgow Corporation	,, 13	11,516	10,189	+1,327	+ 5,625	104	95	,, 31	582,146e	155,243,378	11,935,099	0·90	11·71	5,587	7·51
Halifax Corporation	—	—	—	—	—	27½	18½	Mar. 31	54,969	13,173,924	1,063,764	1·00	12·4	1,960	9·67
Huddersfield Corporation	,, 20	998	868	+ 130	—	48	48	Sept. 30	29,061h	4,649,813	626,031	1·5	11·14	600	11·29
Hull Corporation, E. S.	,, 20	1,722	1,650	+ 72	+ 2,960	19	9½	,, 30	72,331h	17,264,013	1,647,026	1·00	10·54	3,810	4·72
Liverpool Corporation	,, 6	9,032	8,817	+ 215	+36,487	93	78	Dec. 31	87,707	21,065,939	2,218,696	1·11	9·49	5,004	5·07
Liverpool Overhead Railway	,, 21	1,511	1,425	+ 86	− 496	15½	15½	June 30	69,152	8,426,976	787,010a	1·97	21·07a	4,450	15·94a
Newcastle-on-Tyne Corporation	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	—	—	—	—	—	29	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 21	3,939	—	—	—	46¼	—	Mar. 25	191,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82f
Southampton Corporation	,, 18	826	723	+ 103	—	11	—	,, 31	28,973	4,761,149	696,159	1·45	9·95	2,630	—
Sunderland Corporation	,, 14	962	999	− 37	—	19	17	,, 31	57,307	13,569,808	1,170,207	1·01	11·75	3,360	6·31

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
h Half-year's figures. c Include rail and tram. d Total receipts. e Electric traction only. f Including one section of horse traction.

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